The Impact of Exchange Rate Volatility on Bank Profitability: *An Empirical Analysis of the Egyptian Banking Sector Before and After the Egyptian Currency Devaluation*[1]

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ABSTRACT

This study investigated the impact of bank-specific and macroeconomic factors on the profitability of 11 listed banks in Egypt, focusing on the periods before and after the currency devaluation in late 2016. Utilizing a dynamic panel data model and the Generalized Method of Moments (GMM) approach, the research analyzed the persistence of profits and evaluated the determinants of bank profitability from 2012 to 2022. Key findings revealed that the capital adequacy ratio had an insignificant effect on return on assets (ROA) across both periods, aligning with previous literature. However, liquidity risk exhibited a positive significant relationship with ROA post-devaluation, indicating that higher liquidity could enhance profitability under certain economic conditions. Revenue diversification consistently showed a positive impact on ROA, while operational efficiency negatively affected profitability throughout the study period. Additionally, the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model was initially used to measure exchange rate volatility; however, due to a lack of evidence of volatility, the real exchange rate was instead used as an independent variable, which demonstrated a shift from an insignificant to a significantly negative relationship with ROA after devaluation, highlighting increased sensitivity of bank financial performance to exchange rate fluctuations.

Keywords: Bank Profitability, Currency Devaluation, Egyptian Banking, Exchange Rate Volatility

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1. INTRODUCTION

Banks play a crucial role in promoting financial stability and economic growth by mobilizing resources across the economy. Consequently, a sound and profitable banking system enhances resilience against economic shocks. A gap has been identified in the recent literature to study how currency devaluation affects bank profitability and its determinants in Egypt. Although previous studies examined these determinants in different contexts, their results have varied. Given the history of changes in the exchange rate of the Egyptian Pound against the US dollar, including the recent currency devaluation in late 2016 and evolving regulatory frameworks, it is important to understand how these factors affect bank profitability in this context. A key contribution of this study is the measurement of exchange rate volatility using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model. However, the analysis revealed no significant evidence of exchange rate volatility. Therefore, the real exchange rate will be used as an independent variable to capture changes in the exchange rate and their effect on bank profitability. Moreover, given the significant devaluation of the Egyptian Pound in late 2016, the thesis investigates how such devaluation events affect the relationships between the identified variables in dynamic profitability models. To achieve this, the research employs a comparative analysis using the Generalized Method of Moments (GMM) model, dividing the sample period into pre- and post-devaluation phases (2012-2016 and 2017-2022). This comparative approach provides a comprehensive understanding of how Egyptian banks have worked through economic challenges and adapted to changes in policy. This study aims to address the identified gap by investigating the internal and external determinants of bank profitability in Egypt. The findings will contribute to the existing literature by providing empirical evidence on the specific dynamics of the Egyptian banking sector. The remainder of the research will be organized as follows: first, a literature review including previous studies; then the methodology section, which will describe the data, develop research hypotheses, and explain the analysis techniques. This will be followed by an analysis of the results and, finally, a conclusion.

2. LITERATURE REVIEW

2.1 Egyptian Banking Sector Overview

The Egyptian banking sector has been evolving significantly, playing a crucial role in the country's economy. Profitability in this sector is essential, as it provides a buffer against economic downturns and enhances resilience to negative shocks. This is particularly important in transitional economies like Egypt, where legal and macroeconomic frameworks are continuously being restructured to align with international standards set by the World Bank (WB) and the International Monetary Fund (IMF). A strong and resilient banking system is vital for maintaining financial stability, especially in economies dependent on commodities. Historically, Egypt's banking sector dates to 1856. Following the 1952 Revolution, the sector underwent nationalization, which led to the creation of major banking institutions, including the Central Bank and four public commercial banks, along with some specialized banks. However, in the mid-1970s, Egypt adopted the Open Door Policy, allowing foreign banks to operate within its borders. Despite this, no new commercial banking licenses have been issued since then. As a result, new banks, whether domestic or foreign, must acquire existing banks to enter the market, as seen with First Abu Dhabi Bank's acquisition of Bank Audi Egypt, Arab Banking Corporation's purchase of BLOM Bank, and Attijariwafa Bank's acquisition of Barclays Bank Egypt. In terms of ownership structure, the sector includes publicly owned, privately owned, and foreign banks, with most operating as commercial banks. Major public banks, such as Bank Misr, Banque du Caire, and the National Bank of Egypt, dominate the sector. Meanwhile, private banks, like Commercial International Bank (CIB) and Qatar National Bank (QNB) Al Ahli, mainly serve the private business sector and have expanded their retail services. As of December 2022, Egypt had 37 registered banks under the supervision of the Central Bank of Egypt (CBE), with 12 of them listed on the Egyptian Stock Exchange. This number decreased from 38 due to the merger of First Abu Dhabi Bank with Bank Audi Egypt.

2.2 Literature on Bank Profitability Determinants

Understanding the factors that influence bank profitability is essential for maintaining economic stability, as the health of the banking industry directly impacts the overall well-being of the economy. Extensive research across various countries and regions has examined these factors, generally categorizing them into bank-specific (internal) factors and macroeconomic (external) factors. Bank-specific determinants are basically the internal factors utilized to measure banks' profitability, including variables like asset size, capital adequacy, asset quality, liquidity, deposits, asset management, operating efficiency, financial risk, and branches. Macroeconomic variables encompass broader economic, industrial, and legal environments beyond the bank's control, such as economic activity, inflation, exchange rate, and interest rate. While bank profitability is usually measured by return on assets (ROA), return on equity (ROE), and net interest margin (NIM).

2.2.1Capital Adequacy Ratio

Previous studies have discussed capital adequacy or capitalization ratio as a crucial factor influencing bank profitability. A strong capital structure, as noted by Al-Homaidi, Tabash, Farhan, and Almaqtari (2018) and Hasanov, Bayramli, and Al-Musehel (2018), bolsters both profitability and resilience against financial instabilities. Specifically, capital adequacy is often measured by the percentage of equity to total assets (Al-Harbi, 2019; Al-Homaidi et al., 2018; Derbali, 2021; Hasanov et al., 2018; and O'Connell, 2022). Derbali (2021) states that a lower capital adequacy ratio indicates fewer resources available to the bank if assets face impairment, as demonstrated during the 2007-2008 Financial Crisis. Consequently, Pasiouras and Kosmidou (2007) argue that there could be a negative relationship between the capital adequacy ratio and bank performance. High capital-asset ratios suggest lower leverage and risk, which results in lower funding costs. However, well-capitalized banks, requiring less external funding, might experience increased profitability. Moreover, studies show mixed results regarding the impact of capital adequacy on profitability, influenced by performance measures and the country's context. For instance, Al-Homaidi et al. (2018) found that capital adequacy had an insignificant impact on profitability.

Conversely, Derbali (2021) revealed a negative significant relationship with bank profitability. On the other hand, Al-Harbi (2019), Hasanov *et al.* (2018), and O'Connell (2022), and Pasiouras and Kosmidou (2007) concluded a positive significant relationship between capital and bank profitability.

2.2.2Bank Size

One key question in the literature is whether bank size maximizes profitability. Bank size is important, as larger institutions generally benefit from economies of scale, which reduce costs (Boyd & Runkle, 1993). However, larger banks may also face inefficiencies or management challenges that could negatively impact profitability (O'Connell, 2022). Studies have shown mixed results: Hasanov *et al.* (2018) noted that larger, financially leveraged banks may be more vulnerable to risks from debt markets. Empirical evidence on this topic varies. For example, Al-Harbi (2019) and Pasiouras and Kosmidou (2007) found a positive and significant relationship between bank size and profitability, supporting the economies of scale hypothesis. In contrast, Dietrich and Wanzenried (2011) observed a negative relationship in Switzerland, where larger banks reported higher loan loss provisions and lower net interest margins during the financial crisis. Additional studies, including those by Adelopo, Lloydking, and Tauringana (2018), Al-Homaidi et al. (2018), Bucevska and Misheva (2017), Menicucci and Paolucci (2016), Mokni and Rachdi (2014), Noman et al. (2015), and Trad, Trabelsi, and Goux (2017) reported an insignificant impact on banks' profitability. Similarly, Al-Harbi (2019) and Derbali (2021) found a negative impact of bank size on profitability.

2.2.3 Liquidity Risk

Liquidity is crucial for assessing bank performance, as it determines a bank's ability to meet its commitments, primarily to depositors (Ongore and Kusa, 2013). Liquidity risk involves the possibility that banks may not have enough cash or borrowing capacity to cover withdrawals or new loans, potentially forcing them to pay high-interest rates for emergency funding (Chowdhury and Rasid, 2017). In developing countries, liquidity risk tends to increase during financial crises due to significant information asymmetry (Adelopo et al., 2018). It is important to mention the inverse relation between liquidity and liquidity

risk as high levels of liquidity implies lower liquidity risk and vice versa. Liquidity risk is measured in various ways, including the ratio of cash to total assets (Islam and Nishiyama, 2016), total loans to total assets (Menicucci and Paolucci, 2016), and total loans to customer deposits (Pasiouras and Kosmidou, 2007). Adelopo et al. (2018), Derbali (2021), and O'Connell (2022) found a negative relationship between liquidity and profitability, indicating that more liquid banks might hold higher levels of capital and risk. Menicucci and Paolucci (2016) observed an insignificant effect of liquidity on profitability as measured by ROA and ROE, but a significant positive effect on NIM. Also, Ongore and Kusa (2013) found no significant effect of liquidity on bank performance. Moreover, Islam and Nishiyama (2016) and Molyneux and Thornton (1992) found an inverse relationship between liquidity and profitability. Pasiouras and Kosmidou (2007) observed a positive impact of liquidity on domestic banks' profitability but a negative impact on foreign banks' profitability. Similarly, Al-Homaidi et al. (2018) reported a positive impact of liquidity on profitability, measured by ROE and NIM.

2.2.4 Operational Efficiency

Operational efficiency is another important internal factor impacting bank profitability. It is typically measured by the cost-to-income ratio, which reflects how well banks manage their expenses relative to their revenues. Higher cost-to-income ratios usually indicate inefficiencies, negatively affecting profitability (Dietrich and Wanzenried, 2011; and Pasiouras and Kosmidou, 2007). Furthermore, Trujillo-Ponce (2013) highlighted that technological advancements have improved banks' operational efficiency, leading to reduced expenses and increased profitability. According to Trujillo-Ponce (2013), a lower cost-to-income ratio positively impacts profitability, suggesting that better expense management enhances overall profitability. Conversely, studies Adelopo et al. (2018), Derbali (2021), Neves, Gouveia, and Proença (2020), Noman et al. (2015), and Rahman, Hamid, and Khan (2015) found a negative effect of operational efficiency on profitability, indicating that higher expenses decrease bank profits. Al-Homaidi et al. (2018) and O'Connell (2022) used the ratio of total operating expenses to total assets to measure operational efficiency and reported that

improved management and reduced operating expenses enhance efficiency; They found a negative relationship between operating expense management and bank profitability, emphasizing that better management should ideally lead to higher profitability.

2.2.5 Revenue diversification

Revenue diversification is a significant factor affecting bank profitability, though it has not been extensively covered in previous literature. Ahamed (2017) suggests that banks with diverse revenue sources can reduce income volatility and benefit from non-traditional financial activities. However, Trujillo-Ponce (2013) found that the impact of income diversification on profitability is ambiguous, as it could result from economies of scope but does not consistently show a positive effect on profitability. Trujillo-Ponce (2013) used the ratio of non-interest income to total operating revenues and found diversification to be insignificant for bank profitability. Kapaya and Raphael (2016) and Saona (2016) also reported a negative impact of revenue diversification, implying that banks may not benefit from diversified revenue sources. Similarly, Abobakr (2018) found a negative and significant relationship between income diversification and liquidity. In contrast, Ahamed (2017) found that non-interest income activities positively affect bank profits and risk-adjusted profits, particularly for foreign banks, though it had no effect on domestic banks' risk-adjusted profits. Sharma and Anand (2018) observed that banks with medium to large asset sizes benefit from diversification, improving returns and risk mitigation, whereas smaller banks face a diversification discount. Alper and Anbar (2011) and Rahman et al. (2015) concluded that revenue diversification has a positive and significant impact on profitability, as measured by ROA.

2.2.6 Real Exchange Rate

The exchange rate represents the value of a country's currency in relation to another currency. Exchange rate volatility directly affects banks engaged in foreign exchange activities. These activities involve assessing exchange rate behaviour and associated risks, impacting the bank's foreign currency liabilities and profitability. It is quite noticeable that most of the studies included in their macroeconomic variables inflation, GDP, money supply, and interest rates;

however, the number of studies that analyzed the exchange rate volatility wasn't as much; with that being said, Keshtgar, Eskandari, and Aghaei (2020) found that exchange rate volatility negatively impacts Iranian banks' ROE due to risks in foreign currency liabilities. Similarly, Al-Homaidi et al. (2018) concluded that a declining exchange rate negatively affects the profitability of Indian banks, measured by ROE, ROA, and NIM. Moreover, Trad et al. (2017) found a negative relationship between exchange rates and ROA. Caliskan and Silva Lecuna (2020) discuss that exchange rates have a significant influence on how well banks perform. Furthermore, it is sought that the degree the banks' profitability and liquidity could be affected by the exchange rate volatility is based on country specific factors, the degree of local currency deterioration against the foreign currencies, and the size of of foreign direct investments. Elhussein and Osman (2019) found an insignificant impact of exchange rate volatility on bank performance due to economic isolation of Sudan from international markets. Furthermore, Ademola, Olusegun, and Ogundipe (2016) observed that while exchange rate fluctuations insignificantly affect Nigerian banks' ROA, they significantly negatively impact the Loan to Deposit Ratio (LDR). Topak and Talu (2017) concluded that exchange rates negatively affect ROA but have an insignificant impact on ROE in Turkish banks. Similarly, Hasanov *et al.* (2018) noted a negative effect of exchange rate fluctuations on ROA. In contrast, Osuagwu (2014) found mixed results in Nigeria, with exchange rates negatively impacting ROE but positively. These findings highlight a gap in recent studies on exchange rate volatility's impact on bank performance, particularly in an Egyptian context, indicating the need for further empirical investigation across different settings.

2.2.7 Economic Growth

Gross Domestic Product (GDP) is a key macroeconomic indicator that reflects total economic activity and influences bank profitability. Several studies have examined the relationship between GDP and bank performance, but results remain inconsistent. Athanasoglou et al. (2008) and Djalilov and Piesse (2016) conclude a positive effect of GDP growth on profitability, while Al-Homaidi et al. (2018) and Ongore and Kusa (2013) report that GDP has a negative effect on

profitability when measured by ROA and NIM but a positive effect when measured by ROE. Also, Islam and Nishiyama (2016), Saeed (2014), and Saona (2016) found a negative effect of GDP growth on bank profitability. On the other hand, Al-Harbi (2019) also reported no significant effect of GDP on profitability, suggesting that high economic efficiency does not necessarily translate to better bank profitability. Likewise, Batten and Vo (2019) and Derbali (2021) found that GDP has no effect on profitability as measured by ROA. Finally, O'Connell (2022) found that cyclical GDP, reflecting deviations from GDP trends, had an insignificant impact on bank profitability. Overall, while GDP generally has a positive effect on bank profitability due to increased credit demand in a growing economy, the impact can vary depending on measurement methods and the specific context of different banks.

3. METHODOLOGY

This section outlines the research approach for evaluating the impact of bank-specific and macroeconomic determinants on bank profitability as well as the impact of exchange rate volatility in Egypt. The study uses the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) method to measure exchange rate volatility. Where in case that volatility is not significant, the real exchange rate (RER) is used as an alternative measure. Further key determinants analysed include capital adequacy, bank size, liquidity, operational efficiency, revenue diversification, and GDP. The study aims to test hypotheses to address the primary research questions: whether exchange rate volatility affects bank profitability, and how various internal and external factors influence bank profitability in the context of currency devaluation. Consequently, a comparative analysis is conducted for periods before and after currency devaluation to understand how these factors influence key profitability metrics such as Return on Assets (ROA), particularly in the context of developing economies like Egypt. Moreover, the research employs Generalized Method of Moments (GMM) and fixed effects models to analyse data from 2012 to 2022. This section provides details on the study's population and sampling design, data collection methods, and techniques used to prepare and test the data. It also describes the econometric models used along with the variables' description.

Additionally, this study adopted a deductive approach by drawing upon existing literature and theories to formulate hypotheses. Moreover, a quantitative methodology is employed to analyze data gathered from secondary sources, where analyses were performed using Stata 18 Software. The research used a sample of eleven banks, presented in table 1 listed on the Egyptian Stock Exchange (EGX) from 2012 to 2022. The study utilizes financial data from these banks, which are consistently listed and have reported full quarterly data for the specified period. Number of banks operating in Egypt are totalled to thirty-eight banks; however, only listed banks' data is accessible and is provided through the Egypt for Information Dissemination (EGID). The selection of this period is strategic, covering pre-, during, and post-currency devaluation phases. Macroeconomic data is sourced from the International Financial Statistics (IFS), Ministry of Planning and Economic Development, and the Central Bank of Egypt (CBE). The final dataset includes 484 observations, providing a comprehensive view of the determinants of bank profitability over an 11-year period.

Table 1: Listed Banks in Egypt

#	Bank	Listing Date
1	Abu Dhabi Islamic Bank- Egypt	19/06/1996
2	Al Baraka Bank Egypt	25/12/1984
3	Banque Du Caire	19/02/2017
4	Commercial International Bank (Egypt)	02/02/1995
5	Credit Agricole Egypt	03/07/1996
6	Egyptian Gulf Bank	17/11/1983
7	Export Development Bank of Egypt (EDBE)	14/12/1995
8	Faisal Islamic Bank of Egypt	07/06/1995
9	Housing & Development Bank	13/09/1983
10	Qatar National Bank Alahly	03/07/1996
11	Societe Arabe Internationale De Banque S.A.E.	29/11/1980
12	Suez Canal Bank S.A.E	15/09/1982

Source: Central Bank of Egypt

3.1 Variable Description and Hypothesis Development

The dependent variable for the study is the Return on Assets (ROA). ROA is a key metric for assessing a bank's efficiency and operational performance, reflecting the ability of management to generate profits from its assets, whether

financial or real. In this study, ROA is employed to measure the return generated for every dollar invested in assets following (Ahamed, 2017; Al-Harbi, 2019; Djalilov & Piesse, 2016; and Trad et al., 2017). As for the independent variables, firstly, capital adequacy reflects a bank's capacity to absorb losses and remain solvent. The impact on profitability is debated; higher capitalization may imply lower risk and returns, but well-capitalized banks can remain profitable during economic shocks. This study will investigate the influence of capital adequacy on bank profitability, as explored in various prior studies as (Al-Harbi, 2019; Al-Homaidi et al., 2018; Derbali, 2021; Hasanov et al., 2018; O'Connell, 2022; and Trad et al., 2017). Second independent variable is bank size. Bank size is analysed for its impact on profitability. On one hand, larger banks may benefit from economies of scale, thereby enhancing profitability. However, excessive size can lead to inefficiencies. Additionally, larger size also means more diversification, potentially lowering risk. Bank size will be included following (Adelopo et al., 2018; Al-Homaidi et al., 2018; Derbali, 2021; Hasanov et al., 2018; O'Connell, 2022; Trad et al., 2017). Moreover, Liquidity risk measures a bank's ability to meet its obligations. Higher ratios indicate lower liquidity and higher risk, which can influence profitability positively or negatively. Pasiouras and Kosmidou (2007) concluded that liquidity risk has a positive significant impact on bank profitability which indicates the negative relationship between level of liquid assets and profitability.

Additionally, operational efficiency reflects the impact of expense management on profitability where higher cost-to-income ratios indicate inefficiencies and are expected to negatively affect profitability. Previous studies that measured operational efficiency include Adelopo et al., 2018; Derbali, 2021; Mokni & Rachdi, 2014; and Noman et al., 2015. Fifth independent variable is the revenue diversification which examines income from non-core banking activities relative to total earnings. Its impact on profitability is mixed; diversification can enhance returns and mitigate risk, but it may also lead to lower profitability due to economies of scope or a diversification discount (Sharma and Anand, 2018; and Trujillo-Ponce, 2013). Previous studies that measured the impact of this variable include Alfadli & Rjoub, 2020; Kapaya & Raphael, 2016; Saona, 2016; and Trujillo-Ponce, 2013. As for the macroeconomic independent variables, the study

tested the real exchange rate and the economic growth. Given the Egyptian economy's dynamic nature, characterized by frequent fluctuations in the Consumer Price Index due to exchange rate movements, this study opted to use the real exchange rate to incorporate inflation effects to determine the exchange rate volatility measured as follows:

$$\text{RER} = \text{NER} * {}^{Pt}/_{P}$$

Where RER is the real exchange rate against US dollars adjusted for inflation, NER is the nominal exchange rate, Pt is the foreign price index (US CPI), and P represents the CPI of Egypt. The nominal exchange rate and CPI for each country are collected from International Financial Statistics (IFS). The study will employ the GARCH model, which builds on the ARCH model by Engle (1982), to capture conditional volatility and volatility clustering in exchange rate data. However, in cases where exchange rate volatility cannot be measured due to the absence of significant evidence of volatility clustering, along with other criteria that will be tested in the analysis section, the study will utilize the real exchange rate itself as a proxy, Al-Homaidi et al. (2018), Anarfi et al. (2016), Hasanov et al. (2018), Topak and Talu (2017), and Trad et al. (2017). Lastly, economic growth is a key factor influencing bank profitability. Positive economic conditions generally enhance borrowers' financial stability, increasing loan demand and boosting bank profits. However, during economic downturns, the demand for credit diminishes and credit quality declines, leading to credit losses that negatively affect bank profitability. While a positive relationship between GDP and bank profitability is typically expected, the impact can vary. Economic growth will be included following (Akoi & Andrea, 2020; Bucevska & Misheva, 2017; Derbali, 2021; Homaidi et al., 2018; Saona, 2016; Trad et al., 2017). Table 2 summarizes the variables that have been discussed earlier and will be incorporated into the analysis sections. It also details the various data sources employed to compile the complete datasets used in the study. Following this, table 3 provides a summary of the research hypotheses developed based on the previous literatures.

Table 2: Variable Description and Data Sources

Variable		Code	Measurement	Data Source
Dependent Variable				
Bank Profitability	Return on Assets	ROA	Net Income before Tax / Total Assets	Annual Reports of the listed banks in Egypt
Independent Variables				
Bank-specific Variables	Capital Adequacy Ratio	CAR	Total Equity / Total Assets	Annual Reports of the listed banks in Egypt
	Bank Size	SIZE	Natural Logarithm of Total Assets	
	Liquidity Risk	LIQ	Total Loans/Total Customer Deposits	
	Operational Efficiency	OE	Total Costs / Net Income	
	Revenue Diversification	DIV	Non-interest Income / Total Revenues	
Macroeconomic Variables	Exchange Rate Volatility	ERV	GARCH model	International Financial Statistics
	Real Exchange Rate	RER	NER * Pt/P	
	Economic Growth	GDP	Percentage change in real GDP	Ministry of Planning and Economic Development

Table 3: Research Hypotheses

H1a: Capital adequacy has a significant impact on profitability of banks before currency devaluation
H1b: Capital adequacy has a significant impact on profitability of banks after currency devaluation
H2a: Liquidity risk has a significant impact on profitability of banks before currency devaluation
H2b: Liquidity risk has a significant impact on profitability of banks after currency devaluation
H3a: Revenue diversification has a significant impact on profitability of banks before currency devaluation
H3b: Revenue diversification has a significant impact on profitability of banks after currency devaluation
H4a: Bank size has a significant impact on profitability of banks before currency devaluation
H4b: Bank size has a significant impact on profitability of banks after currency devaluation
H5a: Operational efficiency has a significant impact on profitability of banks before currency devaluation
H5b: Operational efficiency has a significant impact on profitability of banks after currency devaluation
H6a: Real exchange rate has a significant impact on profitability of banks before currency devaluation
H6b: Real exchange rate has a significant impact on profitability of banks after currency devaluation
H7a: Economic Growth has a significant impact on profitability of banks before currency devaluation
H7b: Economic Growth has a significant impact on profitability of banks after currency devaluation

3.2 Model Specifications

This study employed a panel data approach to examine the impact of bank-specific and macroeconomic variables on bank profitability in Egypt, focusing on the periods before and after the late 2016 currency devaluation. In banking literature, fixed and random effects models are commonly used for panel data analysis. However, these models face challenges when dealing with the persistence of bank profitability over time, as this persistence can influence profitability in subsequent years (Athanasoglou et al., 2008). The inclusion of a lagged dependent variable can complicate the use of these models. Furthermore, endogeneity in statistical analysis occurs when a variable in a model is correlated with the error term or other independent variables, leading to biased and unreliable results. Endogeneity can arise from omitted variable bias, where unaccounted-for variables affect both bank profitability and other independent variables, as well as from reverse causality, where the relationship between variables is bidirectional. To tackle these issues, this study employs Generalized Method of Moments (GMM), which addresses challenges in dynamic panel modelling of bank profitability by considering unobserved bank-level heterogeneity and potential endogeneity. GMM accounts for constant and unobservable heterogeneity and incorporates a lagged dependent variable, capturing the dynamic nature of profitability and examining how past values influence future outcomes. This method is particularly effective in addressing profit persistence and reverse causality, which may lead to biased results in fixed and random effects models. The research will employ system GMM rather than difference GMM where system GMM employs both levels and first differences not just the first differences as the difference GMM. Furthermore, system GMM corrects biases found in difference GMM and is more suitable for panels with small time periods. Thus, following previous literature, the basic equation for this dynamic model would be:

$$BP_{it} = \alpha_{it} + \delta BP_{t-1} + \sum_{b=1}^{B} \beta_b X_{it}^{b} + \sum_{m=1}^{M} \beta_m X_{it}^{m} + \varepsilon_{it} \qquad (1)$$

$$\varepsilon_{it} = v_i + u_{it}$$

Where bank profitability is represented by BP_{it} at time t for bank i, i= 1,..., N, t= 1, ..., T, as for α, it is the constant term. According to Djalilov and Piesse (2016), recent research indicates that bank profits typically persist over a period due to factors such as barriers to market competition, limited access to information, and susceptibility to regional-macroeconomic shocks, specially that these such effects are particularly connected with each other. Therefore, in this paper, a lagged dependent variable is employed, such that BP_{t-1} is a one-period lagged variable, which measures the degree of persistence of the bank profitability measure, and the speed of adjustment, δ, to equilibrium takes a value between 0 and 1, implying that profits eventually return to equilibrium. A value towards 0 indicates a highly competitive industry that rapidly adjusts to equilibrium, whereas a value close to 1 implies a slow adjustment to equilibrium and hence lower levels of competition. X_{it}^{b} are the bank specific variables, while X_{it}^{m} are the macroeconomic variables, and ε_{it} is the disturbance term with v_i the unobservable bank-specific effect, and u_{it} the is the random disturbances that change over time. Therefore, the following dynamic model is the main equation for this research:

$$\boldsymbol{BP_{it} = \alpha_{it} + \beta_1 Capital\ Adequacy + \beta_2 Bank\ Size_{it} + \beta_3 Liquidity\ Risk_{it} + \beta_4 Operational\ Efficiency_{it} + \beta_5 Revenue\ Diversification_{it} + \beta_6 RER_{it} + \beta_7 GDP_{it} + \varepsilon_{it}} \quad (2)$$

4. EMPIRICAL ANALYSIS

4.1 Measuring Exchange Rate Volatility

Capturing volatility in the real exchange rate for the Egyptian Pound against the U.S. Dollar was done in this research using the GARCH method. The GARCH model accounts for time-varying volatility, which is crucial for capturing volatility clustering. Augmented Dickey Fuller (ADF) showed the data was stationary, so differencing was unnecessary. Moving to the mean equation, the appropriate number of lags for the AR and MA can be estimated using the partial autocorrelation and autocorrelation respectively where ARMA (1,2) was the most appropriate. However, significant evidence of volatility clustering, essential for applying the GARCH model, was not found in the exchange rate

data. Figure 1 illustrates the lack of volatility clustering, which typically involves large changes in a financial time series tend to be followed by large changes, and small changes tend to be followed by small changes. Instead, the exchange rate data appears to be more uniform and does not display the typical bursts of activity associated with volatility clustering, making the GARCH model unsuitable for this dataset.

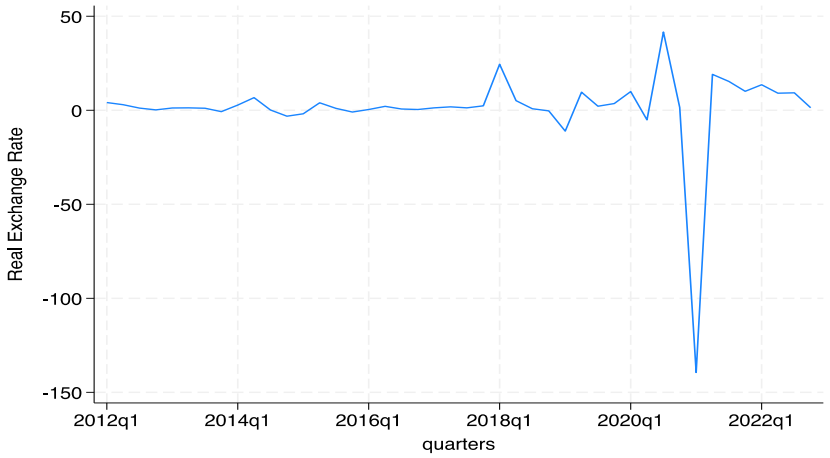

Figure 1: Exchange Rate Quarterly Data

Source: Research Data

After that, ARCH LM test was performed which is an analysis to the squared residuals, to ensure that there is an ARCH effect in the squared residuals of the mean equation; however, a P-value of 0.8106 suggests that there is no evidence of conditional heteroskedasticity as it is above significance level (0.05) and also suggests that the variance of residuals is constant over time. This also implies that the GARCH model may not be optimal for the data, as it does not exhibit volatility clustering. Additionally, the GARCH model requires that all coefficients in the conditional variance, including the squared residuals and the GARCH terms, be non-negative (Brooks, 2019). This constraint was not met as the squared residuals had a negative coefficient. Additionally, the sum of the coefficients of the squared residuals and GARCH term was 1.26, exceeding the required maximum of 1 for persistent volatility. Having that said, it is concluded that the GARCH model couldn't be used to estimate exchange rate volatility and

its effect on bank profitability in this research. Alternatively, the real exchange rate will be used as an independent variable to capture the change in exchange rate and its effect on bank profitability as one of the main factors affecting bank profitability. This will be done using GMM estimation and by including different internal and external factors that are assumed to have a significant effect on the model. Moreover, a comparative analysis of the periods before and after currency devaluation will be conducted to assess whether the internal and external factors included in the study were influenced by this economic event.

4.2 Descriptive Statistics and Multicollinearity

Table 4: Descriptive Statistics

Variable	Mean	Maximum	Minimum	Standard Deviation
ROA	0.0069	0.0172	-0.0083	0.0031
Capital Adequacy	0.0914	0.1617	0.0429	0.0286
Liquidity Risk2	0.4951	1.0889	0.0985	0.1751
Revenue Diversification	-0.110	0.1122	-0.4158	0.0769
Operational Efficiency	5.350	20.619	-4.2042	3.8568
Size	10.734	11.8018	9.8333	0.3909
Economic Growth	0.0407	0.098	-0.017	0.0215
Real Exchange Rate	3.051	19.14	-11.06	5.419

Source: Research Analysis

The descriptive statistics for the variables in the study are based on quarterly financial reports from 11 listed banks, totalling 440 quarters, and include macroeconomic data from various sources. For the dependent variable, return on assets (ROA), a measure of bank profitability relative to total assets, has a mean of 0.69%, with a standard deviation of 0.31%, indicating a significant variability around the mean. The maximum ROA is 1.72%, and the minimum is -0.83%, reflecting that some banks experienced losses, particularly Abu Dhabi Islamic Bank in its early year's post-acquisition. The negative income reported by some banks suggests a risk of potential bank failures in Egypt, especially due to insufficient regulations on maintaining adequate bank capital. For the independent variables, the capital adequacy ratio, measured by total equity to total assets, has a mean of 9.14%, with a standard deviation of 2.86%. The highest

capital adequacy ratio is 16.17%, recorded by Housing and Development Bank. Moreover, Liquidity risk has a mean of 49.51% and a standard deviation of 17.51%, showing that banks closely maintain their loans to customer deposits ratio effectively. The highest liquidity risk was observed at Export Development Bank of Egypt (EDBE), and the lowest at Faisal Islamic Bank of Egypt.

Revenue diversification has a mean of -11%, with maximum and minimum values of 11.22% and -41.5%, respectively, indicating some banks reported negative non-interest income in certain quarters. Furthermore, the relatively high standard deviation of the operational efficiency in comparison to its mean value highlights wide variance among sampled banks in terms of managing expenses, with the highest value reported by Société Arabe Internationale De Banque (SAIB) and the lowest by Abu Dhabi Islamic Bank. Moreover, the maximum and minimum values of bank size are very close. Although bank size is a key variable in previous literature and plays an important role in bank efficiency, using the natural logarithm of total assets minimizes the differences between the banks. The descriptive statistics reveal minimal variation, indicating that differences in bank sizes are not evident. Economic growth, measured by GDP growth, recorded a minimum of -1.7% in Q4 2020, reflecting the COVID-19 pandemic's impact on key sectors like tourism and prolonged lockdowns. The real exchange rate, calculated using the nominal exchange rate adjusted for inflation, has a mean of 3.051 and a standard deviation of 5.419, indicating variability in the relative value of the Egyptian pound against the US dollar. Also, a minimum value of -11.06 EGP was recorded in Q1 2019 due to significant changes in inflation rates in Egypt and the US, and the maximum value recorded in Q2 2021.

Table 5: Variance Inflation Factor for Explanatory Variables

Variables	VIF	1/ VIF
Capital Adequacy	1.33	0.749568
Size	1.24	0.803898
Operational Efficiency	1.24	0.805675
Liquidity Risk	1.18	0.847400
Revenue Diversification	1.15	0.870886
Economic Growth	1.13	0.887154
Real Exchange Rate	1.09	0.919322
Mean VIF	1.19	

Source: Research Analysis

The variance inflation factor (VIF) is one way to measure multicollinearity where it has different levels in literature; Daoud (2017) recommended that VIF should not exceed 5 which corresponds to a tolerance of 0.5; while several other studies such as Marquardt (1970) and Neter et al. (1989) agreed that maximum value of VIF of 10; however, according to Table 5, there is no multicollinearity problem among the variables as indicated by the VIF values. Therefore, all independent variables are not correlated with each other.

4.3 Results

The empirical results of the research model are presented in Table 6. This section outlines the findings from the main model using the system GMM estimator to compare internal and external determinants of bank profitability before and after the currency devaluation in November 2016. Due to the dynamic nature of bank profitability models, both OLS and fixed effects estimators are biased and inconsistent because of the correlation between unobserved individual-specific characteristics and the lagged dependent variable. To address these econometric issues, Arellano and Bond (1991) introduced the GMM estimator for dynamic panel models, which is better suited for handling endogeneity problems such as unobservable heterogeneity, profit persistence, and reverse causality. The study employs the system GMM estimator. The reliability of the system GMM estimation depends on instrument validity and assumption of no residual autocorrelation. So, this study uses the Sargan test for instrument validity and

Arellano-Bond tests for autocorrelation. The Sargan test showed p-values of 0.536 and 0.111 for both sample periods, indicating that the null hypothesis cannot be rejected, and all moment conditions are met. For autocorrelation, AR (1) p-values were 0.002 and 0.001, and AR (2) p-values were 0.230 and 0.681, respectively, for both periods. AR (1) rejection is expected due to the model's dynamic nature, while AR (2) acceptance is necessary to validate the GMM instruments.

Table 6: Dynamic Panel Results for Determinants of Bank Profitability, ROA Model

Variable	Before Devaluation 2012-2016		After Devaluation 2017-2022	
	Coefficient	P-value	Coefficient	P-value
L.ROA	0.42108	0.000***	0.17009	0.002**
CAR	-0.0020	0.691	-0.0090	0.322
LR2	0.00154	0.052	0.00156	0.001**
RD	0.01523	0.000***	0.01276	0.000***
SZ	0.00114	0.009**	0.00091	0.127
OE	-0.00011	0.001**	-0.00031	0.000***
RER	-0.00004	0.467	-0.00002	0.043*
EG	0.0032	0.711	-0.00281	0.426
Constant	-0.00652	0.158	-0.00029	0.963
Observations	193		203	
No. of banks	11		11	
AR (1) (p-value)	0.002		0.001	
AR (2) (p-value)	0.230		0.681	
Sargan Test	0.536		0.111	

Note: The table provides the results of a dynamic panel analysis investigating the determinants of bank profitability across two periods (2012-2016 and 2017-2022) for a sample of 11 banks listed on the Egyptian Stock Exchange. Using the system GMM estimation method, the study focuses on Return on Assets (ROA) as the main dependent variable, reflecting net income before tax divided by total assets. Key variables analysed include the lagged dependent variable of bank profitability (L.ROA), Capital Adequacy Ratio (CAR) measured by equity to total assets, Liquidity Risk (LR2) represented by the ratio of total loans to total customer deposits, Revenue Diversification (RD) captured by non-interest income to total revenues, Operational Efficiency (OE) assessed through the cost-to-income ratio, Bank Size (BS) indicated by the natural logarithm of total assets, Real Exchange Rate (RER) calculated as the nominal exchange rate adjusted by the ratio of US CPI to Egypt's CPI, and Economic Growth (EG) measured by the percentage change in real GDP. Statistical significance levels (***, **, *) highlight the significance of results at the 1%, 5%, and 10% levels, respectively. *AR* (1) and *AR* (2) are Arellano–Bond tests that average autocovariances in residuals of order 1 and 2. (Ho: no autocorrelation). Sargan's test for over-identifying restrictions in GMM dynamic model estimation is used.

Source: Research Analysis

The results in Table 6 indicate that the lagged dependent variable of bank profitability, represented by L.ROA, remains significantly positive both before and after the devaluation, suggesting profit persistence and supporting the use of a dynamic model. Egyptian banks that were profitable before devaluation continued to sustain their profitability afterward. The high coefficient value for L.ROA indicates strong influence from past profitability, pointing to less competitive conditions before devaluation, where profits were stable despite current market conditions. Similar coefficients were reported by Al-Homaidi et al. (2018) and O'Connell (2022). However, the L.ROA coefficient significantly declined after devaluation, indicating reduced profit persistence and increased sensitivity to current market conditions and competition. This pattern aligns with findings from Batten and Vo (2019), Hasanov et al. (2018), Horobet, Dumitrescu, and Popescu (2021), and Isayas (2022), who also observed lower coefficients in their models post-devaluation.

The capital adequacy ratio (CAR) has an insignificant impact on bank profitability, as measured by ROA, for both sample periods. This aligns with the findings of Al-Homaidi et al. (2018), Batten and Vo (2019), and Dietrich and Wanzenried (2011). Also, similar results were concluded by El-Ansary and Megahed (2016) in their study on the Egyptian banks before and after the financial crisis This insignificance is attributed to the consistent compliance of Egyptian banks with substantial capital regulations set by the CBE (Central Bank of Egypt, 2022). Therefore, H1a and H1b are rejected. As for the liquidity risk, it had an insignificant relationship with ROA before the devaluation but showed a strongly significant positive relationship after the devaluation. This is consistent with Al-Homaidi et al. (2018), and Ćurak, Poposki, and Pepur (2012) who found an insignificant effect of liquidity on ROA, while Mokni and Rachdi (2014) suggested a positive relationship between liquidity risk and Islamic banks' profitability. The positive impact indicates that higher risk and lower liquidity lead to increased profitability. Before devaluation, the stable liquidity in the Egyptian banking sector had minimal impact on profitability. After devaluation, high inflation and tightened monetary policy with higher interest rates led to banks be flushed with liquidity, resulting in lower profitability for banks that

couldn't effectively utilize the increased liquidity to provide more loans and boost interest income. Therefore, H2a is rejected, while H2b is accepted.

Furthermore, revenue diversification as measured by non-interest income to total revenues, shows a positive significant relationship with ROA before and after currency devaluation. Therefore, accepting H3a and H3b. This significance suggests that revenue diversification has a robust impact on bank profitability across various economic conditions, highlighting its importance in enhancing profitability despite economic challenges. This finding aligns with Trujillo-Ponce (2013), who noted that banks can improve profitability by generating income from non-interest activities, especially when interest rates are declining. Similarly, Ahamed (2017) states that diversified revenue sources, which are not perfectly correlated, positively impact profitability and reduce income volatility through non-intermediation activities. These results are consistent with Alper and Anbar (2011) and Rahman et al. (2015), who also found a significant positive relationship between revenue diversification and bank profitability measured by ROA.

Bank size has a significantly positive effect on ROA before devaluation, therefore accepting H4a. This suggests that larger banks in Egypt leverage economies of scale to reduce operational expenses. Studies by Abobakr (2018), Al-Homaidi et al. (2018), Hasanov et al. (2018), Isayas (2022), and Trad et al. (2017) also found a positive significant relationship between bank size and ROA. However, post-devaluation, bank size becomes insignificant for profitability measured by ROA and therefore rejecting H4b. Mokni and Rachdi (2014) concluded the same insignificant results. This aligns with changes in profit persistence and competition levels discussed in the results of the lagged dependent variable, as larger banks failed to utilize their size effectively to enhance profitability due to increased competition after devaluation; therefore, bank size lost its advantage. Additionally, the large amount of liquidity negatively affecting bank profitability supports the same reasoning, as large banks tend to face greater liquidity challenges.

The operating efficiency has a negative significant relationship with bank profitability measured by ROA, both before and after currency devaluation,

therefore, accepting H5a and H5b. This suggests that a higher ratio, reflecting less efficiency in managing costs, negatively impacts profitability. The consistency of results pre- and post-devaluation indicates that effective cost management is crucial for better performance, regardless of economic conditions. The increased coefficient value in the second period suggests that cost efficiency has become even more important for banks listed on the EGX after devaluation, likely due to heightened competition. This finding aligns with Adelopo et al. (2018) and Dietrich and Wanzenried (2011) for both before and after the financial crisis and is supported by previous studies such as Rahman et al. (2015), Batten and Vo (2019), Derbali (2021), Alfadli and Rjoub (2020), and Neves et al. (2020). For the macroeconomic variables, real exchange rate had an insignificant relationship with ROA during 2012-2016, but a negative significant relationship during 2017-2022, indicating that depreciation of the Egyptian Pound negatively impacts bank profitability. This shift highlights increased sensitivity of banks to exchange rate changes, although the impact is not dominant as the coefficient is very small. These results align with Al-Homaidi et al. (2018), Hasanov et al. (2018), and Trad et al. (2017). The results imply rejecting H6a and accepting H6b. Lastly, economic growth showed an insignificant relationship with ROA, rejecting both H7a and H7b. The results for both exchange rate and real GDP can be explained by the tight policies adopted by the CBE during most of the sample period, which helped protect the Egyptian banking sector from adverse economic conditions.

5. CONCLUSION

The objective of the study is to investigate the impact of bank-specific and macroeconomic factors on profitability of 11 listed banks in Egypt before and after the currency devaluation that took place in 2016. To facilitate a comparative analysis, the sample period is divided into 2012-2016 (the period before currency devaluation) and 2017-2022 (the period after currency devaluation). A dynamic panel data model was adopted to explore the persistence of profits in banks and evaluate their profitability using the GMM method, which accounts for profit persistence and other endogeneity problems. Furthermore, the study aimed to assess exchange rate volatility in Egypt using the GARCH method, particularly

in the context of a currency devaluation. However, the analysis revealed that key conditions for applying the GARCH model, such as volatility clustering and the non-negativity constraint, were not met. Consequently, the GARCH model was found to be unsuitable for this dataset, indicating that Egypt's quarterly exchange rate data does not exhibit significant volatility. As a result, the real exchange rate itself was utilized as an independent variable to capture changes in the exchange rate and their effect on bank profitability. Thus, the study shifted from using the GARCH model to employing the real exchange rate directly, focusing on its role as a primary factor affecting bank profitability.

Lagged ROA has a positive significant relationship with bank profitability, confirming the dynamic nature of the estimated models and the presence of profit persistence. In terms of capitalization, the capital adequacy ratio had no significant impact on profitability as measured by ROA, with results showing no change before and after the currency devaluation. However, the impact of liquidity risk on profitability varied across the periods; it was insignificant for ROA before devaluation but showed a positive significant impact after devaluation. Similarly, while revenue diversification consistently exhibited a positive significant impact on ROA, showing no change across the periods, the impact of bank size on profitability differed before and after devaluation. Operational efficiency, on the other hand, had a consistently negative significant impact on ROA both before and after devaluation. Meanwhile, the real exchange rate had an insignificant impact on ROA before devaluation but became significantly negative after devaluation, although the effect was minimal. Lastly, economic growth showed an insignificant impact on profitability measured by ROA during both periods, indicating a stable relationship regardless of the currency devaluation.

6. LIMITATIONS AND RECOMMENDATIONS

The existing literature highlights the need for updated research on bank performance, especially given Egypt's recent economic changes and regulatory reforms. This thesis addresses that gap by examining internal and external factors affecting bank profitability. First, the analysis aimed to assess exchange rate volatility using the GARCH model, but since key conditions such as volatility

clustering and the non-negativity constraint were not met, the model was unsuitable. As a result, the real exchange rate was used as an independent variable. Second, the study investigated bank-specific and macroeconomic factors impacting profitability before and after the currency devaluation, utilizing a dynamic panel model (GMM) to account for profit persistence and endogeneity issues. However, the research faced limitations in sample size and variation due to the challenges of data collection in Egypt. Only listed banks had complete data for the entire sample period, which excluded significant banks like HSBC Bank Egypt, National Bank of Egypt, and Banque Misr, limiting the generalizability of the results, as larger banks from different ownership groups were excluded. Another limitation of the study is that it only covers data up to 2022. Although there was a significant currency devaluation in 2023, the primary objective was to compare the effects of devaluations across two distinct periods. Incorporating data from 2023 would have complicated this comparative analysis, as it would not have provided sufficient time to fully assess the post-devaluation effects. Additionally, at the time of analysis, the Q4 financial statements for most listed banks had not yet been published, which further limited the inclusion of 2023 data in the study. Last key limitation is that few studies, whether in Egypt or elsewhere, have included the real exchange rate as a macroeconomic variable when measuring profitability determinants. This limitation makes it difficult to compare the results of this research with those of other studies. Even though it represents a significant contribution to the current research. On the other hand, comparing the findings of this thesis with those from other studies in both developing and developed countries supports the results. It is recommended to include a wider range of macroeconomic and bank-specific variables for a more comprehensive analysis. Extending the study period and sample size allow researchers to track profitability trends through different economic phases and crises which will be helpful for comparative studies. Additionally, focusing on the real exchange rate's impact with monthly data can provide deeper insights into its effect on bank profitability and its interaction with other macroeconomic factors.

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أثر تقلبات أسعار الصرف على الأداء المالي للبنوك: تحليل تطبيقي للقطاع المصرفي المصري قبل وبعد تعويم العملة المصرية

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ملخص البحث باللغة العربية

تبحث هذه الدراسة في تأثير العوامل الداخلية والخارجية على ربحية 11 بنكا مدرجا في البورصة المصرية، مع التركيز على الفترات قبل وبعد تخفيض العملة المصرية في أواخر عام 2016. التركيز على التغير المستمر لهذه العوامل هو أساس الدراسة لأنه جزء هام من تقييم ربحية البنوك والذي يتطلب استخدام طريقة التحليل الاحصائي (GMM). نتج عن البحث تحليل تفصيلي لاستمرارية ربحية البنوك المصرية عبر فترة التقييم مع التركيز على محددات الربحية في الفترة من 2012 إلى 2022. وتكشف النتائج الرئيسية أن نسبة كفاية رأس المال لها تأثير ضئيل على العائد على الأصول (ROA) خلال كلتا الفترتين، بما يتماشى مع الدراسات السابقة. ومع ذلك، أظهرت مخاطر السيولة علاقة إيجابية كبيرة مع العائد على الأصول بعد تخفيض قيمة العملة، مما يشير إلى أن السيولة الأعلى يمكن أن تعزز الربحية في ظل ظروف اقتصادية معينة. كما أظهر متغير تنويع الإيرادات تأثيرا إيجابيا على العائد على الأصول، بينما أثرت الكفاءة التشغيلية سلبا على الربحية طوال فترة الدراسة. بالإضافة إلى ذلك، تم استخدام نموذج الانحدار الذاتي المشروط المتغاير (GARCH) في البداية لقياس تقلبات سعر الصرف؛ ومع ذلك، ونظرًا لعدم وجود أدلة على التقلبات، تم استخدام سعر الصرف الحقيقي بدلاً من ذلك كمتغير مستقل، مما أظهر تحولًا من علاقة ضئيلة إلى علاقة سلبية كبيرة مع العائد على الأصول بعد تخفيض قيمة العملة، مما يسلط الضوء على زيادة حساسية الأداء المالي للبنوك لسعر الصرف. التقلبات.

الكلمات الدالة: ربحية البنوك، تخفيض قيمة العملة، البنوك المصرية، تقلب أسعار الصرف

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