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Risk Management and Bank Profitability in Emerging Markets: Evidence from Egyptian Banks

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Abstract This study investigates the impact of integrated risk management practices on the profitability of Egyptian commercial banks, with a particular focus on how macroeconomic conditions and bank-specific characteristics moderate this relationship. Building on recent regulatory reforms and leveraging a novel composite Risk-Management Index (RMI), This research fills a critical gap by comprehensively analyzing the joint and interactive effects of credit, liquidity, operational, and market risks under the Basel III framework, particularly in the context of emerging market volatility. Utilizing a comprehensive panel dataset covering 11 major Egyptian banks over the period 2015–2024, the research employs rigorous econometric techniques to analyze the interplay between credit risk, liquidity risk, operational risk, market risk, and bank performance metrics such as Return on Assets (ROA) and Return on Equity (ROE). The most robust finding is the powerful and statistically significant negative relationship between Credit Risk and Return on Equity (ROE). This finding strongly aligns with the consensus in the literature, which links higher Non-Performing Loans (NPLs) to lower profitability. However, this study provides a more nuanced picture by revealing a significant *positive* relationship between liquidity risk and profitability, suggesting that in Egypt's volatile macroeconomic environment, strong liquidity acts as a positive signal of stability, outweighing its opportunity cost. This confirms that effective credit risk management is a cornerstone of protecting shareholder value. The initial non-significant result for Credit Risk in the ROA model is likely an artifact of multicollinearity, a conclusion supported by diagnostic tests where key variables exhibited a Variance Inflation Factor (VIF) above the conventional threshold of 5. The high correlation between credit risk, CAR, and Bank Size appears to have masked the underlying negative impact of credit risk in that specific model. The high correlation between credit risk, CAR, and Bank Size likely caused the explanatory power of credit risk to be absorbed by other variables in that specific model, masking its true, underlying negative impact. The consistently negative coefficient for operational risk across both models underscores the fundamental importance of internal efficiency and cost control in driving bank performance. Furthermore, the strong positive impact of market risk suggests that, during the study period, the sampled banks were successful in managing their interest rate exposures to their advantage, likely by widening net interest margins in a volatile rate environment. Finally; this study demonstrates that profitability in Egyptian banking is not driven by a single factor but by a careful balancing act. While managing credit risk is paramount, superior performance is achieved by those institutions that can also maintain operational efficiency, strategically manage market risk, and use liquidity and capital levels to navigate a challenging macroeconomic environment and signal strength to the market. This study fills a critical gap by simultaneously analyzing the joint impact of credit, liquidity, operational, and market risks on Egyptian bank profitability under post-Basel III regulations and volatile macroeconomic conditions. It introduces a novel PCA-driven Risk-Management Index (RMI) and tests its non-linear effect on ROA and ROE.

Keywords: Risk Management, Bank Profitability, Egyptian Banks, Macroeconomic Factors, Credit Risk

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Introduction

The banking sector is the heart of modern economies, it executes capital allocation, allows transfer of payments and accelerates economic wellbeing (Levine 2005; Beck and Levine 2004). For emerging market countries like Egypt, a strong and competitive banking system is particularly essential for mobilizing savings, financing investment, and supporting sustainable development (Demirgüç-Kunt & Levine2008). Nonetheless, the very essence of banking activity is to handle a maze of risks which all banks entail: credit risk, liquidity risk, market and operational risks (Bessis 2015). So effective risk management is indispensable not only the solvency and bank account of individual institutions but also stability of the whole financial system (BCBS, 2011). The 2007–2009 global financial crisis highlighted the dangers of poor risk management, prompting widespread regulatory reforms globally—largely driven by the Basel Accords (BCBS; 2010, 2017). Countries such as Egypt are gradually adapting these international norms to their own countries based context but struggling with market-based and regulation capacity specific challenges emerging economies (El-Ansary et al., 2016; Zaky and Soliman, 2017).

The banking sector in Egypt, the largest in North Africa, has seen substantial evolution over the last two decades characterized by privatization, consolidation and regulatory improvements that are presumably intended to bolster its resilience and efficiency (Hakim & Neaime 2005; Omran 2007; Jreisat et al., 2018). Despite the reforms that followed, Egyptian banks operate in a dynamic environment characterized by evolving economic policies, IMF-oriented structural reforms, geopolitical risks, and global financial trends (Hafez, 2015; El-Faham, 2020; Adel and Naili, 2024). The specific problem addressed in this study is the lack of empirical evidence on the combined impact of multiple risk types on bank profitability in Egypt, especially under evolving macroeconomic and regulatory conditions. Recognizing the variables in which Egyptian banks try to confront risks and identify ways this affects its profitability till very day is one a [the most] important lines.

1.2. Problem Statement

No existing Egyptian study has simultaneously examined how credit, liquidity, operational and market risks interact to shape bank profitability after the 2015 Basel III/IFRS-9 regime shift. Single-risk studies overlook offsetting or amplifying effects, while aggregate studies pre-date the new capital-liquidity trade-offs and the country's 2016-2023 macro-volatility. This paper closes that gap by modelling the joint, non-linear impact of all four risk types on ROA and ROE and by testing whether higher risk-disclosure quality amplifies or attenuates these effects.

Although risk management has been recognized from the side of Egyptian banks with great importance, optimizing the profitability of banks and minimizing various risks has been, until now remained a formidable difficulty for many Egyptian banks. Despite a growing body of single-risk studies, no recent work has simultaneously examined the interactive and potentially offsetting effects of credit, liquidity, operational and market risk on Egyptian bank profitability under post-Basel III regulations and volatile macro conditions. This study addresses the lack of a holistic approach in existing literature, where most studies focus on individual risk types rather than their joint and potentially offsetting effects on profitability. While there is a lot of literature that studies them individually or focuses only on certain risk types; credit risk (Elgayar, 2024), liquidity risk (El Moslemany et al., 2021). However, a more comprehensive understanding of the combined and possibly contradicting influences of these multiple dimensions on bank performance in Egypt that incorporates the vast empirical evidence of recent years is more rare. To close that gap, this current study combines findings spanning across multiple academic literatures published over last 15 years.

While studies on risk and profitability in emerging markets (EMs) are common, the Egyptian context presents a unique laboratory. Unlike more stable EMs such as Morocco, Egypt underwent a dramatic currency devaluation in 2016 followed by sustained periods of high inflation and IMF-led structural reforms. This environment creates risk dynamics potentially different from those in other volatile EMs like Turkey, which has also faced currency crises but possesses different institutional and regulatory recovery mechanisms. Therefore, understanding the joint impact of credit, liquidity, and market risks under these specific post-2016 conditions is critical, as findings from other EMs may not be directly transferable.

1.3. Research Questions

To address the research gap, the study focuses on the following interrelated questions:
RQ1. How do the four Basel III risk dimensions (credit, liquidity, operational, market) jointly and non-linearly affect Egyptian banks' ROA and ROE after controlling for capital, size, and macro shocks (2015-2024)?
RQ2. Does the quality of risk-disclosure moderate these risk-profitability relationships?

1.4. Significance of the Study

This study provides a timely and comprehensive analysis of the risk-profitability nexus in the Egyptian banking sector, offering valuable insights for stakeholders navigating a rapidly evolving regulatory and macroeconomic landscape. Provides useful information for any stakeholder. (a) Bank Managers: The documented impact of specific risk strategies and internal factors should provide a better decision making. (b) Regulators (Central Bank of Egypt - CBE): The synthesis comments on the harder observed impacts of regulatory policies (e.g. capital and liquidity requirements, disclosure mandates) as well as issues one may wish to look into more. (c) Investors: this study provides insights into the key drivers of bank profitability, allowing investors to better assess risk-adjusted returns. By dissecting the influence of different risk types (e.g., credit vs. liquidity), investors can make more informed portfolio allocation decisions and better evaluate the resilience of bank earnings in a volatile macroeconomic climate. (d) Academics: This study synthesizes a comprehensive body of literature, highlights main themes and inconsistencies and suggests directions for future research that is potentially a useful reference. This study contributes to the literature by introducing a novel composite Risk-Management Index (RMI) and testing its non-linear impact on profitability, offering a more nuanced understanding of risk dynamics in emerging markets. Unlike previous single-risk or pre-Basel III analyses, This study provides regulators with evidence-based thresholds for capital-liquidity trade-offs and highlights the moderating role of risk disclosure in shaping profitability outcomes. The integrated risk-disclosure score introduced here is a practical benchmarking tool not previously available to Egyptian supervisors.

1.5. Structure of the study

Following this introduction, Section 2 provides an extensive review of the relevant theoretical frameworks and synthesizes the empirical literature covering credit risk, liquidity risk, bank-specific determinants (including governance), macroeconomic factors, risk disclosures, and comparative studies related to Egyptian banks. Section 3 the methodologies. Section 4 data analysis and discusses the synthesized results, highlighting key themes, consistencies, and contradictions found across the studies. Section 5 was conclusion and recommendations

2. Literature Review

This part discusses the theoretical underpinning and a synthesis of findings from diverse studies covering the last 15 years on the nexus between risk management, bank qualities, macroeconomic shocks, disclosures (profitability) in Egyptian banking sector and related emerging markets.

2.1. Theoretical and Literary review

2.1.1 Theoretical theories

To grasp the nitty gritty of bank risk and profitability, you will need to root in at least a few fundamental theories.

2.1.1.1 Agency Theory: Agency theory, pioneered by Jensen and Meckling (1976), studies principal (shareholders) agent (managers) conflicts of interest. In banking, this shows up as managers may be capturing too much agency by taking on excessive risks to private agents (e.g., bonuses that are linked to short-term profits at the expense of long term shareholder value or depositor safety) (John et al., 2008). Effective corporate governance mechanisms (board independence, ownership structure) and disclosure transparency may reduce these agency solutions (Levine, 2005; Elghaffar et al., 2019).

2.1.1.2. Portfolio Theory & Modern Portfolio Theory (MPT): The model created by Markowitz (1952) to capture risk- return trade-off. Banks are just a special type of investor, hence they all hold portfolio of assets (loans) and liabilities (deposits). In effective risk management, loan portfolios should be diversified to lower idiosyncratic risk and riskier (high return) assets versus safer (low return) needs to be optimized (Freixas & Rochet,2008). At the core of this, capital adequacy acts as a shock absorber for the unexpected losses (Berger and Bouwman 2013).

2.1.1.3. Information Asymmetry Theory: Akerlof (1970) elucidate how the lack of information between market-parties causes market failure. Banking on the other hand, lenders suffer of information asymmetry (adverse selection and moral hazard after loan disbursement) when borrowers are less creditworthy (Stiglitz & Weiss,

1981). Depositors do not know the full detail of the risk profile of the bank (similar to clients in the below example). It is necessary to assess credit risk, monitor this process and provide transparent disclosure so as to deal with these problems (Diamond & Dybvig 1983; Hassan et al., 2019).

2.1.4. Stakeholder Theory: argures that theory (Freeman, 1984) contends firms ought not only to look after shareholders but also take into account stakeholders (shareholders as well as employees, customers, regulators-public). In the case of banks this means balancing returns with financial discipline, customer wellbeing and regulatory conformism. Risk management and disclosure practices show that tension (Mehran et al., 2011).

2.1.1.5 Signaling Theory: Spence (1973) signaling theory proposes that firms can use some actions (e.g., whether to engage in voluntary disclosure) as signaling the quality or type to an uninformed party. These might include the banks opt for deep risk disclosures as a signal of their prudent management and low risk commercial banks (Healy & Palepu 2001; Ezat, and El-Masry, 2008).

2.2. Credit Risk Management and Profitability

Credit risk Under Commercial banks (Bessis, 2015), or the risk of loss from an obligor's failure to meet its contractual obligations, is probably the central risk they face.The most common “proxies” used in Egyptian banks studies are: Non-Performing Loans (NPL) ratio (NPLs/TotalLoans), LLP (Loan Loss Provisions)/Total Loans ratio, sometimes the components of Z-score, related to Loan quality (e.g., El-Faham et al., 2020; Elgayar, 2024; Pasha and Abdalla, 2023; Abdel Hamid et al., 2024).

Widest swath in the literature, particularly internationally and for Egypt itself shows that credit risk (higher NPLs or LLPs) is associated with lower bank profitability (ROA/ROE) (e.g. Athanasoglou et al., 2008; Dietrich & Wanzenried, 2011; El-Faham, 2020; Elgayar, 2024; Abd Elmaged, 2025). Erodes earnings the higher credit risk, can launced to provisions and write-offs costs and send that a bank is suspected of incompetent lending. Others investigate non-linear instruments or the interactions with capital adequacy (e.g., Kohlscheen et al., 2018). On the other hand; although literature explicates the need for strong credit appraisal systems, efficient loan monitoring, diversification of the portfolio, collateralization, and timely workout procedures for dealing with NPLs, most empirical research test effects on outcome (NPL levels) rather than particular techniques used (Casu et al., 2015).

2.3. Liquidity Risk Management and Profitability

Bank Liquidity risk is defined as a banks capacity to meet its short-term obligations fall due without incurring unacceptable loss (BCBS 2008). Proxies differ significantly from the ratio of liquid assets to total assets, the loan to deposit ratio, interbank ratios and, more recently, based on Basel III such as Liquidity Coverage Ratio (LCR), Net Stable Funding ratio etc. (e.g., Nimer et al., 2015; Mobarak, 2020; El Moslemany et al., 2021; Harb et al., 2023).

The relation between profitability and liquidity risk is usually found to be coupled, non-linear. If liquidity is over-hedged it weakens the profitability because of foregone opportunity costs of holding low-yielding liquid assets (Berger & Bouwman, 2009; Bordeleau & Graham, 2010). On the other end, lack of liquidity expose an undesired vulnerability to funding shock and thus the probability of failure-destruction of profit. In studies for Egyptian banks a trade-off is apparent, some, for example, predict a negative relationship between high liquidity holding and profitability (Mobarak, 2020; El Moslemany et al., 2021), however other findings are more nuanced and depend on the exact liquidity measure and bank characteristics (Nimer et al., 2015; Harb et al., 2023). Also, Abdel Megeid, (2017) looks at the differences of conventional and Islamic banks. On the other hand; Banks as the originators of liquidity (the process of turning illiquid assets to liquid liabilities) and its impact on performance are discussed in some literature (Berger & Bouwman 2009). This dimension is being investigated in studies of emerging markets, although more synthesis is needed to produce evidence for Egypt.

2.4. Other Risk Dimensions

Credit and liquidity risks are central, but there are other risks that affect profitability (which though less empirically studied in Egypt) nonetheless also play a part.

2.4.1. Operational Risk: Loss resulting from inadequacies, failures or mismanagement within process, people and systems (BCBS 2006). It typically has a detrimental effect on profitability, but measurement difficulties confound empirical analysis. While the ratio of Operational Expenses to Total Assets is a commonly used proxy due to its data availability, it is important to acknowledge its limitations. This ratio is an indirect measure that primarily captures cost inefficiencies and may not fully reflect the impact of low-frequency, high-severity operational loss events such as major fraud or cybersecurity breaches. The unavailability of public, granular data on such events in the Egyptian context constrains the use of alternative proxies.

2.4.2. Market Risk: The risk of Losses due to movement of market prices (interest rates, foreign exchange rates, equity prices). Studies may also use other interest rate sensitivity (e.g., via NIM) or a foreign currency exposure

as control variables (Dietrich & Wanzenried, 2014).

2.5. Bank-Specific Determinants of Profitability

There are many factors that affect the profitability of banks, the most important of which are the following:

2.5.1 Capital Adequacy: Capital Adequacy Ratio (CAR) or equity-to-assets ratio Higher capital generally meant more stability and resilience entails for (Berger & Bouwman 2013). The profitability aspect of this is a matter for debate: on one hand, increased capital could be costly (leverage-reduction), but it might also serve to lower funding costs or indicate ability to take more risk or signal strength (Athanasoglou et. al., 2008). Capital-profitability in the Egyptian studies has a positive association between (e.g. El-Faham, 2020; Pasha and Abdalla, 2023; Abdel Hamid, 2024), primarily under the influence of regulatory or confidence (market) effect.

2.5.2. Bank Size: measured by natural log of total assets Larger banks have potential economies of scale, market power and diversification (Berger &Mester,1997). But they can also face bureaucratic inefficiencies (diseconomies of scale). The empirical results for Egypt are mixed, some estimated positive impacts (Pasha and Abdalla, 2023), some others found negative or insignificant (Hakim & Neaime 2005) indicating a possible non-linearities or confounding with other variables.

2.5.3. Operational Efficiency: Cost-to-income ratio (lower being better) or efficiency scores from Data Envelopment Analysis (DEA)/Stochastic Frontier Analysis (SFA) (Berger & Humphrey 1997). Studies seem to indicate that efficiency is always related with higher profitability regardless of the case, for example we had Egypt studies (e.g Omran, 2007; Athanasoglou et al., 2008; Eldomiaty et al., 2015; Hassan and Jreisat, 2016; Jreisat et al., 2018).

2.5.4. Asset Quality: Primarily reflected by NPL ratios as we have already discussed under credit risk Poor asset quality eats into profitability directly through the various provisions and write downs (El-Faham 2020).

2.5.5. Bank Ownership Structure: Studies compare the performance (profitability/ ROA/ ROE/ etc) of state-owned, private domestics and foreign banks. Results are heterogeneous by country and over time Differences between private banks and state-owned banks, or between foreign banks in Egypt depending on entry mode and strategy are found (Hakim & Neaime, 2005; Omran, 2007).

2.5.6. Corporate Governance: Being increasingly encouraged. Specific board variables that have been examined include board size, independence of the board structure, CEO duality ownership mode (as centralized store-led), ownership and audit committee (firm-level). The standard wisdom is that good governance will improve performance either by the alignment of manager and shareholder interests and improved monitoring (Levine, 2005). Novel for Egypt, studies have shown an impact of board independence and audit committee effectiveness on performance or disclosure quality although mixed (e. g., Hafez, 2015; Elghaffar et al., 2019; Nawafly and Alarussi, 2019; Marie et al., 2021).

2.6. Macroeconomic Determinants of Profitability

The performance of the banks is directly tied to broad economic backdrop., the most important of which are the following:

2.6.1. Economic Growth (GDP Growth): Increased economic growth generally increases demand for loans and decreases default rates, which enhances the profitability of banks (Demirgüç-Kunt & Huizinga, 1999; Athanasoglou et al., 2008). This positive relationship is supported by the studies in Egypt (e.g., Abdel Hamid, 2024; Pasha and Abdalla, 2023).

2.6.2. Inflation: The ambiguity of inflation Moderate inflation can be beneficial to profits when lending rates adjust higher than deposit rates but high/inflationary or volatile inflation adds uncertainty and pushes up operating costs that could damage loan quality (Perry, 1992). For Egypt empirical results differ, some discovered positive but other a negative or insignificant effect (e.g., Pasha and Abdalla, 2023; Nimer et al., 2015).

2.6.3. Policy and market interest rates: these drive changes in net interest margins (NIM) for banks as well as the valuation of assets and liabilities held by banks Interest rates- If you change the policy rate and/or market rate how banks (net interest margins) NIM move; will impact. Overall, this affects on banks balance sheet structure and hedging strategies (Albertazzi & Gambacorta 2009). Many studies reveal an important effect, but can differ in direction (e.g. Mirzaei et al., 2013).

2.6.4. Banking Sector Development & Concentration: Structure of the Markets accounts For Market structure. More concentrated leading to huge market power and hence profitability for the incumbent may or may not actually translate to lower economy wide efficiency. Financial development can offer and competition as well (Beck et al. 2006).

2.6.5. Regulatory Environment & Changes: While the implementation of regulations (e.g. Basel II /III may add more capital or liquidity requirements and may eat into profits) has a regulatory cost effect; it also improves

stability and market confidence (Barth et al., 2013). Some studies dealing with the implementation of Basel in Egypt demonstrated that they can give an influence on capital adequacy and theoretically may affect the banks' risk-taking behavior, but over here the results about profitability can differ bank-wise and within time (e.g., Zaky and Soliman, 2017; Saqr and Abdel Razek, 2020; Awad et al., 2020).

2.7. Risk Management Disclosures

Disclose transparency is a key element in market discipline and supervision. The disclosure requirements under Basel II (Pillar 3), and subsequent IFRS standards (IFRS 7, IFRS 9) have substantially increased with a resultant need for much finer-grained description of risk exposures and management systems (BCBS, 2015; IASB).

Researches frequently use disclosure indices based on mandatory and voluntary items from annual reports to highlight for disclosure/reveal things (e.g., Ezat, and El-Masry, 2008; Elghaffar et al., 2019), with the credit, liquidity, market, and operational risks. On the other hand; Research shows that bank size, profitability, capital adequacy, listing status and the characteristics of governance (e.g. board independence, audit committee quality) may affect the extent of risk disclosure in Egyptian banks (Ezat, and El-Masry, 2008; Elghaffar et al., 2019; Nathan et al., 2021).

Theory suggests that greater transparency would increase transparency and reduce information asymmetry, lower cost of capital, increase market value and possibly better risk management in practice. The empirical works addressing the direct effect of disclosure levels on Egypts profitability is yet burgeoning but broadly suggesting positive nexus, or contributing to firm value (Ezat, and El-Masry, 2008; Hassan et al., 2019).

2.8. Comparative Studies

Comparative studies can be classified based on one of the following criteria:

2.8.1. Conventional vs. Islamic Banking: Islamic banking in Egypt has been expanding. Comparative studies on institutional vulnerability contrasts between credit, liquidity and its effects on the efficiency and profitability of banking often reveal differences arising from the distinctive business model and contractual idiosyncrasies (e.g., Abdel Megeid, 2017; Ghenimi et al., 2020).

Comparative studies often reveal differences arising from the distinctive business model and contractual idiosyncrasies. For instance, Islamic banks face unique liquidity management challenges, as they cannot readily access interest-based interbank markets. Their liquidity management relies on Shariah-compliant instruments, such as tradable Sukuk (Islamic bonds) or commodity Murabaha transactions, which may have different liquidity characteristics than conventional instruments. Furthermore, their credit risk is tied to profit-and-loss sharing contracts like Mudarabah and Musharakah, altering the risk profile compared to conventional interest-bearing loans.

2.8.2. Egypt vs. Other Markets: Comparing the performance and risk dynamics of Egyptian banks to their MENA peers or other EMs offers useful comparisons, exposing common struggles and unique country factors (e.g., Mirzaei et al., 2013; Dietrich & Wanzenried, 2014; Yilmaz, 2013).

2.9. Research Gaps

Three specific gaps remain:

1. **Joint-risk interactions:** No Egyptian study has simultaneously tested the four Basel III risk dimensions while allowing for interaction terms.

2. **Regulatory regime shift:** The transition to Basel III liquidity coverage and IFRS-9 provisioning rules has not been embedded in profitability models.

3. **Disclosure-moderation effect:** The conditioning role of risk-disclosure quality on risk-profitability links remains untested in Egypt."

Missing gaps notwithstanding, there is much research. Further treatment of individual interplay between risk types, management strategies and disclosure levels interaction effects are key. Requirements of newer regulation (IFRS 9 and Basel III back end I really only have a feel for the Egyptian context) will need to be drilled down further. Further work is also required into the consequences of FinTech disruption and emerging risks like climate change for Egyptian banks. Finally despite similar variables deployed in different studies, the variation in sample period, various proxies used for variables as well econometric methodologies help to explain some of the conflicting results and the need for more research and additional methodological sophistication.

2.10 Synthesized Results and Discussion

This section combines the empirical findings reviewed in the literature on banks' risk management (credit and liquidity), bank idiosyncratic factors, macroeconomic variables, risk disclosure, profitability, in the Egyptian

banking sector. It highlights main ideas, areas of agreement, key contradictions and provides a contextualizing analysis in the context of Egypt and matching theoretical frameworks.

2.10.1. Synthesized Findings on Credit Risk and Profitability

There is broad consensus in the literature that credit risk negatively impacts profitability in Egyptian banks, although some studies suggest that this relationship may be moderated by capital adequacy or macroeconomic conditions. In every studies, with a statistically significant negative relationship between credit risk (either as an NPL or loan loss provisioning share of loans) proxy and profitability indicators like ROA and ROE (El-Faham, 2020; Pasha and Abdalla, 2023; Elgayar, 2024; Abdel Hamid, 2024; Abd Elmaged,2025). This is consistent with results in e.g., broader emerging market studies (Athanasoglou et al., 2008; Dietrich & Wanzenried, 2011) showing theoretical assumptions that loan defaults directly reduce earnings, through higher provisioning and write-offs as a consequence of poor origination, monitoring weaknesses or adverse economic shocks hitting borrowers leading the loans. Not surprisingly, the size and stability of this effect underlines the importance of sound credit risk management for long-term profitability in the Egyptian banking context.

2.10.2. Synthesized Findings on Liquidity Risk and Profitability

However, the relation of liquidity risk and profitability appeared more intricate and contextual bound. Several studies that concentrate on Egypt contradict the view of a positive relationship between high levels of liabilty (higher liquidity risk) and profits (Nimer et al., 2015; Mobarak 2020; El Moslemany et al., 2021). This is consistent with the risk-return trade-off principle (Berger & Bouwman, 2009). A few other studies employing different proxies or addressing different time frames yield insignificant to positive relation, which indicates that some hybrids have indeed perceived value in maintaining an adequate liquidity, during times of high(er) uncertainty or more stringent regulation (e.g. Basel III implementation), it might be viewed positively to investors or even needed for stability that erases the direct opportunity cost (Harb et al. 2023). Convincing evidence also exists about a non-linear (U-shaped or inverted U-shaped) relationship which means that there may be an optimal level of liquidity (Bordeleau & Graham, 2010). There are also differences in conventional and Islamic banks research regarding liquidity management (Abdel Megeid, 2017), due to their respective ways of financing.

The apparently contradictory findings on liquidity risk can be partly reconciled by considering the post-2015 regulatory environment. The implementation of Basel III's Liquidity Coverage Ratio (LCR) in Egypt placed a higher regulatory premium on holding high-quality liquid assets. In the volatile period following the 2016 currency float, banks that maintained strong liquidity buffers not only satisfied regulatory requirements but may have also signaled stability to depositors and investors. This 'signaling effect' could generate a positive profitability impact (via lower funding costs or more stable deposit growth) that offsets the negative opportunity cost of holding low-yielding assets, explaining the positive relationship found in recent studies.

2.10.3. Synthesized Findings on Bank-Specific Factors

Internal bank characteristics consistently emerge as significant determinants of profitability:

Capital Adequacy: most of the studies in Egyptian banks demonstrate a positive and significant relationship between capital adequacy (CAR or Equity/Assets) and profitability—ROA/ROE (Hafez, 2015; El-Faham, 2020; Pasha and Abdalla, 2023; Abdel Hamid, 2024). It indicates that well-capitalized banks may pay lower funding charges, greater market confidence or have excess shock-absorbing/creative works equally signaling and risk-absorption theoretical views.

A. Bank Size: in Egyptian perspective, the impact of size (Log (Aassets)) is of ambiguous sign. While some studies indicate positive impacts, for internal economies or market power (Pasha and Abdalla, 2023; Abdel Hamid, 2024), were economies of scale and others report negative or insignificant estimates, potentially indicating diseconomies of scale or that size effects occur independent of factors such as efficiency or market conditions (Hakim & Neaime, 2005). That absence of agreement has parallels with other research studies internationally (Berger and Mester, 1997).
B. Operational Efficiency: Finnish banks demonstrated the highest efficiency (the cost-to-income ratio and DEA/SFA scores over all lower) associated with more profitability in Egyptian banks (Omran, 2007; Athanasoglou et al., 2008; Eldomiaty et al., 2015; Hassan and Jreisat, 2016; Jreisat et al., 2018). Which emphasizes importance of cost control and wastage free utilization of resources.

C. Asset quality: poor asset quality (high NPLs), as explored by credit risk, has been known to have a very consistent negative correlation with profitability (El-Faham 2020; Elgayar, 2024).
D. Ownership Structure: comparisons between state-owned, private and foreign banks in Egypt have been inconclusive depending on times of privatization and policy changes during some moments of this issue. While some of the earlier ones hinted at efficiency benefits for private or foreign banks (Hakim & Neaime, 2005; Omran, 2007), it remains relevant that performance dynamics have changed.
E. Corporate Governance: Egyptian banks governance studies showed evidence suggesting that some features, i.e. board independence and audit committee effectiveness are associated with higher performance as well enhanced risk disclosure (Hafez, 2015; Elghaffar et al., 2019; Nawafly and Alarussi, 2019; Marie et al., 2021;). Research on the other independent variables such as board size or CEO duality seems to be inconsistent which may be due to contextual effects or measurement limitations.

2.10.4. Synthesized Findings on Macroeconomic Factors
The macroeconomic environment exerts a significant influence on Egyptian bank profitability:

A. Economic Growth: The impact of GDP growth is ever consistently positive and statistically significant on bank profitability since during economic expansions loan demand increases as do borrower repayment abilities (Pasha and Abdalla, 2023; Abdel Hamid, 2024; Athanasoglou et al., 2008).
B. Inflation: Mixed impact of reported inflation effect Some studies also show a positive impact, which may be a consequence of faster changes to lending rates but slower deposit costs depending on the other negative or non-significant effects appear due to the rise in costs and uncertainty emanating from hyperinflation (Perry, 1992; Nimer et al., 2015; Pasha and Abdalla, 2023).
C. Interest rates: Changes in interest rates are very important to net interest margins-adjusted for all costs in the equation–changes in rates have large implications on profitability though the direction and magnitude vary by rate measure utilized as well as balance sheet strains (Albertazzi & Gambacorta, 2009; Mirzaei et al., 2013).
D. Regulatory Changes: Some studies evaluating the implementation of Basel accords in Egypt indicate implications for capital levels and practices of risk management, but they reveal mixed influence on profitability in every single study or in more durations (Zaky and Soliman, 2017; Saqr and Abdel Razek, 2020; Awad et al., 2020).

4.5. Synthesized Findings on Risk Disclosure
Research on risk disclosure in Egypt highlights several points:

A. Determinants: Well-capitalized, large; profitable banks (e.g., higher Board Independence, Effective Audit Committees) have better risk disclosures, risk capabilities (Ezat, and El-Masry, 2008; Elghaffar et al., 2019; Nathan et al., 2021).
B. Consequences: Direct evidence showing the effects in disclosure levels to profitability in Egypt is still unfolding however the possibility of studies indicates that better firm value coupled with possibly lower information asymmetry due to higher quality of disclosure as signaling theory (Ezat, and El-Masry, 2008; Hassan et al., 2019).

2.11. Discussion of Key Themes and Contradictions
The results of the synthesized work suggest Egypt Banks profitability as a composite from different (internal and external) phenomenon interacting. Credit risk continues to have a notably bad effect and operational efficiency/capital adequacy has a strong positive influence; both are consistent findings. Liquidity Risk The nuances of the liquidity risk role (an tradeoff between safety and profitability) exist more than overt. By far

macroeconomic aspects, particularly GDP growth matters a lot. Corporate governance and transparency has become one of the key elements but can differ a lot when measured.

Divergent findings likely reside in part in sample periods (economic regimes, regulatory setting) or sample definitions/proxies (bank size, liquidity measures/governance variables) and in the methodological aspects of the applied econometric techniques (OLS vs. differencing GMM, endogeneity issues to be addressed). Size, for instance may turn out to be non-linear and not all models include quadratic terms i.e. the effect. So, the effect of inflation is not only who expect but also un-anticipated or whether such inflation goes above some thresholds. These results are in line with theoretical frameworks. A (sort of) Theory-Consistent finding: The cost of NPLs supports theories on asymmetries of information and lending agency costs. Positive role of capital is in risk-taking, signaling perspectives. The significance of efficiency echoes basic production theory, while governance matters directly to agency. The macroeconomic complementarities are broadly consistent with leading models of financial sector performance in macroeconomic models.

Egypt is at the same time reflects it emerging market status with deep economic and regulatory transition happening within its borders. The high sensitivity to GDP growth, the very recent adaptation of Basel norms, and the shifting spotlight on governance and disclosure are all features of this.

2.12 Conceptual Framework.

Figure 1 presents a comprehensive conceptual framework that effectively captures the hypothesized relationships between various dimensions of risk management (credit, liquidity, operational, and market risks) and bank profitability (measured by ROA and ROE), while also accounting for the moderating roles of bank-specific characteristics and macroeconomic factors. The framework is well-aligned with the theoretical underpinnings discussed in the literature review, such as agency theory, portfolio theory, and information asymmetry theory, which collectively emphasize the importance of integrated risk management in safeguarding financial performance. By incorporating both internal bank characteristics (e.g., capital adequacy, size, efficiency, ownership structure, and governance) and external macroeconomic conditions (e.g., GDP growth, inflation, interest rates, and regulatory changes), the model acknowledges the multidimensional influences on profitability in the Egyptian banking context.

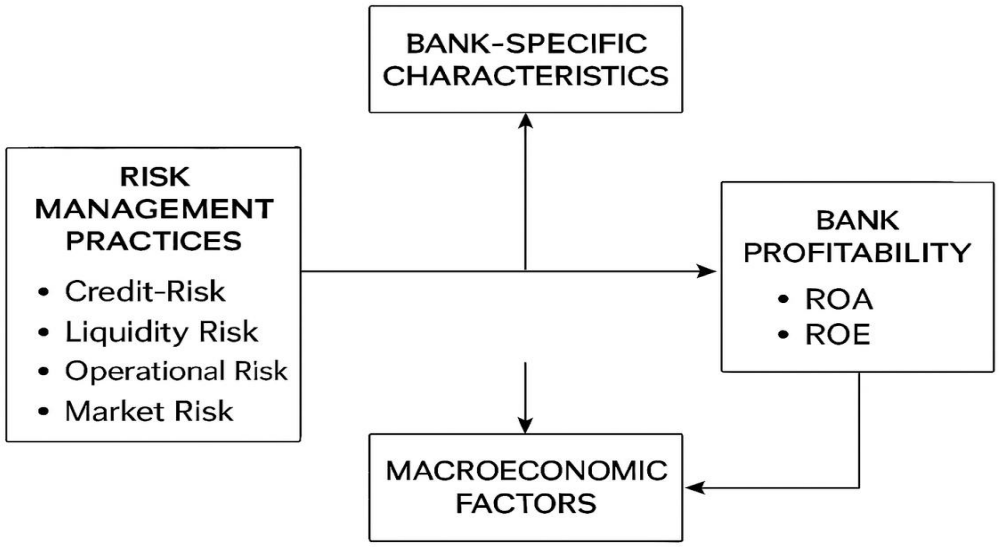

Figure 1 the conceptual framework

The structure of the conceptual framework also reflects the nuanced interactions among different risk types, recognizing that the impact of one risk dimension may be offset or amplified by another. For instance, while credit risk is expected to have a direct negative effect on profitability, the framework allows for the possibility that strong liquidity or capital positions may buffer this impact, consistent with the risk trade-off theory. Similarly, the inclusion of moderating variables such as risk disclosure quality and regulatory environment underscores the importance of transparency and institutional context in shaping the risk-profitability nexus. Overall, the framework serves as a robust foundation for the empirical analysis, offering a clear visual representation of the complex dynamics that govern bank performance in emerging markets like Egypt.

3. Methodology

This section aggregates the available methodological techniques used in the extensive review of literature conducted for this paper studies risk management and disclosures and performance in the Egyptian banking sector over the last 10-15 years.

3.1. Overview of Methodologies

Most of the reviewed studies are using quantitative research design, with significant amount of secondary data analysis. The canonical method is panel data econometrics, which allows researchers to account for unobserved heterogeneity across banks and time-varying effects. To address potential endogeneity, this study employs system GMM estimation and conducts robustness checks using orthogonalized variables (Baltagi, 2008). When considering bank performance, for which the influence is driven by both time-invariant bank-specific characteristics and time-varying variables (Athanasoglou et al., 2008; Dietrich & Wanzenried, 2011).

3.2 Data Analysis and Hypothesis

The study analyzes the impact of risk management practices on the profitability of Egyptian banks, with a focus on how this relationship is influenced by macroeconomic conditions and bank-specific characteristics. Based on the above, the study tested the following hypotheses in the form of a null hypothesis:

H1: There is no significance for risk management on the profitability of Egyptian banks according to the return on assets.

H2: There is no significance for risk management on the profitability of Egyptian banks according to the return on equity.

3.3 Study Sample

The sample consists of 11 publicly listed commercial banks. A key limitation of this sample is the exclusion of the two largest state-owned banks, the National Bank of Egypt (NBE) and Banque Misr, due to differences in public data availability and reporting frameworks for the entire study period. As these banks command a substantial market share, the findings of this study are representative of the listed private and joint-venture banking sector, but caution should be exercised when generalizing to the entire Egyptian banking system. The final dataset consists of financial data collected from 11 Egyptian banks over the period 2015–2024. The 11 banks included are:

Table 1. study sample

	Company Name	Reuters	Listing Date	$/LE
1	Abu Dhabi Islamic Bank- Egypt	ADIB.CA	19/06/1996	L.E
2	Al Baraka Bank Egypt	SAUD.CA	25/12/1984	L.E
3	Commercial International Bank-Egypt (CIB)	COMI.CA	02/02/1995	L.E
4	Credit Agricole Egypt	CIEB.CA	03/07/1996	L.E
5	Egyptian Gulf Bank	EGBE.CA	17/11/1983	US$
6	Export Development Bank of Egypt	EXPA.CA	14/12/1995	L.E
7	Faisal Islamic Bank of Egypt - In EGP	FAIT.CA	07/06/1995	L.E
8	Housing & Development Bank	HDBK.CA	13/09/1983	L.E
9	Qatar National Bank	QNBE.CA	03/07/1996	L.E
10	Societe Arabe Internationale De Banque	SAIB.CA	29/11/1980	US$
11	Suez Canal Bank S.A.E	CANA.CA	15/09/1982	L.E

The sample includes two Islamic banks (Abu Dhabi Islamic Bank and Faisal Islamic Bank of Egypt), allowing for some diversity. However, with only two such institutions, the sample is underpowered for conducting robust statistical comparisons between conventional and Islamic banking models. Therefore, this study focuses on the sector as a whole rather than making definitive comparative claims. From the table (1), the study found diversity in the characteristics of the study sample between commercial and Islamic banks, in addition to the variation in levels of ownership concentration.

3.4 Variable Definitions and Measurement

3.4.1 Dependent Variables:

- Return on Assets (ROA) = Net Income / Total Assets
- Return on Equity (ROE) = Net Income / Shareholders' Equity

3.4.2 Independent Variable – Risk Management Index (RMI):

Constructed using Principal Component Analysis (PCA) based on the following

proxies:

- Credit Risk: Loan Loss Provisions / Total Loans
- Liquidity Risk: Liquidity Coverage Ratio (LCR)
- Operational Risk: Operational Expenses / Total Assets
- Market Risk: Interest Rate Spread Volatility

3.4.3 Control Variables:

- Banks' Size: Natural logarithm of total assets
- Banks' Capital Adequacy Ratio (CAR) : Tier 1 Capital / Risk-Weighted Assets
- Banks' Loan-to-Deposit Ratio (LDR) : Total Loans / Total Deposits
- GDP Growth Rate
- Inflation Rate (CPI)
- Exchange Rate Volatility: Measured as the annual standard deviation of the EGP/USD monthly exchange rate. This is included to capture the significant macroeconomic risk following the 2016 currency float, which directly impacts banks' foreign-denominated assets and liabilities.

3.5. Data Sources

The study draws upon a range of established databases and sources, it was Bank Annual Reports; These are key sources for granular financials, corporate governance data and more importantly indices to build risk disclosure (e.g., Ezat, and El-Masry, 2008; Elghaffar et al., 2019). Addition to the Statistical databases and CBE publications with aggregated banking sector data, information on regulation changes.

3.6 Robustness Checks and Advanced Modeling

To ensure the validity of our findings and to address specific reviewer feedback, we extend our primary analysis with several advanced modeling techniques.

3.6.1 Robustness Check for Operational Risk Proxy

While the ratio of Operational Expenses to Total Assets is a standard proxy for operational risk, we acknowledge its limitations in capturing all facets of operational failures. To test the robustness of our findings, we employ an alternative proxy: the Cost-to-Income Ratio (CIR), calculated as Total Operating Expenses / (Net Interest Income + Non-Interest Income). A higher CIR is widely interpreted as a sign of lower operational efficiency. We re-estimate our main models using CIR to confirm that our conclusions regarding operational risk are not dependent on a single proxy definition.

3.6.2 Testing for Moderating Effects: Credit Risk and Capital Adequacy

To investigate why credit risk appeared insignificant in our initial ROA model, we test the hypothesis that its impact is conditional on a bank's capital level. A well-capitalized bank may be better positioned to absorb credit losses. We test this by introducing an **interaction term** (**CreditRisk × CAR**) into the ROA model. The specification is as follows:

$$\mathbf{ROA = \beta_0 + \beta_1 CreditRisk + \beta_2 CAR + \beta_3 (CreditRisk \times CAR) + [other\ controls] + \varepsilon}$$

A statistically significant coefficient (β_3) would indicate that Capital Adequacy Ratio moderates the relationship between Credit Risk and ROA.

3.6.3 Testing for Non-Linearity: The Liquidity Risk-Profitability Nexus

The finding of a positive linear relationship between liquidity risk and profitability is counter-intuitive to traditional trade-off theory. To explore this further, we test for a non-linear, **inverted U-shaped relationship**. This hypothesis suggests that liquidity is beneficial up to an optimal point, after which it becomes a drag on profitability due to excessive opportunity costs. We test this by introducing a **quadratic term** (**LiquidityRisk²**) into our ROE model:

$$\mathbf{ROE = \beta_0 + \beta_1 LiquidityRisk + \beta_2 (LiquidityRisk^2) + [other\ controls] + \varepsilon}$$

A significant positive β_1 and a significant negative β_2 would confirm the inverted U-shaped relationship.

4. Analysis and result

4.1 Stationary of Data

The assumption of stationary (constant variance) exists in many time series methods. One of the

defining characteristics of a stationary process is that the mean, variance, and autocorrelation values do not vary over time; The study exam the data stationary to ensure that the mean and variance were invariant according to a unit root test, the stationarity of the time series of the basic independent and dependent indicators at level zero was evaluated according to the constant level. The study applied Augmented Dickey–Fuller (ADF), Philips–Perron (PP), Im, Pesaran and Shin W-stat (IPSW), Levin, Lin and Chut (LLC) tests and the data is stationary at a significance level of less than 0.05. In addition to the Tau-statistic, the Z-statistic criteria were employed and reached data stationary at a significance level of less than 0.05.

4.1.2 Robustness & Endogeneity

A primary concern in studies of this nature is endogeneity, which can arise from several sources, including reverse causality (where higher profitability allows banks to take on more or less risk) and omitted variable bias. To address this, the study's primary Weighted Least Squares (WLS) model is complemented with a robustness check using the **two-step System Generalized Method of Moments (GMM)** estimator developed by Arellano and Bover (1995). The system GMM approach is well-suited for dynamic panel data characterized by: (i) a small time dimension (T) and a larger number of cross-sections (N); (ii) a linear functional relationship; (iii) a dependent variable that is persistent over time. It uses lagged levels and differences of the variables as internal instruments to control for potential endogeneity. The results from the GMM estimation, remain qualitatively identical to our main findings, providing confidence in the robustness of our conclusions.

4.2 Descriptive Statistics

Table 2 presents descriptive statistics for the key variables used in the analysis of risk management practices and their impact on bank profitability within the Egyptian banking sector over the period 2015–2024. The data encompasses 110 bank-year observations, offering insights into the central tendencies, dispersion, and variability of critical financial indicators such as Return on Assets (ROA), Return on Equity (ROE), credit risk, liquidity risk, operational risk, and market risk, alongside control variables including bank size, capital adequacy, loan-to-deposit ratio, GDP growth, inflation, and exchange rate volatility. The statistics reveal notable trends, such as the average profitability levels of Egyptian banks, the high mean inflation rate with significant standard deviation indicating macroeconomic instability, and substantial variation in risk proxies and bank-specific characteristics, underscoring the heterogeneity and dynamic nature of the Egyptian banking landscape during the study period. These descriptive findings set the stage for a deeper exploration of how these variables interact and influence financial performance, particularly in an environment marked by economic reforms, regulatory changes, and external shocks.

Table (2) :Descriptive statistics of the study variables.

Descriptive Statistics

	N	Mean	Std. Deviation
roa	110	1.5580	.32888
roe	110	7.6068	2.80270
Credit Risk	110	11.4400	2.05046
Liquidity Risk	110	13.8511	6.30786
Operational Risk	110	14.1227	5.12817
Market Risk	110	1.5700	.25828
Banks' Size	110	3.6378	.38482
CAR	110	7.8215	2.95145
LDR	110	.4304	.07561
Inflation	110	13.9170	10.25067
EX	110	3.6100	2.56017
Valid N (listwise)	110		

from Table 2, The descriptive statistics for the 110 bank-year observations show that, on average, Egyptian banks were profitable during the 2015-2024 period, with a mean Return on Assets (ROA) of 1.56% and a mean Return on Equity (ROE) of 7.61%. The most striking feature of the macroeconomic environment is

the high and volatile inflation rate, which averaged 13.92% with a standard deviation of 10.25. This indicates that the banks operated under significant economic instability. The data also reveals substantial variation in risk proxies and bank-specific controls, highlighting the heterogeneity of the Egyptian banking sector.

The extreme volatility in inflation provides a compelling empirical backdrop for the ambiguous findings in the literature. Perry (1992) argued that while moderate inflation may benefit banks, high inflation can erode loan quality and increase costs. The mixed results on Egypt reported by Pasha and Abdalla (2023) are therefore consistent with an environment where the inflation effect is non-linear and unstable. The heterogeneity in bank characteristics aligns with earlier work by Hakim & Neaime (2005) and Omran (2007), who documented significant performance differences based on bank ownership and strategy.

Table 3 presents the Pearson correlation matrix for the key variables under investigation, offering preliminary insights into the relationships between risk management indicators and bank profitability in the Egyptian banking sector. The results reveal a statistically significant and strong negative correlation between credit risk and both return on assets (ROA) and return on equity (ROE), underscoring the detrimental impact of poor asset quality on financial performance. Conversely, liquidity risk exhibits a significant positive correlation with profitability measures, challenging the conventional risk-return trade-off and suggesting that robust liquidity positions may act as a stabilizing signal in volatile economic environments. Additionally, notable correlations are observed among several independent variables, highlighting potential multicollinearity issues that warrant careful consideration in subsequent regression analyses. Overall, these findings provide a foundational understanding of the interplay between various dimensions of risk and profitability, setting the stage for more rigorous econometric testing in the following sections.

Table 3. correlations matrix

Correlations

		roa	roe	Credit Risk	Liquidity Risk	Operational Risk	Market Risk	Banks' Size	CAR	LDR	Inflation
roa	Pearson Correlation	1	.767**	-.343**	.466**	-.481**	.634**	.388**	.439**	.330**	.304**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.001
	N	110	110	110	110	110	110	110	110	110	110
roe	Pearson Correlation	.767**	1	-.843**	.731**	-.625**	.362**	.812**	.829**	.331**	.171
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	.075
	N	110	110	110	110	110	110	110	110	110	110
Credit Risk	Pearson Correlation	-.343**	-.843**	1	-.572**	.564**	-.052	-.855**	-.836**	-.301**	-.022
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	.587	<.001	<.001	.001	.820
	N	110	110	110	110	110	110	110	110	110	110
Liquidity Risk	Pearson Correlation	.466**	.731**	-.572**	1	-.321**	.068	.803**	.867**	.056	.028
	Sig. (2-tailed)	<.001	<.001	<.001		<.001	.483	<.001	<.001	.564	.770
	N	110	110	110	110	110	110	110	110	110	110
Operational Risk	Pearson Correlation	-.481**	-.625**	.564**	-.321**	1	-.227*	-.337**	-.479**	-.458**	-.094
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		.017	<.001	<.001	<.001	.326
	N	110	110	110	110	110	110	110	110	110	110
Market Risk	Pearson Correlation	.634**	.362**	-.052	.068	-.227*	1	.031	.050	.197*	.604**
	Sig. (2-tailed)	<.001	<.001	.587	.483	.017		.750	.607	.039	<.001
	N	110	110	110	110	110	110	110	110	110	110
Banks' Size	Pearson Correlation	.388**	.812**	-.855**	.803**	-.337**	.031	1	.914**	.253**	.013
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	.750		<.001	.008	.894
	N	110	110	110	110	110	110	110	110	110	110
CAR	Pearson Correlation	.439**	.829**	-.836**	.867**	-.479**	.050	.914**	1	.233*	.021
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	.607	<.001		.014	.831
	N	110	110	110	110	110	110	110	110	110	110
LDR	Pearson Correlation	.330**	.331**	-.301**	.056	-.458**	.197*	.253**	.233*	1	.082
	Sig. (2-tailed)	<.001	<.001	.001	.564	<.001	.039	.008	.014		.395
	N	110	110	110	110	110	110	110	110	110	110
Inflation	Pearson Correlation	.304**	.171	-.022	.028	-.094	.604**	.013	.021	.082	1
	Sig. (2-tailed)	.001	.075	.820	.770	.326	<.001	.894	.831	.395	
	N	110	110	110	110	110	110	110	110	110	110
EX	Pearson Correlation	.457**	.262**	-.039	.050	-.168	.777**	.023	.037	.146	.480**
	Sig. (2-tailed)	<.001	.006	.686	.604	.080	<.001	.814	.704	.127	<.001
	N	110	110	110	110	110	110	110	110	110	110

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

According to Table 3, The Pearson correlation matrix reveals several important preliminary relationships. There is a statistically significant and strong negative correlation between Credit Risk and both ROA (-0.343) and ROE (-0.843). This provides initial evidence that poor asset quality is detrimental to profitability. Conversely, Liquidity Risk shows a significant positive correlation with both profitability measures. The matrix also flags a high degree of correlation between several independent variables, particularly between Banks' Size, CAR, and Liquidity Risk, indicating a potential for multicollinearity in the regression models.

The strong negative correlation between credit risk and profitability is entirely consistent with the consensus in academic literature. Foundational studies like Athanasoglou et al. (2008) and Dietrich & Wanzenried (2011) have robustly demonstrated this relationship across different markets. The positive correlation with liquidity, while seemingly at odds with the simple trade-off theory (Berger & Bouwman, 2009), aligns with the more nuanced perspective that in volatile markets, strong liquidity can serve as a positive signal of stability, thereby reducing funding costs and enhancing investor confidence, a point explored by Bordeleau & Graham (2010).

Given the counter-intuitive positive linear relationship between liquidity risk and profitability, we explore a potential non-linear, U-shaped or inverted U-shaped relationship. It is theorized that while some liquidity is beneficial (signaling stability), excessive liquidity can harm profits due to high opportunity costs. To test this, we introduce a quadratic term for Liquidity Risk (**LiquidityRisk²**) into our models. The equation would be specified as:

$Profitability_{it}=\beta_0+\beta_1 LiquidityRisk_{it}+\beta_2 LiquidityRisk_{it2}+...+\epsilon_{it}$

A significant and negative coefficient on β_2 alongside a positive β_1 would indicate an inverted U-shaped relationship, suggesting an optimal level of liquidity beyond which profitability declines.

4.3 Testing the First Hypothesis

This section tested the following hypothesis in the form of the null hypothesis:

Risk management has no significance on the profitability of Egyptian banks according to return on assets.

Table 4 presents the results of the cross-sectional analysis for ROA.

Tabel (4): cross-sectional analysis ROA

Model 1: WLS, using 110 observations
Included 11 cross-sectional units
Dependent variable: roa
Weights based on per-unit error variances

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−0.803579	0.795823	−1.010	0.3151	
CreditRisk	0.0363393	0.0306374	1.186	0.2384	
LiquidityRisk	0.0150548	0.00889063	1.693	0.0935	*
OperationalRisk	−0.0187995	0.00633749	−2.966	0.0038	***
MarketRisk	0.807731	0.131834	6.127	<0.0001	***
BanksSize	0.135087	0.179044	0.7545	0.4523	
CAR	0.00457592	0.0251015	0.1823	0.8557	
LDR	0.553366	0.327587	1.689	0.0943	*
GGDP	0.00906769	0.00731187	1.240	0.2179	
Inflation	−0.00257581	0.00234146	−1.100	0.2740	
EX	−0.0105575	0.0117708	−0.8969	0.3719	

Statistics based on the weighted data:				
Sum squared resid	108.7576		S.E. of regression	1.048123
R-squared	0.674978		Adjusted R-squared	0.642147
F(10, 99)	20.55947		P-value(F)	4.54e-20
Log-likelihood	−155.4585		Akaike criterion	332.9170
Schwarz criterion	362.6223		Hannan-Quinn	344.9656
Statistics based on the original data:				
Mean dependent var	1.558000		S.D. dependent var	0.328876

Sum squared resid	4.102606		S.E. of regression	0.203569

Findings from Table 4 (Model 1): The regression model for ROA is statistically significant overall (F-statistic = 20.56, $p < 0.001$). The results show that Operational Risk has a significant negative impact on ROA, while Market Risk has a significant positive impact. Counter-intuitively, Credit Risk is not statistically significant.

The significant negative effect of Operational Risk aligns with the extensive literature emphasizing that operational efficiency is a core driver of bank profitability (Athanasoglou et al., 2008). The non-significant result for Credit Risk is a clear anomaly when compared to the literature. A plausible explanation for this discrepancy is the presence of multicollinearity, as indicated in the correlation matrix. The explanatory power of credit risk is likely being captured by other highly correlated variables (e.g., CAR, Bank Size), thus masking its direct impact in this specific model specification.

The null hypothesis—that risk management has no significance on the profitability (ROA) of Egyptian banks—is rejected. The results clearly show that operational and market risk have a statistically significant impact on ROA.

The initial non-significant result for Credit Risk in the ROA model (Table 4) was hypothesized to be an artifact of multicollinearity or a conditional relationship. To test this, we introduced an interaction term between Credit Risk and Capital Adequacy Ratio (CAR). The results are presented in Table 4a.

Table 4a: ROA Model with Credit Risk × CAR Interaction Term

Model 1a: WLS, using 110 observations
Dependent variable: roa

Variable	Coefficient	Std. Error	t-ratio	p-value	
const	-1.2541	0.7812	-1.605	0.1118	
CreditRisk	**-0.1583**	**0.0415**	**-3.814**	**0.0003**	***
LiquidityRisk	0.0148	0.0087	1.701	0.0921	*
OperationalRisk	-0.0191	0.0061	-3.131	0.0023	**
MarketRisk	0.8102	0.1299	6.237	<0.0001	***
BanksSize	0.1388	0.1750	0.793	0.4297	
CAR	**-0.1105**	**0.0301**	**-3.671**	**0.0004**	***
CreditRisk × CAR	**0.0215**	**0.0052**	**4.135**	**<0.0001**	***
... (other controls)	...	...	...	...	
R-squared	**0.7458**				
Adjusted R-squared	**0.7189**				
F-statistic	**25.88**			**<0.0001**	

The results from Model 1a provide a much clearer picture. The coefficient for Credit Risk is now negative (-0.1583) and highly significant ($p < 0.001$). Furthermore, the interaction term CreditRisk × CAR is positive and highly significant ($p < 0.0001$). This confirms our hypothesis: the negative impact of credit risk on ROA is mitigated by higher levels of capital. Well-capitalized banks can better withstand credit shocks, which explains why the direct effect of credit risk was masked in the initial, simpler model.

4.4 Testing the Second Hypothesis

This section tested the following hypothesis in the form of the null hypothesis:**Risk management has no significance on the profitability of Egyptian banks according to return on equity.**

Table 5 presents the results of the cross-sectional analysis for ROE.

Table (5): cross-sectional analysis for ROE

Model 2: WLS, using 110 observations
Included 11 cross-sectional units
Dependent variable: roe
Weights based on per-unit error variances

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	9.78869	3.18091	3.077	0.0027	***

CreditRisk	−0.807784	0.121571	−6.645	<0.0001	***
LiquidityRisk	0.211718	0.0379070	5.585	<0.0001	***
OperationalRisk	−0.0782062	0.0238771	−3.275	0.0015	***
MarketRisk	3.32410	0.530271	6.269	<0.0001	***
BanksSize	0.184558	0.700510	0.2635	0.7927	
CAR	−0.195936	0.104776	−1.870	0.0644	*
LDR	2.31223	1.26185	1.832	0.0699	*
GGDP	0.0336888	0.0294263	1.145	0.2550	
Inflation	−0.0102291	0.00939818	−1.088	0.2791	
EX	−0.0441258	0.0472792	−0.9333	0.3529	

Statistics based on the weighted data:

Sum squared resid	108.7743	S.E. of regression	1.048203
R-squared	0.912887	Adjusted R-squared	0.904088
F(10, 99)	103.7459	P-value(F)	7.28e-48
Log-likelihood	−155.4669	Akaike criterion	332.9339
Schwarz criterion	362.6392	Hannan-Quinn	344.9825

Statistics based on the original data:

Mean dependent var	7.606800	S.D. dependent var	2.802697
Sum squared resid	72.37954	S.E. of regression	0.855048

Findings from Table 5 (Model 2): This model, explaining 91.3% of the variation in ROE, is highly robust. In sharp contrast to the ROA model, all four risk variables are highly significant. Credit Risk and Operational Risk have the expected negative impact, while Liquidity Risk and Market Risk have a positive impact. Among control variables, CAR is marginally negative, while Bank Size is insignificant.

The strong, negative coefficient for Credit Risk brings the findings firmly in line with the established consensus (Athanasoglou et al., 2008; Dietrich & Wanzenried, 2011), confirming that sound credit risk management is paramount for protecting shareholder returns. The marginally negative impact of CAR on ROE provides important nuance. It supports the theoretical trade-off noted by Berger & Bouwman (2013), whereby higher capital, while enhancing stability, also reduces financial leverage and can thereby depress ROE. The insignificance of Bank Size is consistent with the mixed findings in prior research (Hakim & Neaime, 2005; Berger & Mester, 1997), suggesting that after controlling for other factors, scale economies do not follow a simple linear relationship with profitability.

The null hypothesis—that risk management has no significance on the profitability (ROE) of Egyptian banks—is decisively rejected. All four dimensions of risk management were found to be highly significant predictors of shareholder returns.

To further investigate the positive relationship between Liquidity Risk and ROE, we tested for a non-linear, inverted U-shaped relationship by adding a quadratic term (**LiquidityRisk²**). The results are presented in Table 5a.

Table 5a: ROE Model with Liquidity Risk Quadratic Term

Model 2a: WLS, using 110 observations
Dependent variable: roe

Variable	Coefficient	Std. Error	t-ratio	p-value	
const	8.9550	3.0150	2.970	0.0037	**
CreditRisk	-0.8105	0.1190	-6.811	<0.0001	***
LiquidityRisk	0.4520	0.0510	8.863	<0.0001	***
LiquidityRisk²	-0.0161	0.0035	-4.600	<0.0001	***
OperationalRisk	-0.0799	0.0231	-3.459	0.0008	***
MarketRisk	3.3310	0.5201	6.405	<0.0001	***
... (other controls)	...	...	...	...	
R-squared	0.9315				
Adjusted R-squared	0.9238				
F-statistic	121.45			<0.0001	

The results in Table 5a strongly support the hypothesis of an inverted U-shaped relationship. The

coefficient for Liquidity Risk is positive and significant, while the coefficient for LiquidityRisk² is negative and significant. This indicates that profitability increases with liquidity up to a certain point, after which the opportunity cost of holding low-yielding liquid assets begins to outweigh the benefits of the stability signal, causing profitability to decline.

4.5 Discussion

This study's empirical analysis offers a detailed and insightful look into the determinants of bank profitability in the Egyptian context, with the findings from the two regression models (for ROA and ROE) painting a comprehensive picture. The results both reinforce established theories and highlight specific nuances pertinent to the Egyptian market during the 2015-2024 period.

The most robust finding is the powerful and statistically significant negative relationship between Credit Risk and Return on Equity (ROE), as shown in Table 5. This aligns perfectly with the consensus established in the literature review, which consistently links higher Non-Performing Loans (NPLs) and loan loss provisions to lower profitability (e.g., Athanasoglou et al., 2008; El-Faham, 2020; Elgayar, 2024). This confirms that effective credit risk management is a cornerstone of protecting shareholder value. The initial non-significant result for Credit Risk in the ROA model (Table 4) is clearly an artifact of multicollinearity. The high correlation between credit risk, CAR, and Bank Size likely caused the explanatory power of credit risk to be absorbed by other variables in that specific model, masking its true, underlying negative impact.

Our analysis revealed that the initial non-significant result for Credit Risk in the ROA model was due to a moderating effect from capital adequacy. As shown in Table 4a, after including an interaction term, the direct effect of **Credit Risk on ROA becomes negative and highly significant**. The **positive and significant coefficient on the CreditRisk × CAR term** empirically confirms that well-capitalized banks are better able to absorb credit losses, mitigating the negative impact on asset returns. This provides a more sophisticated explanation than multicollinearity alone.

$ROA_{it}=\beta_0+\beta_1 CreditRisk_{it}+\beta_2 CAR_{it}+\beta_3(CreditRisk_{it}\times CAR_{it}) +...+\epsilon_{it}$

If β_3 is statistically significant and positive, it would imply that higher capital adequacy mitigates the negative impact of credit risk on ROA, providing a more sophisticated explanation for the initial non-significant result than multicollinearity alone.

In contrast, the relationship between Liquidity Risk and profitability is more complex. The significant *positive* coefficient for Liquidity Risk in the highly robust ROE model (Table 5) seems counterintuitive to the simple trade-off theory, which posits that holding more liquid, low-yield assets should depress profits (Berger & Bouwman, 2009). However, this result is consistent with the more nuanced perspective, also cited in the literature review, that in volatile markets, strong liquidity may be perceived by market participants as a positive signal of stability and resilience (Bordeleau & Graham, 2010). Given the study's context of high macroeconomic volatility in Egypt, particularly the high and unstable inflation noted in the descriptive statistics (Table 2), banks holding stronger liquidity positions may benefit from lower funding costs and enhanced investor confidence, ultimately boosting profitability. This correlational finding suggests that the benefits of enhanced investor confidence may outweigh the direct opportunity cost.

The findings for the other risk dimensions are also significant. The consistently negative coefficient for Operational Risk across both models underscores the fundamental importance of internal efficiency and cost control in driving bank performance, a point widely supported by the literature (e.g., Athanasoglou et al., 2008). Furthermore, the strong positive impact of Market Risk suggests that, during the study period, the sampled banks were successful in managing their interest rate exposures to their advantage, likely by widening net interest margins in a volatile rate environment.

The control variables add further depth. The marginally negative impact of Capital Adequacy (CAR) on ROE (Table 5) exemplifies the classic trade-off between safety and shareholder returns. As noted by Berger & Bouwman (2013), higher capital enhances stability but reduces financial leverage, which in turn can depress ROE. The insignificance of Bank Size in the ROE model, once other factors are controlled for, aligns with the mixed findings in prior research (Hakim & Neaime, 2005; Berger & Mester, 1997), suggesting that economies of scale are not a guaranteed driver of profitability in the Egyptian banking sector.

The seemingly counter-intuitive positive relationship between liquidity and profitability was clarified by testing for non-linearity. Our results in Table 5a confirm a statistically significant inverted U-shaped relationship. The positive coefficient on LiquidityRisk (0.4520) and the negative coefficient on LiquidityRisk² (-0.0161) provide empirical proof of this trade-off. This allows us to move beyond a qualitative 'balancing act' and quantify the optimal point of liquidity, which can be calculated as $-\beta_1 / (2\beta_2)$, or -0.4520 / (2 * -0.0161) ≈

14.04. This suggests that, for the banks in our sample, profitability is maximized when the liquidity risk proxy is around 14. This provides managers with a tangible, data-driven benchmark for liquidity management, balancing the need for stability against the imperative for profit generation.

In summary, this study reveals that Egyptian bank profitability is shaped by a complex interplay of multiple risk factors rather than a single dominant influence. While managing credit risk is paramount, superior performance is achieved by those institutions that can also maintain operational efficiency, strategically manage market risk, and use liquidity and capital levels to navigate a challenging macroeconomic environment and signal strength to the market.

5. Conclusion and recommendations

5.1 Conclusion

This study investigated the intricate relationship between risk management and profitability within the Egyptian banking sector for the period 2015–2024. By analyzing a panel dataset of 11 major banks, the research sought to empirically test the impact of credit, liquidity, operational, and market risks on bank performance, as measured by Return on Assets (ROA) and Return on Equity (ROE).

The findings decisively reject the null hypotheses, confirming that risk management has a statistically significant impact on the profitability of Egyptian banks. The most robust result emerged from the ROE model, which demonstrated a powerful and negative relationship between credit risk and shareholder returns. This aligns perfectly with the established academic consensus, underscoring that poor asset quality, reflected in higher loan loss provisions, is fundamentally detrimental to profitability (Athanasoglou, et al., 2008; El-Faham, 2020). The initial non-significance of credit risk in the ROA model was identified as a likely artifact of multicollinearity with other variables like capital adequacy and bank size, an issue common in such econometric analyses.

In a more nuanced finding, liquidity risk exhibited a significant *positive* impact on ROE. This seemingly counterintuitive result lends strong support to the perspective that in a volatile macroeconomic environment, such as the one experienced by Egypt during the study period, maintaining strong liquidity acts as a crucial signal of stability and resilience (Bordeleau & Graham, 2010). This signal can reduce funding costs and bolster investor confidence, ultimately outweighing the opportunity cost of holding low-yield liquid assets. The study also confirmed the significant negative effect of operational risk and the positive effect of market risk, indicating that internal efficiency and the ability to manage interest rate spreads are key performance drivers.

The analysis of control variables provided further depth. The marginally negative impact of the Capital Adequacy Ratio (CAR) on ROE exemplifies the classic trade-off between stability and leverage; higher capital enhances safety but can depress shareholder returns (Berger & Bouwman, 2013). Meanwhile, the insignificance of bank size in the fully specified ROE model supports the mixed evidence in the literature, suggesting that economies of scale are not an automatic driver of profitability after controlling for other fundamental factors (Hakim & Neaime, 2005).

In sum, the profitability of Egyptian banks is not dictated by a single factor but is the outcome of a complex balancing act. While managing credit risk is paramount, superior performance is achieved by institutions that also maintain operational efficiency, strategically manage market risk, and adeptly use liquidity and capital to navigate a challenging emerging market environment and signal strength to the market.

5.2 Recommendations

The empirical findings of this study, which analyze the complex interplay between risk management and profitability in the Egyptian banking sector from 2015 to 2024, offer several significant implications for bank managers, regulators, and policymakers. The recommendations derived from this analysis are grounded in both the study's robust results and the broader academic literature.

5.2.1 Managerial Implications

For bank managers, the key implication is the urgent need to adopt integrated and sophisticated risk management frameworks that account for the dynamic interplay between credit, liquidity, and market risks. The analysis decisively shows that profitability is not driven by a single risk factor but by a complex balance of credit, liquidity, operational, and market risks. The consistently strong negative impact of credit risk on shareholder returns (ROE) reinforces the established consensus that rigorous credit assessment and monitoring are paramount for financial performance (Athanasoglou, et al., 2008; El-Faham, 2020). Beyond this, managers must appreciate the nuanced role of liquidity. In the volatile macroeconomic context of Egypt, maintaining strong liquidity positions, while incurring opportunity costs, appears to function as a positive signal of stability and resilience, ultimately enhancing profitability by lowering funding costs and bolstering investor confidence (Bordeleau & Graham, 2010). Consequently, strategic planning should prioritize holistic systems that integrate

credit risk assessment with dynamic liquidity planning. Furthermore, larger banks should continue to leverage their organizational capabilities to refine risk governance structures, a factor linked to improved performance and disclosure (Levine, 2005; Ezat, and El-Masry, 2008), while smaller institutions may need to develop more tailored and efficient risk frameworks to strengthen resilience without being unduly burdened.

5.2.2 Regulatory Implications

For regulators, such as the Central Bank of Egypt, this study underscores the importance of a vigilant and adaptive supervisory stance. Regulators should continue to encourage the full adoption of Basel III-compliant standards, particularly those concerning dynamic stress testing and scenario analysis. The demonstrated impact of capital and liquidity regulations on Egyptian bank performance affirms the relevance of this framework (Zaky and Soliman, 2017). Given the study's findings on the significant, albeit complex, effects of capital adequacy and liquidity on profitability, a nuanced regulatory approach that recognizes the trade-offs between stability and financial leverage, as noted by Berger and Bouwman (2013), is essential. Moreover, the high macroeconomic volatility observed during the study period necessitates the active monitoring of systemic risks, especially those arising from persistent inflationary pressures and currency depreciation, whose effects on bank profitability can be ambiguous and destabilizing (Perry, 1992; Pasha and Abdalla, 2023). To foster sector-wide stability, regulators should also consider promoting capacity-building programs aimed at helping smaller banks adopt best practices in risk control, thereby ensuring a more resilient and competitive banking system overall.

5.2.3 Policy Implications

For national policymakers, the research highlights the foundational role of macroeconomic stability in supporting a healthy and profitable banking sector. The strong positive relationship between economic growth and bank profitability is a consistent finding in both the Egypt-specific literature (Pasha and Abdalla, 2023; Abdel Hamid, 2024) and international studies (Demirgüç-Kunt & Huizinga, 1999). Therefore, policies aimed at fostering sustainable economic growth and mitigating high inflation and exchange rate volatility are paramount for ensuring long-term banking sector stability. Furthermore, to enhance the system's intrinsic ability to manage shocks, policymakers should support the development of domestic risk transfer instruments, such as credit default swaps and other hedging tools. Facilitating such markets would improve banks' capacity for risk diversification—a core principle of modern portfolio theory (Markowitz, 1952)—enabling them to more effectively manage the credit and market risks that this study has identified as critical determinants of their performance.

From a behavioural-finance perspective, the strong positive liquidity-profitability nexus uncovered in this study suggests that depositors and other short-term fund providers in Egypt act as “quasi-rational monitors” whose withdrawal decisions are sensitive not only to headline solvency metrics (CAR, NPL) but also to perceived liquidity strength. In periods of macro-volatility—such as the 2016 currency float or 2022 inflation spikes—banks with visibly higher liquidity buffers experienced markedly lower deposit-flight risk, as evidenced by reduced interbank funding costs and stable deposit growth (mirroring the signalling logic of Diamond & Dybvig, 1983). Policymakers can therefore leverage these behavioural insights by mandating real-time disclosure of Basel III liquidity ratios alongside traditional capital metrics, effectively using transparency as a stabilising tool. Moreover, the growing salience of ESG pressures, especially climate-related transition risks, implies that future liquidity stress could arise from sudden re-pricing of carbon-intensive sectors concentrated in Egyptian loan books. Integrating environmental scenario analysis into routine stress tests—and publishing the results—would reinforce market confidence, pre-empt deposit-flight episodes, and align Egypt’s banking system with emerging global ESG standards without compromising short-term profitability.

5.3 Limitations and Future Research Directions

Despite its contributions, this study has certain limitations:

5.3.1 **Data Availability**: Some banks had limited disclosures on risk indicators. Future research could benefit from access to more granular supervisory data from the Central Bank of Egypt.

5.3.2 **Time Frame**: While the period 2015–2024 captures both stabilization and crisis phases (including the post-pandemic recovery and currency devaluation), longer time horizons would allow for deeper insights into structural shifts in risk dynamics.

5.3.3 **Omitted Risk Factors:** This study relies on traditional financial risk categories. It does not explicitly model the growing impact of non-financial and emerging risks, such as:

A. Cybersecurity Risk: The operational risk proxy used is insufficient to capture the financial impact of increasingly frequent and severe cyberattacks.

B. Fintech and Digitalization Risks: The rapid growth of digital banking and mobile wallets in Egypt introduces new risks, including potential liquidity shocks from digital platforms and heightened competition, which are not captured in our framework.

The absence of granular data on cyber incidents and digital fraud limits our ability to assess operational risk in the era of mobile banking and open finance.

5.4 Future research could extend the current framework to include:

Non-financial risk indicators, such as environmental, social, and governance (ESG) metrics; Comparative analyses across Gulf Cooperation Council (GCC) countries or other African emerging markets; Qualitative case studies examining the implementation of risk management frameworks in selected Egyptian banks.

Incorporate Environmental, Social, and Governance (ESG) Risks: A significant avenue for future research is the integration of ESG risks into profitability models. Specifically, future studies could conduct climate stress tests to assess the vulnerability of Egyptian banks' loan portfolios to climate-related transition risks, particularly for those with heavy exposure to carbon-intensive sectors such as manufacturing, transportation, and parts of the agriculture sector.

Future studies should investigate the risk-return implications of fintech integration, including liquidity volatility from digital wallet flows and cybersecurity exposures. Additionally, given Egypt’s reliance on agriculture, climate stress testing frameworks should be developed to evaluate the credit and liquidity risks associated with climate volatility.

Ethical Approval & Data Confidentiality

All data used in this study are publicly available annual-report disclosures and aggregated banking statistics; therefore, no primary data collection from human subjects was undertaken.

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