JOURNAL OF MANAGEMENT AND BUSINESS SOLUTIONS

Determinants of Credit Risk in Iraqi Commercial Banks: A Dynamic Panel Data Approach (2010–2024)

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ABSTRACT

This study aimed to identify the bank-specific, macroeconomic, and institutional determinants of credit risk in Iraqi commercial banks during 2010–2024 using a dynamic panel data framework. This quantitative longitudinal study analyzed panel data from 24 Iraqi commercial banks over the period 2010–2024. Credit risk was measured by the non-performing loan ratio. The explanatory variables included the lagged non-performing loan ratio, capital adequacy ratio, return on assets, oil price volatility, exchange rate volatility, and a governance indicator. After accounting for the lag structure, the dynamic estimation included 336 bank-year observations. The model was estimated using the two-step System Generalized Method of Moments estimator with robust standard errors to address unobserved heterogeneity, dynamic persistence, and potential endogeneity. Model adequacy was assessed using the Arellano–Bond tests for serial correlation, the Hansen J-test of overidentifying restrictions, the difference-in-Hansen test, and robustness checks based on alternative GMM specifications. The lagged non-performing loan ratio had a positive and significant effect on current credit risk ($\beta = 0.638$, $p < 0.001$), confirming strong persistence in non-performing loans. Capital adequacy significantly reduced credit risk ($\beta = -0.217$, $p = 0.003$), while return on assets also had a significant negative effect ($\beta = -0.384$, $p = 0.001$). Oil price volatility significantly increased credit risk ($\beta = 0.084$, $p = 0.007$), as did exchange rate volatility ($\beta = 0.173$, $p = 0.005$). Improved governance conditions were associated with lower credit risk ($\beta = -1.426$, $p = 0.021$). The AR(2) test was non-significant ($p = 0.441$), and the Hansen J-test supported instrument validity ($p = 0.552$). Robustness analyses confirmed the stability of the coefficient signs and significance across alternative dynamic panel specifications. Credit risk in Iraqi commercial banks is persistent and jointly determined by internal financial strength and external macroeconomic and institutional conditions, indicating that stronger capitalization, profitability, governance, and effective management of oil-price and exchange-rate shocks are essential for reducing non-performing loans.

Keywords: Credit Risk; Non-Performing Loans; Capital Adequacy; Return on Assets; Oil Price Volatility; Exchange Rate Volatility; Governance; System GMM; Iraqi Commercial Banks

Introduction

Credit risk remains one of the most consequential sources of vulnerability in commercial banking because the deterioration of loan quality directly affects profitability, capitalization, liquidity, and ultimately the stability of financial institutions. Commercial banks fundamentally operate by transforming deposits and other funding sources into credit, and this intermediation function necessarily exposes them to the possibility that borrowers will fail to meet

Article history:
Received 27 May 2026
Revised 02 September 2026
Accepted 09 September 2026
Initial Publish 27 October 2026
Published online 01 November 2027

How to cite this article:
Hussen, W. M. H., Abbasian, E., & Fakher, E. (2027). Determinants of Credit Risk in Iraqi Commercial Banks: A Dynamic Panel Data Approach (2010–2024). *Journal of Management and Business Solutions, 5*(6), 1-21. https://doi.org/10.61838/jmbs.426

contractual repayment obligations. When repayment problems become sufficiently severe, loans are classified as non-performing, creating direct losses through impairment charges and loan-loss provisions while simultaneously weakening the quality of bank assets. Persistent growth in non-performing loans can constrain new lending, reduce earnings, erode regulatory capital, and intensify liquidity pressures, thereby transforming institution-specific credit problems into broader systemic vulnerabilities. The importance of such dynamics has become increasingly evident in contemporary banking systems, where credit risk interacts with capital constraints, depositor behavior, macroeconomic shocks, and regulatory intervention rather than operating as an isolated balance-sheet phenomenon. Recent research on systemic risk emphasizes that banking crises tend to evolve through interconnected phases in which weaknesses in credit portfolios can amplify fragility across the financial system, particularly when institutions are simultaneously exposed to correlated economic shocks (1). Consequently, identifying the determinants of credit risk is central not only to individual bank management but also to prudential supervision, financial stability policy, and the broader functioning of credit markets.

The non-performing loan ratio is among the most widely used indicators of realized credit risk because it reflects the proportion of the lending portfolio for which borrowers have experienced serious repayment difficulties. An increase in this ratio indicates deterioration in asset quality and generally signals deficiencies in borrower repayment capacity, loan screening, monitoring, collateral management, or the wider economic environment. Empirical evidence from commercial banks in Jordan, for example, confirms that credit risk is influenced by a combination of institution-specific financial characteristics and external economic conditions, highlighting the necessity of considering both dimensions when explaining variations in non-performing loans (2). Similarly, evidence from banking systems in other developing economies indicates that the quality of credit-risk management practices is closely associated with financial performance, reinforcing the view that asset-quality outcomes are partly shaped by managerial and organizational capabilities rather than exclusively by macroeconomic conditions (3). Credit-risk analysis should therefore incorporate both internal balance-sheet determinants and environmental factors capable of altering borrowers' repayment capacity or banks' ability to identify, price, and control credit exposures.

Among bank-specific determinants, capitalization has particular theoretical and regulatory significance. The capital adequacy ratio measures the extent to which a bank maintains capital relative to its risk-weighted assets and therefore provides an indication of its capacity to absorb unexpected losses. Strong capitalization may reduce credit risk through several mechanisms. Well-capitalized banks may adopt more prudent lending standards, possess greater capacity to provision for problematic loans, and face less pressure to engage in excessive risk taking. Conversely, inadequately capitalized institutions may have stronger incentives to expand into high-risk credit activities in an attempt to improve returns, potentially generating subsequent deterioration in loan quality. Research applying generalized method of moments techniques to listed banks has demonstrated an empirical relationship between credit risk and capital adequacy and has further indicated that institutional characteristics such as bank size and ownership structure can condition this relationship (4). The broader regulatory literature likewise emphasizes that optimal banking regulation must account simultaneously for credit losses and other forms of instability because capital requirements affect both risk-taking incentives and banks' capacity to withstand adverse shocks (5). More recent international evidence additionally indicates that capitalization can influence how portfolio-level credit exposures translate into banking efficiency, suggesting that capital strength remains an important moderating element in contemporary credit-risk dynamics (6).

Profitability represents another central bank-specific determinant because it reflects managerial efficiency, income-generating capacity, and the financial resources available to absorb credit losses. Return on assets is particularly useful in this context because it measures the extent to which a bank generates earnings from its asset base. The relationship between profitability and credit risk can operate in both directions. Poor credit quality increases loan-loss provisions and reduces interest income, thereby weakening profitability, while low profitability may encourage managers to pursue riskier lending strategies or weaken the resources devoted to borrower screening and loan monitoring. International evidence demonstrates a substantive relationship between credit risk and bank profitability and indicates that this relationship remains important across heterogeneous banking environments (7). Comparable evidence from Iran also suggests that higher levels of credit risk and non-performing loans are associated with weaker financial performance, reinforcing the proposition that deterioration in asset quality has material consequences for bank profitability (8). The financing structure of banks can further shape this relationship because differences in funding composition, leverage, and capital configuration influence both risk appetite and performance outcomes (9). These findings support treating profitability not merely as a consequence of credit risk but also as a potentially endogenous determinant within a dynamic empirical specification.

Credit risk also depends heavily on the quality of internal risk-management systems. Effective credit-risk management involves borrower assessment, credit scoring, collateral valuation, loan pricing, portfolio diversification, continuous monitoring, early-warning mechanisms, and structured recovery procedures. Weaknesses in any of these components can increase the probability that credit exposures migrate into non-performing status. The quality of collateral and guarantees is especially relevant in banking systems where formal credit information is incomplete or where legal enforcement mechanisms are comparatively weak. A recent pathological approach to credit-risk management emphasizes that deficiencies in guarantees and collateral can become structural sources of risk when valuation, documentation, enforceability, or monitoring is inadequate (10). This perspective is particularly important for emerging-market banking systems because the apparent existence of collateral does not necessarily imply effective risk mitigation if collateral cannot be readily enforced or liquidated following default. At the supervisory level, risk-based oversight frameworks have similarly gained importance because they seek to identify vulnerabilities before they translate into realized losses. Models of risk-based banking supervision emphasize the need for integrated assessment of institutional risk factors, governance mechanisms, and supervisory responses rather than reliance solely on backward-looking compliance indicators (11).

Technological transformation has added another dimension to contemporary credit-risk management. Financial technology, artificial intelligence, blockchain applications, and advanced data-processing techniques increasingly influence how banks evaluate borrowers, monitor exposures, detect anomalies, and manage information asymmetries. Artificial intelligence applications can improve the processing of heterogeneous borrower information, support more granular credit scoring, and facilitate early identification of deteriorating credit exposures (12). Blockchain-based approaches have also been proposed as mechanisms for improving information integrity, traceability, transparency, and coordination in credit-risk management processes (13). Empirical studies focusing on banks in financial markets have correspondingly examined the role of fintech in reducing credit and liquidity risks and improving financial outcomes (14). Additional evidence suggests that fintech development may reduce credit risk while simultaneously strengthening bank financial performance through improved information processing, transaction efficiency, and monitoring capability (15). Related studies have found that financial technology can contribute to banking efficiency when its effects on credit and economic risks are explicitly considered (16). The

relationship between fintech and financial performance has also been examined with credit risk treated as an intervening mechanism, further demonstrating that technological innovation and risk conditions are increasingly intertwined in banking performance (17). Although technological variables are not directly included in the present model, this emerging literature is important because it underscores that credit risk is shaped by a broader institutional and operational environment and that traditional financial determinants continue to operate alongside rapidly evolving risk-management technologies.

Macroeconomic instability constitutes another major source of bank credit risk because borrowers' repayment capacity is closely connected to income, employment, business profitability, inflation, exchange rates, and overall economic activity. These transmission mechanisms are especially important in economies that are highly exposed to commodity-price fluctuations or external financial shocks. Iraq represents a particularly relevant case because petroleum exports play a dominant role in fiscal revenues, foreign-exchange availability, public expenditure, and aggregate economic activity. Consequently, fluctuations in international oil markets can affect the banking sector indirectly through changes in government spending, private-sector liquidity, investment conditions, household income, and corporate cash flows. Oil-price volatility may therefore increase credit risk even where banks do not directly finance oil-producing firms, because the wider economy remains strongly dependent on hydrocarbon-related fiscal and external balances. Recent international evidence demonstrates that the relationship between energy-related economic structures and bank credit risk can operate through broader growth and balance-sheet channels, illustrating how changes in energy markets can be transmitted into financial-sector risk (18). The growing literature on portfolio exposure and bank efficiency similarly shows that sectoral concentration can interact with both credit risk and capitalization, reinforcing the importance of considering structural economic dependence when evaluating bank stability (6).

Exchange-rate volatility constitutes a second macroeconomic channel that may be especially important for Iraqi banks. Fluctuations in the value of the domestic currency can affect borrowers through import costs, foreign-currency liabilities, inflationary pressures, and changes in the domestic value of assets and collateral. Firms dependent on imported intermediate goods may experience declining profitability when the domestic currency weakens, while borrowers with direct or indirect foreign-currency exposure may face higher debt-service burdens. Such pressures can ultimately increase the probability of default and deteriorate banks' loan portfolios. Exchange-rate instability may also influence market expectations and capital allocation, creating a more uncertain environment for both lenders and borrowers. More broadly, uncertainty has been shown to reduce the operational efficiency of commercial-bank credit activities by increasing the difficulty of evaluating borrowers, allocating credit, and managing risk over time (19). These effects suggest that exchange-rate volatility should be treated not merely as a monetary variable but as a potentially important determinant of realized credit losses within financially exposed developing economies.

Political and geopolitical conditions provide an additional layer of external risk. Banking activities depend on predictable institutions, enforceable contracts, effective regulation, and sufficient governmental stability to sustain confidence in economic transactions. Political instability can reduce investment, weaken borrower cash flows, increase uncertainty, disrupt fiscal operations, and diminish the effectiveness of loan enforcement and recovery. International evidence indicates that geopolitical risk materially affects investment behavior, demonstrating how political uncertainty can alter private-sector economic decisions and potentially influence the financial condition of borrowers (20). For banks, these effects may manifest through weaker credit demand from productive firms, poorer

repayment capacity, deterioration in collateral values, or higher risk premiums. Governmental and regulatory quality may therefore influence credit risk both directly, through supervision and legal enforcement, and indirectly, through the economic environment in which borrowers operate. This institutional dimension is particularly relevant in Iraq, where the banking system has operated under recurring political, fiscal, security, and regulatory pressures during the period examined.

Liquidity and overall bank stability are also closely connected to credit conditions. A deterioration in loan quality can restrict incoming cash flows, increase provisioning requirements, and weaken depositor and investor confidence, thereby linking credit risk to other dimensions of banking vulnerability. Empirical investigation of listed banks has shown that both liquidity risk and credit risk can materially influence bank stability (21). This interdependence is important because non-performing loans may simultaneously weaken profitability, capital, and liquidity, creating feedback loops that magnify the original credit shock. The systemic-risk literature further suggests that such feedback mechanisms can become particularly damaging when multiple institutions experience similar exposures during periods of stress (1). Credit risk should consequently be analyzed as a dynamic process rather than as a static outcome observed independently in each year.

A dynamic approach is methodologically appropriate because current non-performing loans are likely to depend substantially on their own past values. Once loans become distressed, their resolution may require restructuring, foreclosure, legal enforcement, or prolonged recovery procedures, meaning that elevated credit risk can persist across multiple accounting periods. Static panel estimators that omit this persistence may therefore generate incomplete or biased representations of the credit-risk process. Furthermore, several bank-specific variables are potentially endogenous. Profitability may influence credit quality, but credit losses simultaneously affect profitability; capital adequacy may constrain risk-taking, yet rising non-performing loans can themselves erode capital. These reciprocal relationships justify the use of a dynamic panel estimator capable of addressing simultaneity and unobserved heterogeneity. Generalized method of moments approaches are particularly suitable in this setting because appropriately lagged values can serve as internal instruments for endogenous or predetermined regressors. Previous banking research has successfully applied GMM panel techniques to examine credit risk and capital adequacy, demonstrating the usefulness of such methods for controlling dynamic dependence and endogeneity (4).

The need for a dynamic framework is reinforced by evidence that credit risk can influence multiple dimensions of bank performance and efficiency. Studies have linked credit risk to profitability, financial performance, capital strength, operational efficiency, and overall stability (7, 8, 21). At the same time, contemporary regulatory theory indicates that bank-risk management cannot be adequately evaluated without accounting for the interaction between credit losses, capitalization, and broader instability (5). Risk-based supervisory research similarly emphasizes that bank vulnerabilities should be evaluated through interconnected indicators rather than isolated measures (11). These observations are particularly relevant to Iraqi commercial banks because their credit portfolios operate within an environment shaped simultaneously by institution-specific financial conditions and macroeconomic shocks.

Despite the substantial international literature on credit risk, important contextual gaps remain. A large proportion of recent studies has focused on developed banking systems, Asian markets, or neighboring Middle Eastern economies rather than Iraq. Evidence from Jordan has documented significant commercial-bank credit-risk determinants (2), while Iranian research has examined non-performing loans, bank performance, capitalization,

liquidity, fintech, and financing structures (8, 9, 14-17). International studies have additionally investigated uncertainty in credit operations, systemic risk, technological innovation, and the relationship between credit risk and profitability (1, 7, 12, 19). However, the Iraqi banking sector possesses distinctive structural characteristics that limit the direct transferability of findings from these settings. Its dependence on oil-driven economic activity, exposure to exchange-rate disturbances, evolving regulatory environment, and institutional volatility create a configuration of risks that requires context-specific empirical examination.

A further gap concerns the simultaneous incorporation of bank-level and macro-institutional determinants within a dynamic framework over a sufficiently long period. Studies emphasizing technological innovation show that credit-risk management is evolving rapidly (12, 13), while research on collateral and guarantees highlights persistent structural weaknesses in traditional lending mechanisms (10). At the same time, newer work on energy transitions and bank portfolios indicates that structural economic exposures continue to affect credit outcomes through growth and capitalization channels (6, 18). These strands of literature collectively suggest that credit risk should be understood as the result of interacting internal, macroeconomic, institutional, and structural forces. Yet evidence integrating these dimensions for Iraqi commercial banks across the period 2010–2024 remains limited.

Accordingly, examining Iraqi commercial banks over this period provides an opportunity to assess whether credit risk exhibits temporal persistence and whether its evolution is systematically associated with bank capitalization, profitability, oil-price volatility, exchange-rate volatility, and governance conditions. Such evidence can contribute to the credit-risk literature in several respects. First, it extends empirical analysis to a banking system that remains underrepresented in international research. Second, it integrates bank-specific and macro-institutional determinants within a unified dynamic specification. Third, it addresses the possibility of simultaneity and reverse causality through System GMM estimation rather than relying solely on static panel relationships. Finally, it provides evidence relevant to bank managers and regulators seeking to distinguish between credit-risk pressures originating within banks and those transmitted through the broader Iraqi economic and institutional environment.

The aim of this study is to identify the bank-specific and macroeconomic determinants of credit risk in Iraqi commercial banks during 2010–2024 by estimating the dynamic effects of lagged credit risk, capital adequacy, return on assets, oil-price volatility, exchange-rate volatility, and governance conditions using a System GMM panel-data framework.

Methods and Materials

This study adopted a quantitative, longitudinal research design based on dynamic panel data analysis to investigate the determinants of credit risk in Iraqi commercial banks over the period 2010–2024. The use of panel data made it possible to combine the cross-sectional dimension of individual banks with the time-series dimension of annual observations, thereby allowing the analysis to account for both interbank heterogeneity and changes in credit risk over time. The study focused on commercial banks operating in Iraq for which sufficiently continuous and comparable financial information was available during the study period. Banks were included in the analytical sample when their annual financial statements and the required indicators of credit quality, capitalization, profitability, and other bank-specific characteristics could be consistently obtained for a substantial part of the observation period. Observations with insufficient information on the principal study variables were excluded from the relevant estimations. Accordingly, the resulting dataset was structured as a bank-year panel covering the years from 2010 through 2024. The selected period was particularly appropriate for examining credit risk because it

encompassed substantial changes in Iraq's economic and financial environment, including fluctuations in international oil markets, exchange-rate pressures, changes in banking regulation, fiscal instability, political uncertainty, and different phases of macroeconomic adjustment. These conditions provided an appropriate empirical setting for examining the extent to which both internal banking characteristics and external economic conditions contributed to changes in loan portfolio quality.

Credit risk was operationalized through the non-performing loan ratio, which constituted the dependent variable of the study. The non-performing loan ratio was defined as the value of non-performing loans relative to total gross loans of each bank in a given year. This indicator was selected because it directly represents deterioration in the quality of a bank's credit portfolio and is widely used to evaluate the extent to which borrowers have failed to meet contractual repayment obligations. Higher values of the ratio indicate greater exposure to credit risk and weaker asset quality, whereas lower values indicate a healthier loan portfolio. Because credit deterioration is generally persistent rather than completely contemporaneous, the empirical design explicitly incorporated the one-period lag of the non-performing loan ratio. This specification reflects the assumption that the current level of credit risk depends partly on the bank's previous credit-risk position because distressed loans may remain classified as non-performing across several accounting periods and because weaknesses in credit screening, monitoring, restructuring, and loan recovery may have persistent consequences. The dynamic specification therefore provided a more realistic representation of the evolution of credit risk than a purely static panel model.

The study relied exclusively on secondary quantitative data collected from the annual financial and regulatory disclosures of Iraqi commercial banks and from relevant macroeconomic and institutional databases covering the 2010–2024 period. Bank-level information was extracted from audited annual reports, published financial statements, balance-sheet and income-statement disclosures, and, where available, statistical publications and supervisory information issued for the Iraqi banking sector. A structured data-extraction framework was used to record bank-year observations in a consistent format and to ensure comparability of variable definitions across institutions and years. Each observation was identified by bank and year, and the collected data were subsequently reviewed for missing values, coding inconsistencies, extreme values, and discontinuities that could reflect changes in reporting practices rather than actual changes in banking conditions. Macroeconomic and governance indicators were matched to the corresponding year of each bank observation, thereby creating an integrated panel dataset containing both bank-specific and economy-wide determinants of credit risk.

The dependent variable was the credit-risk indicator, denoted by CR_{it}, and measured by the non-performing loan ratio of bank $i$in year t. Its one-period lag, $CR_{i,t-1}$, was incorporated to capture the persistence and path dependence of credit risk. Capital adequacy, denoted by CAR_{it}, represented the capital strength of the bank relative to its risk-weighted exposures and was included because better-capitalized institutions may possess a stronger capacity to absorb unexpected credit losses and may also differ systematically in their lending behavior. Return on assets, denoted by ROA_{it}, measured bank profitability by relating net income to total assets and was used as an indicator of managerial efficiency and overall financial performance. Higher profitability may be associated with better loan screening and monitoring, although profitability can also be influenced by risk-taking behavior, making its empirical relationship with non-performing loans an issue to be determined statistically rather than assumed a priori.

The model further incorporated three external determinants. Oil price volatility, denoted by OPV_t, was included because Iraq is highly exposed to developments in international oil markets and changes in oil revenues can influence fiscal expenditure, liquidity, economic activity, borrowers' repayment capacity, and the overall operating

environment of commercial banks. Exchange-rate volatility, represented by EXV_t, was included to capture instability in the value of the Iraqi currency and its potential effects on borrowers with foreign-currency exposures, import-dependent firms, debt-servicing costs, asset valuations, and collateral values. Government stability and the regulatory environment were represented by the governance indicator GOV_t. This variable captured institutional conditions that may affect the enforcement of financial contracts, the predictability of policy, regulatory effectiveness, confidence in the banking system, and the broader environment in which lending and loan recovery occur. The final empirical dataset therefore combined the non-performing loan ratio and its lag with capital adequacy, return on assets, oil price volatility, exchange-rate volatility, and governance conditions in order to examine credit risk from both microeconomic and macro-institutional perspectives.

The empirical analysis was conducted using a dynamic panel data framework because the inclusion of the lagged dependent variable creates conditions under which conventional pooled ordinary least squares, fixed-effects, and standard random-effects estimators may produce biased or inconsistent estimates. The baseline model was specified as $CR_{it} = \alpha + \rho CR_{i,t-1} + \beta_1 CAR_{it} + \beta_2 ROA_{it} + \beta_3 OPV_t + \beta_4 EXV_t + \beta_5 GOV_t + \mu_i + \lambda_t + \varepsilon_{it}$, where CR_{it}denotes the non-performing loan ratio of bank $i$in year t, $CR_{i,t-1}$represents its first lag, $CAR_{it}$is the capital adequacy ratio, $ROA_{it}$is return on assets, OPV_trepresents oil price volatility, EXV_tdenotes exchange-rate volatility, and GOV_trepresents governance and institutional stability. The term $\mu_i$captures unobserved bank-specific heterogeneity, $\lambda_t$represents common time effects where applicable, and $\varepsilon_{it}$is the idiosyncratic error term. The coefficient ρmeasures the persistence of credit risk, while the remaining coefficients estimate the marginal relationships between the explanatory variables and the non-performing loan ratio after controlling for dynamic dependence and unobserved heterogeneity.

The model was estimated using the System Generalized Method of Moments estimator. System GMM was selected because it is particularly appropriate for dynamic panel models in which the lagged dependent variable is mechanically correlated with the unobserved individual effect and in which one or more explanatory variables may be endogenous or predetermined. In the banking context, such endogeneity is especially relevant because bank profitability and capitalization may simultaneously influence and be influenced by deteriorating loan quality. For example, a higher non-performing loan ratio may reduce profitability through loan-loss provisions, while weak profitability may itself contribute to poorer risk-management practices. Similarly, deterioration in asset quality can reduce regulatory capital, while capitalization can influence the degree of risk assumed by the bank. The System GMM framework addressed these reciprocal relationships by using appropriately lagged values of potentially endogenous variables as internal instruments.

The estimator combined equations expressed in first differences with equations expressed in levels. In the differenced equation, lagged levels of the endogenous variables were employed as instruments for their changes, whereas in the level equation, appropriate lagged differences were used as instruments under the required stationarity-related moment conditions. The fundamental identifying condition was that the selected instruments were correlated with the potentially endogenous regressors but orthogonal to the contemporaneous disturbance term. In general form, this requirement may be expressed as $E[Z_{it}\varepsilon_{it}] = 0$, where Z_{it}denotes the instrument vector. Instrument construction was restricted to theoretically appropriate lag depths in order to reduce the risk of instrument proliferation, which can overfit endogenous variables and weaken specification tests. Where necessary, the

instrument matrix was collapsed and the number of instruments was maintained below a level that would compromise the reliability of the Hansen test.

The analysis began with descriptive statistics for all study variables, including the mean, standard deviation, minimum, and maximum values, in order to characterize the distribution and variability of credit risk, bank-specific indicators, and macroeconomic variables over the study period. Pairwise correlations were subsequently examined to provide an initial assessment of the direction and magnitude of associations among the variables and to identify potentially high correlations among the explanatory variables. Multicollinearity was further evaluated using variance inflation factors, with excessively large values interpreted as evidence that coefficient estimation could be affected by strong linear relationships among regressors. The panel structure of the data was also examined for potential heteroscedasticity and serial dependence, because these characteristics are common in banking panels and can affect conventional statistical inference.

System GMM estimation was performed using robust finite-sample-adjusted standard errors so that statistical inference remained reliable in the presence of heteroscedasticity and within-panel dependence. The statistical significance of individual coefficients was evaluated using the corresponding test statistics and probability values, while the signs and magnitudes of the estimated coefficients were interpreted in terms of their implications for credit risk. Particular attention was given to the coefficient of the lagged non-performing loan ratio because a positive and statistically significant estimate would indicate persistence in credit deterioration, implying that banks experiencing higher non-performing loans in one period tend to retain comparatively higher credit risk in the subsequent period.

Several post-estimation diagnostic tests were used to assess the adequacy of the dynamic specification. The Arellano–Bond test for serial correlation in the first-differenced residuals was applied to examine first- and second-order autocorrelation. First-order serial correlation in the differenced errors may be expected as a mechanical consequence of first differencing, whereas the absence of statistically significant second-order serial correlation was treated as an important requirement for the validity of lagged instruments. Instrument validity was evaluated using the Hansen J-test of overidentifying restrictions. A statistically non-significant Hansen statistic was interpreted as evidence that the instrument set as a whole could not be rejected as exogenous. The number of instruments was also monitored relative to the number of cross-sectional units to avoid excessive instrument proliferation. Taken together, these diagnostic procedures were used to determine whether the System GMM specification adequately addressed endogeneity, dynamic dependence, unobserved bank heterogeneity, and the statistical characteristics of the panel dataset. This analytical framework therefore provided a rigorous basis for estimating the bank-specific, macroeconomic, and institutional determinants of credit risk in Iraqi commercial banks during 2010–2024.

Findings and Results

The final panel consisted of 24 Iraqi commercial banks observed annually over the 15-year period from 2010 to 2024, yielding 360 bank-year observations for variables measured contemporaneously. Because the dynamic specification incorporated the first lag of the credit-risk variable, the first annual observation for each bank was necessarily lost in the dynamic estimation, resulting in 336 usable bank-year observations for the System GMM models. All 24 cross-sectional units remained represented in the final dynamic panel. Examination of the bank-year coverage showed that the analytical sample provided continuous representation across the study period, permitting the temporal evolution of credit risk to be assessed while controlling for persistent bank-specific differences. The sampled banks exhibited substantial heterogeneity in non-performing loan ratios, capitalization, and profitability,

which was desirable for identifying the determinants of credit risk. The macroeconomic series also displayed considerable temporal variation, particularly in oil-price and exchange-rate volatility, reflecting the pronounced external shocks experienced by the Iraqi economy during 2010–2024. Preliminary inspection of the dataset did not reveal systematic coding errors or implausible observations requiring removal. The variation observed across both the cross-sectional and temporal dimensions therefore provided an appropriate empirical basis for dynamic panel estimation.

Table 1. Descriptive Statistics of the Study Variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Credit risk/NPL ratio (CR), %	360	12.84	7.31	2.14	38.76
Lagged credit risk (CRt−1), %	336	12.56	7.08	2.14	37.92
Capital adequacy ratio (CAR), %	360	17.92	4.86	9.73	32.48
Return on assets (ROA), %	360	1.86	1.21	-1.47	5.62
Oil price volatility (OPV), %	360	24.73	11.46	9.18	52.37
Exchange rate volatility (EXV), %	360	6.38	4.27	1.14	17.86
Governance indicator (GOV)	360	-1.24	0.18	-1.56	-0.91

As shown in Table 1, the average non-performing loan ratio across Iraqi commercial banks during 2010–2024 was 12.84%, with a standard deviation of 7.31 percentage points. The ratio ranged from a minimum of 2.14% to a maximum of 38.76%, indicating pronounced heterogeneity in loan-portfolio quality across banks and years. This relatively large dispersion was consistent with the existence of substantial differences in borrowers' creditworthiness, banks' lending and monitoring practices, exposure to macroeconomic disturbances, and institutional conditions during the study period. The lagged non-performing loan ratio had a very similar distribution, with a mean of 12.56% and a standard deviation of 7.08, suggesting considerable persistence in bank credit risk over consecutive periods. The capital adequacy ratio averaged 17.92%, with values ranging from 9.73% to 32.48%, demonstrating considerable variation in banks' capitalization and their capacity to absorb unexpected losses. Return on assets averaged 1.86%, while the minimum value of -1.47% indicated that some bank-year observations were associated with accounting losses. Its maximum of 5.62% further showed marked differences in operating profitability. Among the macroeconomic indicators, oil price volatility averaged 24.73%, with a standard deviation of 11.46, confirming substantial fluctuations in the principal external variable affecting the Iraqi economy. Exchange-rate volatility averaged 6.38% but reached 17.86% in the most unstable periods, suggesting that changes in currency conditions could plausibly affect borrowers' repayment capacity and collateral values. Finally, the governance indicator averaged -1.24 and remained negative throughout the study period. Although some improvement was observed across years, the negative average indicated that Iraqi banks continued to operate within a relatively challenging institutional environment. Taken together, the descriptive results demonstrated sufficient variation in all explanatory variables to support subsequent multivariate and dynamic panel analysis.

Table 2. Correlation Matrix and Variance Inflation Factors

Variable	CR	CRt−1	CAR	ROA	OPV	EXV	GOV	VIF
CR	1.000							—
CRt−1	0.721	1.000						2.04
CAR	-0.409	-0.371	1.000					1.31
ROA	-0.458	-0.396	0.338	1.000				1.28
OPV	0.286	0.253	-0.083	-0.167	1.000			1.41
EXV	0.332	0.297	-0.116	-0.203	0.441	1.000		1.49
GOV	-0.274	-0.241	0.187	0.214	-0.236	-0.306	1.000	1.22

Table 2 reports the pairwise correlations among the study variables together with the variance inflation factor values used to assess potential multicollinearity. The contemporaneous credit-risk ratio was strongly and positively correlated with its one-period lag (r = 0.721), providing preliminary evidence of persistence in non-performing loans and empirically supporting the use of a dynamic rather than purely static panel specification. Capital adequacy had a moderate negative correlation with credit risk (r = -0.409), suggesting that banks with stronger capital positions generally exhibited lower non-performing loan ratios. Return on assets also showed a negative relationship with credit risk (r = -0.458), indicating that more profitable banks tended to maintain better-performing loan portfolios. Both macroeconomic volatility measures displayed positive associations with credit risk. Oil price volatility was positively correlated with the NPL ratio (r = 0.286), while exchange-rate volatility showed a somewhat stronger positive relationship (r = 0.332). These preliminary relationships suggested that instability in external economic conditions was associated with deterioration in bank asset quality. In contrast, the governance indicator was negatively correlated with credit risk (r = -0.274), meaning that improvements in institutional and governance conditions were associated with lower levels of non-performing loans. Correlations among the independent variables themselves remained moderate. The largest correlation among the non-lagged explanatory variables was 0.441 between oil-price volatility and exchange-rate volatility, which was well below conventional thresholds generally associated with serious multicollinearity. The VIF statistics provided further confirmation, ranging from 1.22 for the governance indicator to 2.04 for the lagged dependent variable. As all values were substantially below the conservative threshold of 5, multicollinearity was not considered a material concern. Therefore, all specified determinants were retained in the dynamic panel model.

Table 3. Two-Step System GMM Estimates for the Determinants of Credit Risk

Variable	Coefficient	Robust Standard Error	z-statistic	p-value
Lagged credit risk (CRt−1)	0.638	0.071	8.99	<0.001
Capital adequacy ratio (CAR)	-0.217	0.073	-2.97	0.003
Return on assets (ROA)	-0.384	0.119	-3.23	0.001
Oil price volatility (OPV)	0.084	0.031	2.71	0.007
Exchange rate volatility (EXV)	0.173	0.061	2.84	0.005
Governance indicator (GOV)	-1.426	0.617	-2.31	0.021
Constant	7.312	2.754	2.65	0.008
Number of observations	336			
Number of banks	24			
Number of instruments	19			

The main two-step System GMM estimates presented in Table 3 showed that both bank-specific characteristics and external economic conditions were statistically important determinants of credit risk in Iraqi commercial banks. The coefficient on the lagged non-performing loan ratio was positive and highly significant ($\beta = 0.638$, $z = 8.99$, $p < 0.001$), demonstrating strong persistence in bank credit risk. Holding the remaining determinants constant, a one-percentage-point increase in the previous year's NPL ratio was associated with approximately a 0.638-percentage-point increase in the current NPL ratio. This result indicated substantial inertia in problem loans and suggested that deterioration in asset quality was not rapidly reversed from one period to the next. The magnitude of the coefficient, while clearly below unity, showed that shocks to loan quality tended to persist over several periods rather than disappearing immediately. This finding also validated the decision to adopt a dynamic panel framework, since omission of the lagged dependent variable would have ignored an important component of the credit-risk adjustment process.

Capital adequacy had a negative and statistically significant coefficient (β = -0.217, z = -2.97, p = 0.003). Thus, after controlling for previous credit risk, profitability, macroeconomic volatility, and governance conditions, a one-percentage-point increase in the capital adequacy ratio was associated with an approximately 0.217-percentage-point reduction in the NPL ratio. This result suggested that better-capitalized Iraqi commercial banks were generally characterized by lower credit risk. Stronger capital positions may provide banks with greater loss-absorption capacity and may also reflect more prudent balance-sheet management, stricter credit screening, and lower incentives for excessive risk taking.

Return on assets likewise demonstrated a significant negative relationship with credit risk (β = -0.384, z = -3.23, p = 0.001). A one-percentage-point increase in ROA was associated with an estimated 0.384-percentage-point decrease in the non-performing loan ratio, other factors remaining constant. The result indicated that stronger bank profitability was associated with improved asset quality. Profitable institutions may possess stronger internal resources, more efficient credit-monitoring systems, and better managerial capacity to identify and control deteriorating exposures. Conversely, banks experiencing weak profitability may face greater pressure to expand lending toward riskier borrowers or may possess weaker capacity to manage problematic credit exposures.

Oil price volatility exerted a positive and statistically significant effect on bank credit risk (β = 0.084, z = 2.71, p = 0.007). The positive coefficient indicated that greater instability in international oil-market conditions was associated with higher non-performing loan ratios in Iraqi commercial banks. Although the coefficient was smaller in absolute magnitude than those of several bank-specific determinants, its statistical significance demonstrated that credit risk in Iraq could not be explained solely by internal banking characteristics. Given the importance of petroleum revenues to government expenditure, domestic liquidity, investment, and aggregate economic activity, increased uncertainty in oil prices appeared to transmit indirectly to banks through deterioration in the financial conditions of firms and households.

Exchange-rate volatility also had a positive and statistically significant coefficient (β = 0.173, z = 2.84, p = 0.005). This result indicated that periods of greater currency instability were associated with higher non-performing loan ratios. A one-unit increase in the exchange-rate volatility indicator was associated with an approximately 0.173-percentage-point increase in credit risk, conditional on the other determinants in the model. Exchange-rate disturbances may adversely affect the repayment capacity of import-dependent firms, businesses with foreign-currency obligations, and borrowers whose operating costs respond strongly to currency movements. Currency instability may additionally reduce the real value or reliability of collateral and increase uncertainty regarding borrowers' future cash flows.

The governance indicator had a negative and statistically significant coefficient (β = -1.426, z = -2.31, p = 0.021), indicating that improvement in institutional and governance conditions was associated with lower levels of credit risk. Because higher values of the governance variable represented more favorable institutional conditions, the negative coefficient suggested that stronger governmental stability, regulatory effectiveness, institutional predictability, and enforcement conditions contributed to improved credit performance. The finding was particularly relevant in the Iraqi context because bank lending decisions and loan recovery can be strongly influenced by regulatory quality, contract enforcement, policy stability, and general institutional confidence. Overall, all principal explanatory variables were statistically significant at the 5% level or better, and their signs were economically consistent with the theoretical framework of the study.

Table 4. System GMM Specification and Diagnostic Tests

Diagnostic Test	Statistic	Degrees of Freedom	p-value	Decision
Arellano–Bond AR(1) test	-3.86	—	<0.001	Expected first-order correlation
Arellano–Bond AR(2) test	-0.77	—	0.441	No second-order serial correlation
Hansen J-test	14.62	16	0.552	Instruments valid
Difference-in-Hansen test	5.11	6	0.529	Additional moment conditions valid
Wald test of joint significance	264.73	6	<0.001	Model jointly significant
Number of instruments	19	—	—	Below number of banks
Number of banks	24	—	—	—
Number of observations	336	—	—	—

The post-estimation diagnostic results reported in Table 4 supported the validity of the dynamic System GMM specification. The Arellano–Bond test detected statistically significant first-order serial correlation in the first-differenced residuals, AR(1) = -3.86, $p < 0.001$. Such a result was expected in a correctly specified dynamic panel model because first differencing mechanically induces first-order correlation even when the original idiosyncratic disturbances are serially uncorrelated. More importantly, the AR(2) statistic was not statistically significant ($z = -0.77$, $p = 0.441$), indicating no evidence of second-order serial correlation in the differenced disturbances. The absence of AR(2) correlation was essential because significant second-order autocorrelation would have called into question the validity of lagged levels used as instruments for the differenced equations. The obtained result therefore supported the required orthogonality between the selected lagged instruments and the error process.

Instrument validity was further assessed by the Hansen J-test of overidentifying restrictions. The Hansen statistic was 14.62 with 16 degrees of freedom and a p-value of 0.552. Because the null hypothesis that the instruments were jointly valid could not be rejected, the result indicated that the selected instruments were sufficiently exogenous with respect to the disturbance term. The difference-in-Hansen test also produced a non-significant statistic of 5.11 with 6 degrees of freedom ($p = 0.529$), supporting the validity of the additional moment conditions employed in the system estimator, particularly those associated with the level equations. The number of instruments was restricted to 19, which was below the number of cross-sectional units (24 banks). This relationship was deliberately maintained to reduce the risk of instrument proliferation, excessive fitting of endogenous variables, and deterioration of the Hansen test's discriminatory capacity. Finally, the Wald statistic for the joint significance of the explanatory variables was 264.73 with $p < 0.001$, confirming that the determinants included in the model were jointly significant in explaining variation in the non-performing loan ratio. Overall, the diagnostic evidence showed that the principal requirements of the System GMM estimator were satisfied and that the estimated relationships could be interpreted without evidence of invalid instruments or problematic second-order residual autocorrelation.

Table 5. Robustness Analysis Across Alternative Dynamic Panel Specifications

Variable/Test	Two-Step System GMM	One-Step System GMM	System GMM with Collapsed Instruments	Difference GMM
CRt−1	0.638*** (0.071)	0.651*** (0.076)	0.624*** (0.069)	0.587*** (0.082)
CAR	-0.217*** (0.073)	-0.204** (0.082)	-0.229*** (0.075)	-0.193** (0.088)
ROA	-0.384*** (0.119)	-0.351*** (0.127)	-0.402*** (0.124)	-0.336** (0.139)
OPV	0.084*** (0.031)	0.079** (0.034)	0.087*** (0.032)	0.074** (0.036)
EXV	0.173*** (0.061)	0.161** (0.067)	0.168*** (0.060)	0.152** (0.069)
GOV	-1.426** (0.617)	-1.311** (0.643)	-1.487** (0.621)	-1.268** (0.634)
AR(2) p-value	0.441	0.417	0.463	0.389
Hansen/Sargan p-value	0.552	0.497	0.611	0.318

Number of instruments	19	19	14	16
Observations	336	336	336	312

The robustness analysis presented in Table 5 demonstrated that the principal findings were stable across alternative dynamic panel estimators and instrument specifications. The persistence coefficient for lagged credit risk remained positive, statistically significant, and economically substantial in every specification, ranging from 0.587 in the Difference GMM model to 0.651 in the one-step System GMM model. Thus, the conclusion that credit risk in Iraqi commercial banks exhibits pronounced temporal persistence did not depend on the specific GMM implementation. The estimated effect of capital adequacy remained negative in all specifications, ranging from -0.193 to -0.229, and was statistically significant throughout. Similarly, return on assets retained a negative and statistically significant relationship with the non-performing loan ratio, with coefficients between -0.336 and -0.402. Consequently, the protective relationships associated with capitalization and profitability were robust to changes in estimator construction and instrument treatment.

The macroeconomic results were equally stable. The oil-price volatility coefficient remained positive and statistically significant across all alternative specifications, with estimates ranging from 0.074 to 0.087. Exchange-rate volatility also retained its positive and statistically significant effect, with coefficients ranging from 0.152 to 0.173. These findings indicated that the effects of macroeconomic instability on bank credit risk were not attributable to a particular estimation strategy. The governance coefficient remained negative in all specifications and ranged between -1.268 and -1.487, confirming the importance of improvements in the institutional and regulatory environment for reducing bank credit risk. Importantly, restricting the instrument matrix through instrument collapsing did not materially alter the magnitude, direction, or statistical significance of the main coefficients. This result reduced concern that the baseline findings were driven by an excessively large instrument set.

The specification statistics associated with the robustness models also remained satisfactory. In all four specifications, the AR(2) test was statistically non-significant, with p-values ranging from 0.389 to 0.463, indicating that second-order serial correlation was not present. The overidentification tests were likewise non-significant, with p-values ranging from 0.318 to 0.611, supporting the validity of the respective instrument sets. The collapsed-instrument specification reduced the number of instruments from 19 to 14 without producing substantive changes in the estimated relationships, providing particularly strong evidence that the baseline results were not an artifact of instrument proliferation. The Difference GMM specification produced slightly smaller coefficient magnitudes, as would be expected from its reliance on differenced equations alone, but preserved the substantive conclusions of the System GMM models. Collectively, these robustness results confirmed that the identified determinants of credit risk were insensitive to reasonable changes in estimator type, instrument construction, and dynamic specification.

Taken together, the findings provided a consistent empirical representation of credit-risk dynamics in Iraqi commercial banks over the 2010–2024 period. Credit risk displayed substantial persistence, as demonstrated by the strong positive effect of the previous year's non-performing loan ratio. Among bank-specific determinants, higher capital adequacy and greater profitability were systematically associated with lower credit risk. At the macroeconomic level, both oil-price volatility and exchange-rate volatility significantly increased the non-performing loan ratio, demonstrating the sensitivity of bank asset quality to external instability. Improvements in governance and institutional conditions, in contrast, reduced credit risk. The post-estimation diagnostics supported the validity of the System GMM instruments and dynamic specification, while the robustness analyses showed that the principal

coefficient signs, magnitudes, and statistical conclusions remained stable under alternative estimation procedures. The evidence therefore indicated that credit risk in Iraqi commercial banks was jointly shaped by its own historical persistence, banks' internal financial strength, macroeconomic volatility, and the quality of the institutional environment.

Discussion and Conclusion

The findings of this study provide strong evidence that credit risk in Iraqi commercial banks during 2010–2024 was shaped jointly by its own historical persistence, bank-specific financial conditions, and the broader macroeconomic and institutional environment. The dynamic System GMM estimates showed that the lagged non-performing loan ratio had a positive and highly significant effect on the current level of credit risk, while capital adequacy and return on assets exerted significant negative effects. In contrast, oil price volatility and exchange-rate volatility significantly increased the non-performing loan ratio, whereas improvement in governance conditions was associated with a reduction in credit risk. These relationships remained stable across alternative GMM specifications, and the post-estimation tests supported the validity of the instrument set and the absence of problematic second-order serial correlation. Taken together, the results indicate that credit risk in Iraqi commercial banks should not be interpreted as a purely contemporaneous outcome of individual lending decisions. Instead, it reflects a cumulative process in which past asset-quality problems persist over time and interact with banks' financial strength and external economic shocks.

The positive and statistically significant coefficient of lagged credit risk was one of the most important findings of the study. The estimated coefficient of 0.638 indicated a considerable degree of persistence in non-performing loans, suggesting that a deterioration in loan quality in one period tends to carry over into subsequent periods. This persistence is economically plausible because non-performing loans are rarely resolved immediately. Problem loans may remain on bank balance sheets for prolonged periods because of restructuring negotiations, weak recovery procedures, delays in collateral realization, legal enforcement constraints, or continued borrower distress. The finding therefore supports the use of a dynamic panel specification and confirms that current credit risk depends substantially on the previous condition of a bank's loan portfolio. This result is compatible with the broader literature emphasizing the dynamic nature of bank vulnerability and the tendency of financial distress to evolve cumulatively rather than instantaneously. The life-cycle perspective on systemic risk similarly shows that vulnerabilities can accumulate through time and intensify when adverse balance-sheet conditions are not promptly resolved (1). From the perspective of credit-risk management, this persistence also underscores the importance of early intervention, because unresolved deterioration in asset quality may create a continuing burden on future bank performance.

The negative relationship between capital adequacy and credit risk indicates that better-capitalized Iraqi commercial banks tended to experience lower non-performing loan ratios. The coefficient of -0.217 suggests that increases in regulatory capital were associated with meaningful reductions in credit risk after controlling for profitability, macroeconomic volatility, governance, and prior credit-risk levels. One explanation is that better-capitalized banks are more capable of absorbing unexpected losses and may simultaneously maintain more conservative lending standards. Strong capital positions can also reduce pressure to pursue excessively risky lending strategies in order to generate high short-term returns. In contrast, weakly capitalized banks may face incentives to increase risk exposure in an attempt to restore profitability or capital positions, thereby increasing the probability of future loan deterioration. This interpretation is consistent with the study of credit risk and capital

adequacy using GMM panel methods, which found that capitalization and credit exposure are closely related and should be evaluated jointly rather than independently (4). It is also in line with theoretical work showing that bank regulation must account simultaneously for credit risk and other dimensions of bank fragility because capital requirements influence both risk-taking incentives and loss-absorption capacity (5). More recent evidence further demonstrates that capitalization can shape the relationship between portfolio risk and banking efficiency, confirming that capital structure remains a central element in the transmission of credit risk into performance outcomes (6).

The significant negative effect of return on assets on the non-performing loan ratio further demonstrates the importance of internal bank performance in controlling credit risk. The estimated coefficient of -0.384 implies that more profitable banks generally maintained higher-quality loan portfolios. Several mechanisms can explain this result. Higher profitability may reflect superior managerial efficiency, better borrower screening, stronger loan-monitoring systems, more effective pricing of credit risk, and greater operational capacity to manage delinquent exposures. Profitable banks may also possess stronger internal resources for provisioning and recovery activities. Conversely, persistently weak profitability may encourage management to expand lending toward higher-yield but riskier borrowers or to relax credit standards in an effort to improve short-term earnings. The finding is consistent with international evidence demonstrating a close relationship between credit risk and bank profitability across banking systems (7). It also corresponds with evidence that higher non-performing loans adversely affect financial performance in banks, indicating that the relationship between profitability and credit risk can operate in both directions (8). The evidence on financing structure and credit risk likewise suggests that the configuration of bank funding, capitalization, and exposure to risk jointly influences financial performance (9). The significant ROA coefficient obtained in the present study therefore reinforces the view that profitability and credit quality are dynamically interdependent rather than isolated dimensions of banking performance.

The findings also showed that oil price volatility had a positive and statistically significant effect on credit risk. This result is particularly important in the Iraqi context because the national economy remains highly sensitive to fluctuations in petroleum revenues. Increased oil-price volatility can reduce predictability in government revenue, public expenditure, private investment, liquidity conditions, and aggregate demand. Because a substantial proportion of economic activity is directly or indirectly connected to government expenditure and oil-generated income, uncertainty in oil markets can weaken business cash flows and household repayment capacity even when borrowers are not directly involved in the petroleum industry. As a consequence, periods of elevated oil-price instability can deteriorate borrowers' financial positions and increase the likelihood of delinquency and default. The positive effect identified in this study is consistent with recent evidence showing that changes in energy-related economic conditions can influence bank credit risk through macroeconomic growth and financial transmission channels (18). It also corresponds with evidence that the sectoral concentration of bank portfolios can interact with credit risk, capitalization, and efficiency, indicating that structural exposure to economically dominant sectors can amplify banking vulnerability (6). In Iraq, the dependence of fiscal and economic activity on petroleum revenues provides a plausible mechanism through which oil-market disturbances are transmitted to banks' loan portfolios.

Exchange-rate volatility also produced a positive and statistically significant effect on the non-performing loan ratio. This finding indicates that increased currency instability raises the probability of deterioration in bank loan quality. Exchange-rate fluctuations can affect borrowers through several channels, particularly in an economy where many firms depend on imported goods, equipment, intermediate inputs, or foreign-currency transactions. Depreciation or instability in the domestic currency can increase production costs, reduce profit margins, raise the

local-currency value of foreign-currency obligations, and weaken the repayment capacity of firms. It can also generate inflationary pressures and increase uncertainty in cash-flow planning. In addition, exchange-rate instability can affect the value and liquidity of collateral and may reduce the predictability of future asset prices. The result is consistent with evidence indicating that uncertainty and risk reduce the operational efficiency of commercial-bank credit activities by complicating borrower assessment, credit allocation, and risk monitoring (19). It also aligns with the broader finding that geopolitical and economic uncertainty can influence investment behavior and financial decision-making, thereby creating indirect consequences for borrowers and lenders (20). In the Iraqi banking environment, where currency conditions may interact with oil revenues, fiscal policy, and trade dependence, exchange-rate volatility appears to constitute a meaningful external source of credit deterioration.

The negative and statistically significant effect of the governance indicator is another important result. The coefficient of -1.426 indicates that improvements in governance and institutional conditions were associated with a lower non-performing loan ratio. Better governance can reduce credit risk through stronger regulatory oversight, more predictable economic policy, improved contract enforcement, enhanced legal certainty, and more effective supervision of financial institutions. Stronger institutions may also reduce opportunities for politically motivated lending, connected lending, weak underwriting, or delayed enforcement against defaulting borrowers. This interpretation is consistent with the increasing emphasis placed on risk-based supervision as an integrated mechanism for identifying and controlling banking vulnerabilities before they become systemic problems (11). The finding also complements evidence that well-designed collateral and guarantee systems are essential to effective credit-risk management, because the value of such protections depends not only on their formal existence but also on enforceability, valuation quality, and institutional effectiveness (10). In environments where governance is weak, even apparently secured loans may become difficult to recover if legal processes are slow or enforcement is inconsistent.

The importance of governance is also connected to the broader relationship between credit risk and bank stability. Credit deterioration can weaken multiple dimensions of bank performance simultaneously, including liquidity, profitability, capitalization, and depositor confidence. Previous evidence has shown that credit risk and liquidity risk can materially influence bank stability, suggesting that deterioration in one risk category may spill over into other aspects of institutional vulnerability (21). Such interconnections are particularly important in banking systems facing recurrent macroeconomic and institutional shocks. The present findings therefore reinforce the argument that improving credit-risk outcomes requires more than internal adjustments in lending standards; it also requires a regulatory and institutional environment capable of supporting enforcement, transparency, supervision, and financial discipline.

The results further have implications for the role of technological innovation in credit-risk management. Although fintech, artificial intelligence, and blockchain variables were not directly incorporated into the estimated model, the significant effects of profitability, capitalization, and governance suggest that managerial and informational capacities remain central to credit-risk control. Artificial intelligence can improve borrower classification, early-warning systems, anomaly detection, and continuous monitoring of credit exposures (12). Blockchain-based systems may likewise strengthen data integrity, traceability, and information sharing in credit-risk processes (13). Empirical studies have increasingly shown that fintech can contribute to improved banking performance and lower credit risk by enhancing information processing and operational efficiency (14, 15). Similar evidence indicates that the relationship between financial technology and bank efficiency depends partly on the management of credit and

economic risks (16), while credit risk may also mediate the relationship between fintech adoption and bank financial performance (17). These findings suggest that Iraqi banks may be able to reduce the persistence of non-performing loans by strengthening digital credit assessment and monitoring systems, particularly when such technological developments are accompanied by adequate governance and capital resources.

The robustness results strengthen the substantive interpretation of the main findings. Across the two-step System GMM, one-step System GMM, collapsed-instrument specification, and Difference GMM model, the signs and statistical significance of the principal coefficients remained stable. The lagged credit-risk coefficient remained positive, while capital adequacy and profitability consistently reduced non-performing loans. Oil-price volatility and exchange-rate volatility remained positive determinants, and governance retained its protective negative association. Such stability reduces concern that the main results were produced by a particular instrument configuration or estimation procedure. The diagnostic tests also confirmed that the System GMM framework was appropriate: the absence of statistically significant AR(2) correlation supported the validity of the lag structure, while the Hansen and difference-in-Hansen tests failed to reject the exogeneity of the instruments. The limited number of instruments relative to the number of banks further reduced the risk of instrument proliferation. Consequently, the empirical pattern can be interpreted as a robust representation of the determinants of credit risk within the sampled Iraqi commercial banks.

Overall, the findings are consistent with a growing body of research showing that bank credit risk is multidimensional. Evidence from commercial banks in Jordan has similarly demonstrated that both institution-specific and external factors shape credit-risk outcomes (2). Research on credit-risk management quality indicates that better risk-management practices are associated with stronger bank financial performance (3), while studies of collateral and guarantees emphasize that weaknesses in credit protection mechanisms can become persistent sources of non-performing exposures (10). At the same time, research on systemic risk shows that unresolved financial vulnerabilities can intensify across the life cycle of banking stress (1). The Iraqi evidence extends these findings by showing that credit risk is simultaneously persistent, sensitive to internal bank strength, and strongly exposed to external macroeconomic and institutional shocks. Thus, reducing non-performing loans in Iraq requires coordinated attention to bank capitalization, profitability, risk management, macroeconomic stability, and institutional quality rather than reliance on any single policy instrument.

Several limitations should be considered when interpreting the findings. First, the study was restricted to Iraqi commercial banks for which sufficiently continuous financial information was available over the 2010–2024 period, meaning that the results may not fully represent smaller institutions, newly established banks, specialized banks, or institutions with incomplete disclosure. Second, credit risk was measured primarily through the non-performing loan ratio. Although this is a widely accepted indicator of realized credit deterioration, it does not capture all dimensions of credit exposure, such as expected credit losses, loan-loss provisions, probability of default, recovery rates, loan concentration, or differences in loan classification practices. Third, the model focused on a limited set of bank-specific and macroeconomic determinants. Other potentially relevant variables, including bank size, liquidity, loan growth, cost efficiency, ownership structure, sectoral concentration, inflation, GDP growth, interest rates, fintech adoption, collateral quality, and managerial characteristics, were not included. Fourth, governance and macroeconomic variables were measured at the national level and therefore varied over time but not across banks, limiting the ability to distinguish how individual banks respond differently to the same institutional environment. Finally, although System GMM reduces several forms of endogeneity and unobserved heterogeneity, no

observational econometric design can completely eliminate all possible measurement error, omitted-variable bias, or structural changes occurring during periods of exceptional political and economic disruption.

Future studies should extend the model by incorporating a broader range of bank-specific, macroeconomic, institutional, and technological variables. Bank size, liquidity ratios, loan growth, cost-to-income ratios, ownership structure, sectoral loan concentration, loan-loss provisions, collateral coverage, and funding structure could provide a more detailed understanding of internal credit-risk mechanisms. Macroeconomic extensions could include GDP growth, inflation, unemployment, interest rates, fiscal expenditure, and indicators of political or geopolitical uncertainty. Future research could also distinguish between conventional and Islamic banks, privately owned and state-controlled institutions, or large and small banks to determine whether the effects identified in the present study vary across institutional groups. Nonlinear models may be useful for testing whether capitalization, profitability, oil-price volatility, or exchange-rate instability have threshold effects on non-performing loans. Researchers could additionally examine asymmetric effects, particularly whether adverse oil-price or exchange-rate shocks have stronger consequences than favorable movements. Longer panels and quarterly data would permit more precise investigation of short-run adjustment dynamics. Finally, future studies could integrate measures of fintech adoption, artificial intelligence, digital credit scoring, blockchain-based lending infrastructure, and cybersecurity capacity to determine whether technological modernization moderates the effects of macroeconomic instability on bank credit risk.

For banking practice and supervision, the findings indicate that credit-risk management should emphasize early identification and resolution of deteriorating loans because the strong persistence of non-performing loans means that unresolved problems can continue to affect bank portfolios across multiple periods. Commercial banks should strengthen borrower screening, post-disbursement monitoring, loan restructuring procedures, collateral revaluation, and recovery systems before exposures migrate into prolonged non-performing status. Maintaining adequate capital buffers should remain a priority, particularly during periods of heightened oil-price or exchange-rate volatility, because stronger capitalization provides greater capacity to absorb unexpected credit losses. Banks should also integrate macroeconomic stress scenarios into credit approval and portfolio-management processes, with explicit consideration of oil-price shocks, currency movements, and their effects on borrower cash flows. Supervisory authorities should encourage risk-based monitoring of institutions with rapidly deteriorating profitability, capitalization, or asset quality and should closely evaluate concentration in sectors that are especially sensitive to government expenditure or external commodity conditions. Greater investment in integrated credit-information systems, automated early-warning mechanisms, borrower databases, and digital monitoring tools would improve the timeliness of risk detection. At the policy level, improving regulatory predictability, contract enforcement, transparency, and governance would strengthen the institutional foundations of credit-risk management and could reduce the probability that temporary borrower distress becomes persistent non-performing exposure.

Acknowledgments

We would like to express our appreciation and gratitude to all those who helped us carrying out this study.

Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adheried in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

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