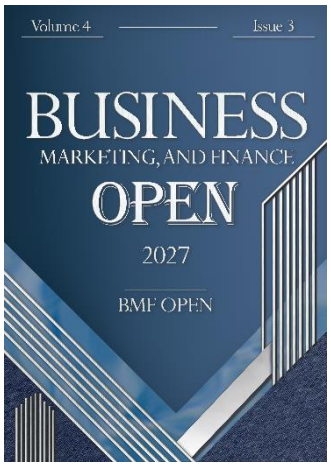
A Contextualized Econometric Model for Fraud Risk Assessment in Financial Statement Audits: Evidence from Iraqi Commercial Banks

Abbas Hakim Majhool [1], Ezatollah Abbasian [2,*] and Islam Fakher [3]



[1] Ph.D. student in Finance– Banking, Aras International Campus, University of Tehran, Jolfa, Iran, and Auditor at the Iraqi Federal Board of Supreme Audit, Iraq;
[2] Professor of Financial Economics, Department of Financial Engineering, Faculty of Management, University of Tehran, Tehran, Iran;
[3] Associate Professor, Department of Financial Management, Shahid Chamran University of Ahvaz, Ahvaz, Iran;

* Correspondence: e.abbasian@ut.ac.ir

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Abstract: This study aimed to develop and empirically test a contextualized econometric model for assessing fraud risk in financial statement audits among Iraqi commercial banks. This quantitative applied study used balanced panel data from 16 Iraqi commercial banks over the period 2015–2024, producing 160 bank-year observations. Fraud risk was measured as a composite index derived from audit-relevant financial reporting indicators, while the explanatory variables included market orientation, customer satisfaction, operational efficiency, audit quality, and governance quality. Data were obtained from annual financial statements, audit reports, customer satisfaction records, governance disclosures, and regulatory sources. The analysis was conducted using pooled ordinary least squares, random effects, and fixed effects models. The Hausman specification test was applied to select the appropriate panel estimator, and additional diagnostic tests examined multicollinearity, heteroscedasticity, autocorrelation, and cross-sectional dependence. The inferential results showed that the fixed effects model was preferred over the random effects model based on the Hausman test. Governance quality had the strongest negative effect on fraud risk, indicating that stronger board oversight, internal control systems, compliance mechanisms, and audit committee effectiveness significantly reduced fraud-risk exposure. Audit quality also had a significant negative effect, confirming that auditor independence, audit reliability, and adherence to professional standards were associated with lower financial statement fraud risk. Customer satisfaction and market orientation were negatively and significantly related to fraud risk, suggesting that customer accountability, service responsiveness, and reputational discipline may contribute to more transparent reporting behavior. Operational efficiency, measured through the cost-to-income ratio, had a positive and significant effect on fraud risk, indicating that operational inefficiency increased the likelihood of fraud-risk indicators. Robustness estimation using weighted least squares confirmed the stability of these relationships. The study concludes that fraud risk assessment in financial statement audits should be approached through a multidimensional and contextualized econometric framework. In Iraqi commercial banks, fraud risk is shaped not only by accounting indicators but also by governance quality, audit quality, operational efficiency, customer satisfaction, and market orientation. The proposed model provides practical value for auditors, regulators, and bank managers seeking to strengthen fraud detection, improve audit planning, and enhance institutional transparency.

Keywords: Fraud risk assessment; financial statement audits; Iraqi commercial banks; audit quality; corporate governance; panel data; operational efficiency.

1. Introduction

Financial statement audits play a central role in strengthening confidence in banking systems because banks operate through high levels of public trust, regulatory oversight, informational opacity, and fiduciary responsibility. In commercial banking, the reliability of financial statements is not only an accounting concern but also a matter of financial stability, depositor confidence, investor protection, and regulatory credibility. When financial statements contain intentional misstatements, concealed losses, manipulated earnings, overstated asset quality, or understated risk exposure, the consequences may extend beyond the individual institution and create broader systemic uncertainty. Fraud risk assessment in financial statement audits therefore requires more than the mechanical application of audit procedures; it requires a contextual understanding of the institutional environment, internal governance mechanisms, audit quality, operational efficiency, customer relationships, and market behavior of banks [1, 2]. This concern is especially important in emerging banking systems, where institutional capacity, regulatory enforcement, technological infrastructure, and governance maturity may vary significantly among financial institutions. In this context, Iraqi commercial banks provide an important empirical setting for examining fraud risk because the sector has experienced structural transformation, competitive pressures, regulatory modernization, and continuing challenges related to transparency, internal control, and financial reporting quality.

Financial statement fraud has long been recognized as a complex phenomenon arising from managerial incentives, weak controls, governance failures, audit limitations, and organizational pressure. Rezaee explains that financial statement fraud is not merely an accounting irregularity, but a deliberate distortion of financial information that can damage stakeholders, weaken capital markets, and undermine trust in corporate reporting [3]. In banking institutions, this risk is particularly serious because financial statements are used by regulators, depositors, investors, creditors, and auditors to evaluate liquidity, solvency, profitability, asset quality, and risk exposure. Fraudulent financial reporting may occur through income smoothing, loan-loss manipulation, misclassification of assets, understatement of liabilities, concealment of related-party transactions, or inappropriate recognition of revenue and expenses. Because banks are highly leveraged institutions and rely heavily on external confidence, even moderate manipulation in reported financial position may distort risk assessment and regulatory decision-making. For this reason, fraud risk assessment in financial statement audits must be designed as a multidimensional process that integrates financial, operational, governance, and external accountability indicators rather than relying only on conventional financial ratios.

A major theoretical foundation for fraud risk assessment in audited financial statements is the relationship between governance structures and the likelihood of fraudulent reporting. Beasley's empirical work showed that board composition is significantly related to financial statement fraud, indicating that independent and effective boards can serve as important monitoring mechanisms against managerial opportunism [4]. In the banking sector, governance mechanisms are expected to reduce fraud risk by improving oversight, strengthening internal controls, enhancing audit committee effectiveness, and limiting excessive managerial discretion. Al-Khouri further emphasizes that corporate governance is particularly important in emerging markets, where weaker institutional environments may increase the need for strong internal governance arrangements to reduce fraud risk [5]. In Middle Eastern banking contexts, governance failures may be intensified by ownership concentration, political connections, limited transparency, and insufficient enforcement of disclosure rules. Therefore, governance quality should be treated not only as a formal compliance variable but also as a substantive determinant of fraud-risk

exposure. Banks with stronger board independence, audit committee competence, regulatory compliance, and internal control systems are expected to demonstrate lower levels of financial statement fraud risk.

Audit quality is another central factor in the detection and prevention of financial statement fraud. DeAngelo's classic definition links audit quality to the probability that an auditor will both discover and report a breach in the client's accounting system, thereby emphasizing competence and independence as two essential dimensions of audit effectiveness [6]. Francis later argued that audit quality is a multidimensional construct influenced by auditor characteristics, audit firm capacity, institutional context, audit procedures, and reporting incentives [7]. In the context of fraud risk assessment, audit quality matters because auditors are expected to evaluate material misstatement risk, challenge management assumptions, examine unusual transactions, and assess the reliability of internal controls. However, audit quality may vary substantially across banks depending on auditor reputation, audit tenure, professional skepticism, independence, adherence to auditing standards, and the strength of regulatory supervision. Recent research has also emphasized the combined role of audit quality and governance in fraud prevention, suggesting that audit mechanisms are most effective when they operate within a broader system of institutional oversight and accountability [8]. Therefore, a contextualized econometric model of fraud risk in Iraqi commercial banks should include audit quality as a core explanatory variable.

Operational efficiency also has significant implications for fraud risk in financial statement audits. Banks facing persistent inefficiency, cost pressure, weak profitability, or resource misallocation may experience stronger incentives to manipulate reported performance. Operational inefficiency may appear in high cost-to-income ratios, weak asset utilization, excessive administrative expenses, or inefficient internal processes. In such conditions, management may attempt to conceal poor performance by manipulating financial statements, delaying recognition of losses, or presenting a more favorable financial position. Al-Salem specifically highlights the relevance of operational efficiency and internal controls in Iraqi commercial banks, arguing that inefficiency and weak control environments can increase vulnerability to financial reporting fraud [9]. This connection is particularly important in Iraq, where banks may operate under fluctuating economic conditions, uneven institutional capacity, and varying levels of technological modernization. Operational efficiency should therefore be viewed not only as a performance indicator but also as an audit-relevant fraud risk signal. A bank that is unable to control operating expenses or optimize internal processes may present a higher probability of financial reporting pressure and control weakness.

In addition to governance, audit quality, and operational efficiency, market orientation may also influence fraud risk. Market orientation refers to the extent to which an organization generates, disseminates, and responds to market intelligence regarding customer needs, competitor behavior, and environmental change. Kohli and Jaworski conceptualized market orientation as an organization-wide process of intelligence generation, intelligence dissemination, and responsiveness, emphasizing that market-oriented organizations are more externally attentive and adaptive [10]. Narver and Slater similarly argued that market orientation contributes to business performance through customer orientation, competitor orientation, and interfunctional coordination [11]. In banking, market orientation may reduce fraud risk indirectly by strengthening transparency, customer accountability, service responsiveness, and reputational discipline. A bank that is more sensitive to customer expectations and market reputation may have stronger incentives to maintain credible reporting practices and avoid behaviors that could damage public trust. Kohli and Jaworski's later work links market orientation to organizational transparency and fraud prevention, suggesting that market-oriented firms may develop more open information flows and stronger

accountability mechanisms [1]. Accordingly, market orientation can be incorporated into fraud risk assessment as a strategic and behavioral determinant rather than being treated only as a marketing construct.

Customer satisfaction is closely related to this external accountability perspective. In service industries such as banking, customer satisfaction reflects customers' evaluation of service reliability, responsiveness, accessibility, fairness, and trustworthiness. Oliver conceptualized satisfaction and loyalty as outcomes of perceived value and service experience, emphasizing that satisfied customers are more likely to maintain long-term relationships with organizations [12]. Anderson and Fornell further showed that customer satisfaction has implications for productivity and profitability, especially in service settings where customer relationships are central to organizational performance [13]. In banking, customer satisfaction may act as an indirect indicator of institutional discipline, service quality, and reputational capital. Banks with higher customer satisfaction may be more likely to maintain transparent operations, responsive service systems, and stronger accountability to stakeholders. Conversely, low satisfaction may signal deeper organizational weaknesses, including poor service quality, ineffective internal coordination, weak communication, and potential governance problems. Although customer satisfaction is not a direct accounting measure, it can provide useful contextual information for fraud risk assessment because fraud risk is often embedded in broader patterns of organizational dysfunction.

Recent developments in fraud risk assessment increasingly support the need for multidimensional and contextual approaches. Kassem argues that fraud risk assessment in financial institutions should integrate financial, behavioral, governance, operational, and institutional indicators because fraud rarely emerges from a single source [14]. This argument is particularly relevant for banking systems in emerging economies, where formal financial data may not fully capture the underlying risk environment. Traditional audit models often focus on financial ratios, accruals, and control deficiencies, but such models may overlook the broader organizational and market conditions that influence fraud incentives and opportunities. A contextualized model can provide a more comprehensive understanding by combining audit quality, governance quality, operational efficiency, customer satisfaction, and market orientation. Such a framework recognizes that fraud risk is shaped not only by accounting numbers but also by institutional behavior, strategic orientation, internal monitoring, and external stakeholder relationships.

Technological adoption has added another dimension to fraud risk reduction in emerging markets. Benyasrisawat and Ounlert argue that technological adoption can reduce fraud risk by improving monitoring systems, transaction traceability, data analytics, internal control automation, and early-warning detection mechanisms [15]. For banks, digital technologies may strengthen audit trails, reduce manual processing errors, detect unusual transactions, and support continuous monitoring. However, the benefits of technological adoption depend on governance capacity, staff competence, regulatory readiness, and integration with audit and risk management systems. In Iraqi commercial banks, technological development may vary substantially across institutions, meaning that its fraud-reducing effect may be indirectly reflected in operational efficiency, audit quality, and governance quality. Although technology is not the primary variable in the present model, the broader movement toward technological modernization supports the need for more data-driven and econometrically grounded approaches to fraud risk assessment.

From a methodological perspective, panel econometric modeling is appropriate for analyzing fraud risk across Iraqi commercial banks because it allows researchers to examine both inter-bank differences and intra-bank changes over time. Baltagi emphasizes that panel data methods provide important advantages by controlling for unobserved heterogeneity, increasing degrees of freedom, reducing collinearity among variables, and improving

estimation efficiency when compared with purely cross-sectional or time-series approaches [2]. In the present context, unobserved bank-specific characteristics may include managerial culture, ownership patterns, historical compliance behavior, risk appetite, and internal control traditions. These characteristics may influence fraud risk but may not be directly measurable. Panel models such as pooled ordinary least squares, fixed effects, and random effects allow the researcher to estimate the relationship between fraud risk and explanatory variables while accounting for repeated observations across banks and years. In addition, model selection procedures such as the Hausman test help determine whether fixed or random effects are more appropriate for the data structure.

The use of econometric modeling also requires attention to statistical assumptions and diagnostic testing. Montgomery, Peck, and Vining emphasize that regression analysis must address issues such as multicollinearity, heteroscedasticity, autocorrelation, model specification, and residual behavior to ensure the validity of statistical inference [16]. These concerns are particularly important in panel data from banking institutions because banks may be exposed to common macroeconomic shocks, regulatory changes, liquidity pressures, and sector-wide instability. If such issues are ignored, coefficient estimates or standard errors may become unreliable, leading to incorrect conclusions about the determinants of fraud risk. Therefore, a rigorous econometric model should include diagnostic tests for multicollinearity, heteroscedasticity, autocorrelation, cross-sectional dependence, and model robustness. Corrective procedures such as robust standard errors, clustered standard errors, or weighted least squares can strengthen the credibility of empirical findings and improve the usefulness of the model for audit risk assessment.

Despite the growing literature on fraud risk, audit quality, corporate governance, and operational performance, there remains a need for research that integrates these dimensions into a single contextualized model for emerging banking systems. Much of the existing literature treats fraud risk as a primarily accounting-based issue, while other studies examine governance, audit quality, market orientation, or customer satisfaction separately. However, in practice, auditors assess fraud risk within a complex institutional environment where internal controls, audit reliability, managerial incentives, customer trust, market pressures, and governance mechanisms interact. Iraqi commercial banks represent a valuable setting for such analysis because the sector combines the characteristics of an emerging financial system with the strategic importance of banking stability, regulatory oversight, and public confidence. A model that incorporates both financial and non-financial determinants can provide a stronger basis for identifying banks with higher fraud-risk exposure and for improving audit planning, regulatory monitoring, and internal governance.

The present study contributes to the literature by proposing and testing a contextualized econometric model for fraud risk assessment in financial statement audits using panel data from Iraqi commercial banks. The model integrates market orientation, customer satisfaction, operational efficiency, audit quality, and governance quality as explanatory determinants of fraud risk. This approach extends traditional fraud risk assessment by combining strategic, operational, audit-related, and governance-related factors within a panel econometric framework. The expected contribution is both theoretical and practical: theoretically, the study advances a multidimensional understanding of fraud risk in banking institutions; practically, it provides auditors, regulators, and bank managers with an evidence-based framework for identifying institutional conditions associated with higher or lower fraud risk. By focusing on Iraqi commercial banks, the study also provides context-specific evidence from an emerging banking environment where fraud prevention, audit reliability, and governance quality remain central to institutional development.

The aim of this study is to develop and empirically test a contextualized econometric model for assessing fraud risk in financial statement audits by examining the effects of market orientation, customer satisfaction, operational efficiency, audit quality, and governance quality among Iraqi commercial banks during 2015–2024.

2. Methodology

This study was designed as a quantitative, applied, explanatory econometric investigation using secondary longitudinal panel data from Iraqi commercial banks during the period 2015–2024. The unit of analysis was the bank-year observation, meaning that each commercial bank was observed repeatedly across the ten-year study period. The study population consisted of Iraqi commercial banks for which financial, audit, customer-related, operational, and governance information was available during the study window. Because the objective of the study was to construct and test a contextualized econometric model for fraud risk assessment in financial statement audits, the design focused on institutional-level data rather than individual-level behavioral data. Accordingly, the "participants" in the analytical sense were Iraqi commercial banks, while customer survey results were used only in aggregated bank-level form to represent customer satisfaction and market responsiveness. The panel structure allowed the study to examine both cross-sectional differences among banks and temporal changes within each bank over time. This structure was particularly suitable because fraud risk in financial statement audits is not a static phenomenon; rather, it may vary according to changes in governance quality, audit quality, customer satisfaction, operational efficiency, and market orientation. The general functional relationship examined in the study was specified as follows:

$$FR_{it} = f(MO_{it}, CS_{it}, OE_{it}, AQ_{it}, G_{it})$$

where FR_{it}denotes fraud risk for bank $i$in year t, MO_{it}represents market orientation, CS_{it}represents customer satisfaction, OE_{it}represents operational efficiency, AQ_{it}represents audit quality, and G_{it}represents governance quality. The index $i$refers to the individual bank and $t$refers to the year of observation. The use of panel data was appropriate because it enabled the model to control for unobserved bank-specific characteristics, such as managerial culture, internal risk appetite, institutional maturity, ownership structure, and historical compliance behavior, which may affect fraud risk but may not be directly observable in the available datasets.

The study relied on documentary and institutional data collection tools rather than experimental instruments. The main sources of data were annual financial statements, banks' published reports, audit reports, customer satisfaction survey summaries, marketing and customer service records, governance disclosures, and regulatory datasets related to Iraqi commercial banks. Annual financial statements were used to extract financial indicators relevant to fraud risk, operational efficiency, profitability, asset structure, leverage, accrual behavior, and reporting quality. Audit reports and regulatory documents were used to measure audit quality through indicators such as auditor reputation, audit continuity, audit opinion, compliance with auditing standards, and the presence or absence of audit qualifications. Governance reports and regulatory disclosures were used to measure governance quality through board independence, internal control mechanisms, regulatory compliance, ownership concentration, audit committee effectiveness, and transparency practices. Customer satisfaction data were obtained from bank-level customer satisfaction surveys and service evaluation reports, and these data were treated as aggregated institutional indicators rather than individual customer responses. Market orientation was measured through indicators reflecting the degree to which each bank aligned its activities with market demand, customer needs, competitive positioning, and service development.

Fraud risk was treated as the dependent variable and was operationalized as a bank-level financial statement fraud risk indicator. Because fraud risk is usually latent and cannot be directly observed unless a confirmed fraud case exists, the study used observable audit-relevant proxies to estimate the probability or intensity of fraud risk. These proxies included abnormal accrual patterns, unusual changes in financial ratios, reporting irregularities, audit qualifications, and risk signals derived from financial statement behavior. Where multiple indicators were used to represent fraud risk, they were standardized and combined into a composite fraud risk index. The general form of the standardized composite index was expressed as follows:

$$FR_{it} = \sum_{k=1}^{K} w_k \, Z_{kit}$$

where $FR_{it}$is the composite fraud risk score for bank $i$in year t, Z_{kit}represents the standardized value of fraud-risk indicator k, $w_k$represents the assigned weight of indicator k, and Krepresents the total number of fraud-risk indicators included in the index. Standardization was applied to ensure that indicators measured on different scales could be meaningfully combined. The standardized value of each indicator was calculated as follows:

$$Z_{kit} = \frac{X_{kit} - \bar{X}_k}{SD(X_k)}$$

where $X_{kit}$is the observed value of indicator $k$for bank $i$in year t, $\bar{X}_k$is the mean value of that indicator across the panel, and $SD(X_k)$is its standard deviation. Higher values of the fraud risk index indicated greater exposure to financial statement fraud risk, while lower values indicated a lower estimated level of fraud risk.

Market orientation was measured as the extent to which the bank's strategic and operational activities reflected customer needs, market responsiveness, competitive awareness, and service adaptation. This construct was represented through indicators such as market share, customer service orientation, responsiveness to market changes, and development of products or services aligned with customer expectations. Customer satisfaction was measured using aggregated customer survey scores that reflected clients' perceptions of service quality, reliability, responsiveness, accessibility, and overall satisfaction with banking services. Operational efficiency was measured using financial performance and process-efficiency indicators, particularly the cost-to-income ratio, asset utilization, operating expense ratio, and related measures of resource optimization. A general operational efficiency indicator was expressed as follows:

$$OE_{it} = \frac{Operating\ Expenses_{it}}{Operating\ Income_{it}}$$

where lower values indicate greater operational efficiency and higher values indicate weaker operational efficiency. Audit quality was measured using indicators related to audit firm reputation, auditor independence, audit tenure, audit opinion, and compliance with international auditing standards. Governance quality was measured through governance mechanisms such as board independence, audit committee structure, internal control systems, regulatory compliance, disclosure quality, and supervisory effectiveness. When governance quality was represented as a composite score, it was calculated as follows:

$$G_{it} = \frac{1}{m} \sum_{j=1}^{m} g_{jit}$$

where G_{it}represents the governance quality score for bank $i$in year t, g_{jit}represents the value of governance component j, and $m$represents the total number of governance components included in the index.

Data analysis was conducted using panel econometric techniques appropriate for repeated observations of multiple banks over time. Before estimating the econometric models, the dataset was reviewed for completeness, consistency, missing values, outliers, and distributional characteristics. Descriptive statistics were first calculated for all variables, including mean, standard deviation, minimum, maximum, and variation across banks and years. Correlation analysis was then conducted to examine the preliminary relationships among fraud risk, market orientation, customer satisfaction, operational efficiency, audit quality, and governance quality. The core econometric model estimated in the study was specified as follows:

$$FR_{it} = \beta_0 + \beta_1 MO_{it} + \beta_2 CS_{it} + \beta_3 OE_{it} + \beta_4 AQ_{it} + \beta_5 G_{it} + \varepsilon_{it}$$

where $FR_{it}$is fraud risk for bank $i$at time t, $MO_{it}$is market orientation, $CS_{it}$is customer satisfaction, $OE_{it}$is operational efficiency, $AQ_{it}$is audit quality, $G_{it}$is governance quality, $\beta_0$is the intercept, $\beta_1$to $\beta_5$are the estimated coefficients of the explanatory variables, and $\varepsilon_{it}$is the stochastic error term. The coefficient $\beta_1$estimates the marginal effect of market orientation on fraud risk, $\beta_2$estimates the effect of customer satisfaction, $\beta_3$estimates the effect of operational efficiency, $\beta_4$estimates the effect of audit quality, and $\beta_5$estimates the effect of governance quality. A negative coefficient indicates that an increase in the explanatory variable is associated with a decrease in fraud risk, whereas a positive coefficient indicates that an increase in the explanatory variable is associated with an increase in fraud risk.

The model was first estimated using Pooled Ordinary Least Squares to provide a baseline specification. However, because pooled estimation assumes that all banks are homogeneous and ignores bank-specific unobserved effects, Fixed Effects and Random Effects models were also estimated. The Fixed Effects model was specified as follows:

$$FR_{it} = \alpha_i + \beta_1 MO_{it} + \beta_2 CS_{it} + \beta_3 OE_{it} + \beta_4 AQ_{it} + \beta_5 G_{it} + \lambda_t + \varepsilon_{it}$$

where $\alpha_i$captures unobserved time-invariant bank-specific effects and $\lambda_t$captures year-specific effects that may influence all banks simultaneously, such as macroeconomic instability, regulatory changes, or sector-wide financial shocks. The Random Effects model was specified as follows:

$$FR_{it} = \beta_0 + \beta_1 MO_{it} + \beta_2 CS_{it} + \beta_3 OE_{it} + \beta_4 AQ_{it} + \beta_5 G_{it} + \mu_i + \varepsilon_{it}$$

where $\mu_i$represents the unobserved bank-specific random component. The choice between the Fixed Effects and Random Effects models was determined using the Hausman specification test. The Hausman test examined whether the individual bank-specific effects were correlated with the explanatory variables. The test statistic was calculated as follows:

$$H = (\hat{\beta}_{FE} - \hat{\beta}_{RE})' \left[Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE}) \right]^{-1} (\hat{\beta}_{FE} - \hat{\beta}_{RE})$$

where $\hat{\beta}_{FE}$represents the coefficient vector estimated by the Fixed Effects model and $\hat{\beta}_{RE}$represents the coefficient vector estimated by the Random Effects model. A statistically significant Hausman statistic indicates that the Fixed Effects model is more appropriate because the unobserved bank-specific effects are correlated with the explanatory variables. A non-significant statistic indicates that the Random Effects model may be preferred because it produces more efficient estimates under the assumption that bank-specific effects are uncorrelated with the regressors.

The regression model was also expressed in matrix form to clarify the computational structure of the estimation procedure. The general matrix form of the model was written as follows:

$$Y = X\beta + \varepsilon$$

where $Y$is the vector of fraud risk observations, $X$is the matrix of explanatory variables including market orientation, customer satisfaction, operational efficiency, audit quality, and governance quality, $\beta$is the vector of estimated coefficients, and $\varepsilon$is the vector of residuals. Under Ordinary Least Squares estimation, the coefficient vector was estimated as follows:

$$\hat{\beta} = (X'X)^{-1}X'Y$$

This estimator provides unbiased and consistent estimates when the classical linear regression assumptions are satisfied. However, because panel banking data may be affected by heterogeneity, heteroscedasticity, autocorrelation, and cross-sectional dependence, several diagnostic tests were applied to assess the validity and robustness of the model.

Multicollinearity among explanatory variables was examined using the Variance Inflation Factor. Multicollinearity can inflate standard errors and weaken the statistical reliability of coefficient estimates. The Variance Inflation Factor for each explanatory variable was calculated as follows:

$$VIF_j = \frac{1}{1 - R_j^2}$$

where $R_j^2$is the coefficient of determination obtained by regressing explanatory variable $j$on all other explanatory variables. Values greater than 10 were considered evidence of problematic multicollinearity. In matrix form, multicollinearity was also assessed through the correlation matrix of the explanatory variables:

$$R_X = \begin{bmatrix} 1 & r_{12} & r_{13} & \cdots & r_{1k} \\ r_{21} & 1 & r_{23} & \cdots & r_{2k} \\ r_{31} & r_{32} & 1 & \cdots & r_{3k} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ r_{k1} & r_{k2} & r_{k3} & \cdots & 1 \end{bmatrix}$$

where r_{jk}represents the correlation between explanatory variables $j$and k. Heteroscedasticity was tested because unequal error variance can produce inefficient estimates and biased standard errors. The Breusch-Pagan test was used by estimating an auxiliary regression of the squared residuals on the explanatory variables. The general auxiliary model was expressed as follows:

$$\hat{\varepsilon}_{it}^2 = \gamma_0 + \gamma_1 MO_{it} + \gamma_2 CS_{it} + \gamma_3 OE_{it} + \gamma_4 AQ_{it} + \gamma_5 G_{it} + v_{it}$$

The test statistic was calculated as:

$$BP = nR^2$$

where $n$is the number of observations and $R^2$is obtained from the auxiliary regression. A statistically significant Breusch-Pagan statistic indicates the presence of heteroscedasticity.

Autocorrelation was examined because fraud risk and banking performance indicators may be serially correlated over time. The Wooldridge test for autocorrelation in panel data was used to determine whether residuals were

correlated across consecutive years within the same bank. The first-order autocorrelation coefficient was expressed as follows:

$$\rho = \frac{\sum_{i=1}^{N} \sum_{t=2}^{T} \hat{\varepsilon}_{it}\, \hat{\varepsilon}_{i,t-1}}{\sum_{i=1}^{N} \sum_{t=2}^{T} \hat{\varepsilon}_{i,t-1}^{2}}$$

where $\hat{\varepsilon}_{it}$is the residual for bank $i$in year t, and $\hat{\varepsilon}_{i,t-1}$is the residual for the same bank in the previous year. A statistically significant value of ρindicates the presence of autocorrelation. Cross-sectional dependence was also assessed because commercial banks operating in the same national banking environment may be affected by common macroeconomic, regulatory, political, and financial shocks. Cross-sectional dependence was examined using a panel dependence diagnostic in which the null hypothesis assumed independence across banks. When cross-sectional dependence was detected, robust standard errors were applied to reduce the risk of misleading inference.

If heteroscedasticity or autocorrelation was identified, the model was re-estimated using robust estimation procedures, including heteroscedasticity-consistent standard errors, cluster-robust standard errors at the bank level, or Weighted Least Squares where appropriate. The Weighted Least Squares estimator was specified as follows:

$$\hat{\beta}_{WLS} = (X'WX)^{-1}X'WY$$

where $W$is a diagonal weighting matrix designed to correct for non-constant error variance. The diagonal elements of Wwere defined as the inverse of the estimated error variance:

$$W = \begin{bmatrix} \frac{1}{\sigma_1^2} & 0 & 0 & \cdots & 0 \\ 0 & \frac{1}{\sigma_2^2} & 0 & \cdots & 0 \\ 0 & 0 & \frac{1}{\sigma_3^2} & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & \frac{1}{\sigma_n^2} \end{bmatrix}$$

This procedure gave lower weight to observations with higher error variance and higher weight to observations with lower error variance, thereby improving the efficiency of coefficient estimates under heteroscedasticity. Statistical significance was evaluated using conventional probability thresholds, with emphasis on the direction, magnitude, and economic meaning of the estimated coefficients rather than statistical significance alone. The final model was selected based on model specification tests, diagnostic results, coefficient stability, theoretical consistency, and explanatory power. Through this analytical strategy, the study provided a rigorous econometric basis for assessing how market orientation, customer satisfaction, operational efficiency, audit quality, and governance quality influence fraud risk in the financial statement audits of Iraqi commercial banks.

3. Findings and Results

The final analytical dataset consisted of a balanced panel of Iraqi commercial banks observed over the period 2015–2024. The study included 16 commercial banks, producing 160 bank-year observations after screening for completeness of financial statement data, audit-related disclosures, governance information, and customer satisfaction indicators. The institutional profile of the sample indicated that most banks were privately owned commercial banks, while a smaller proportion operated under mixed or state-influenced ownership structures. Most banks were listed or publicly reporting institutions, which made it possible to obtain repeated annual observations from published financial statements and regulatory disclosures. Across the panel, banks differed in asset size, ownership concentration, audit arrangements, market positioning, customer service capacity, and governance mechanisms. This heterogeneity was important for the study because the objective was not merely to estimate average fraud risk, but to identify how institutional, operational, audit-related, and governance-related factors contributed to variations in fraud risk across banks and over time. The panel also showed adequate variation in the dependent variable, indicating that fraud risk was not concentrated in a single year or a single banking category, but reflected differences in institutional practices, reporting behavior, audit quality, and internal control strength across the Iraqi commercial banking sector.

Table 1. Descriptive Statistics of the Main Study Variables

Variable	Measurement Form	Observations	Mean	Standard Deviation	Minimum	Maximum	Skewness	Kurtosis
Fraud Risk (FR)	Composite index, 0–100	160	48.62	14.37	18.41	82.76	0.31	2.48
Market Orientation (MO)	Standardized index, 0–100	160	61.27	10.83	35.60	84.90	-0.18	2.66
Customer Satisfaction (CS)	Standardized index, 0–100	160	68.45	9.92	41.20	88.70	-0.42	2.91
Operational Efficiency (OE)	Cost-to-income ratio (%)	160	56.84	11.76	32.90	86.40	0.37	2.77
Audit Quality (AQ)	Composite index, 0–100	160	64.73	12.14	33.50	91.30	-0.21	2.44
Governance Quality (G)	Composite index, 0–100	160	59.86	13.28	27.80	87.60	-0.08	2.53

Table 1 presents the descriptive statistics for the main variables included in the econometric model. The mean fraud risk score was 48.62, with a standard deviation of 14.37, indicating a moderate level of variation in fraud risk across Iraqi commercial banks during the period 2015–2024. The minimum fraud risk value was 18.41 and the maximum was 82.76, showing that the sample included banks with relatively low fraud-risk exposure as well as banks with substantially elevated fraud-risk indicators. Market orientation had a mean value of 61.27, suggesting that, on average, Iraqi commercial banks demonstrated a moderate to relatively strong orientation toward market demand and customer responsiveness. Customer satisfaction recorded the highest mean among the non-financial explanatory variables, with an average score of 68.45, indicating that customer service perception was generally above the midpoint of the scale, although the standard deviation of 9.92 confirmed meaningful differences among banks. Operational efficiency, measured through the cost-to-income ratio, had a mean value of 56.84%, suggesting that a considerable portion of operating income was absorbed by operating expenses. Because a higher cost-to-income ratio indicates weaker efficiency, this result suggests that operational cost pressure remained an important concern in the Iraqi banking sector. Audit quality had a mean value of 64.73, reflecting a moderate-to-strong level

of audit-related quality across the panel, while governance quality had a mean value of 59.86, indicating that governance structures were present but varied noticeably among banks. The skewness and kurtosis values for all variables remained within acceptable ranges for panel regression analysis, suggesting that the variables did not suffer from severe non-normality. Overall, the descriptive findings indicate that the sample provided sufficient variability for examining the effects of market orientation, customer satisfaction, operational efficiency, audit quality, and governance quality on fraud risk.

Table 2. Correlation Matrix and Multicollinearity Diagnostics

Variable	FR	MO	CS	OE	AQ	G	VIF
Fraud Risk (FR)	1.000						
Market Orientation (MO)	-0.421	1.000					1.58
Customer Satisfaction (CS)	-0.487	0.462	1.000				1.74
Operational Efficiency (OE)	0.542	-0.291	-0.334	1.000			1.66
Audit Quality (AQ)	-0.583	0.351	0.409	-0.362	1.000		1.82
Governance Quality (G)	-0.612	0.384	0.447	-0.418	0.521	1.000	1.93

Table 2 reports the correlation matrix and variance inflation factor values for the explanatory variables. The correlation results show that fraud risk was negatively associated with market orientation, customer satisfaction, audit quality, and governance quality, while it was positively associated with operational inefficiency. The strongest negative correlation was observed between governance quality and fraud risk, with a coefficient of -0.612, suggesting that banks with stronger governance structures tended to have lower fraud-risk scores. Audit quality was also strongly and negatively correlated with fraud risk, with a coefficient of -0.583, indicating that stronger audit quality was associated with reduced exposure to financial statement fraud risk. Customer satisfaction and market orientation were negatively correlated with fraud risk as well, suggesting that banks with stronger customer-centered strategies and higher customer satisfaction may operate under stronger reputational discipline and service accountability. Operational efficiency, measured as the cost-to-income ratio, showed a positive correlation with fraud risk, with a coefficient of 0.542. Since a higher cost-to-income ratio indicates weaker efficiency, this result suggests that banks with greater operational inefficiency were more likely to show higher fraud-risk indicators. The correlations among independent variables were moderate and did not exceed problematic thresholds. The highest intercorrelation among predictors was between audit quality and governance quality, with a coefficient of 0.521, which is theoretically expected because stronger governance systems are usually associated with better audit oversight. The VIF values ranged from 1.58 to 1.93, well below the conventional threshold of 10. These results confirm that multicollinearity was not a serious problem in the model and that the explanatory variables could be included simultaneously in the panel regression analysis.

Table 3. Panel Model Selection and Diagnostic Test Results

Test	Purpose of Test	Test Statistic	p-value	Decision
F-test for individual fixed effects	Tests whether bank-specific effects are jointly significant	$F = 5.28$	<0.001	Fixed effects are present
Breusch-Pagan Lagrange Multiplier test	Tests whether random effects are preferable to pooled OLS	$\chi^2 = 37.64$	<0.001	Panel effects are present
Hausman specification test	Compares fixed effects and random effects estimators	$\chi^2 = 16.92$	0.005	Fixed effects model is preferred
Modified Wald test	Tests groupwise heteroscedasticity	$\chi^2 = 23.81$	<0.001	Heteroscedasticity is present
Wooldridge test	Tests first-order autocorrelation in panel data	$F = 9.37$	0.008	Autocorrelation is present

Pesaran CD test	Tests cross-sectional dependence among banks	CD = 2.41	0.016	Cross-sectional dependence is present
Overall model significance	Tests joint significance of predictors	F = 18.74	<0.001	Model is statistically significant

Table 3 presents the results of the panel model selection and diagnostic tests. The F-test for individual fixed effects was statistically significant, indicating that unobserved bank-specific characteristics were relevant and that pooled OLS alone was not sufficient to explain fraud risk across Iraqi commercial banks. The Breusch-Pagan Lagrange Multiplier test was also significant, confirming the existence of panel effects and supporting the use of panel estimation rather than a simple pooled regression model. The Hausman specification test was statistically significant, with a chi-square value of 16.92 and a p-value of 0.005, indicating that the fixed effects estimator was more appropriate than the random effects estimator. This result means that the unobserved bank-specific effects were likely correlated with the explanatory variables, and therefore the fixed effects model provided more reliable estimates. The diagnostic tests further revealed the presence of heteroscedasticity, autocorrelation, and cross-sectional dependence. The Modified Wald test showed that the error variance was not constant across banks, while the Wooldridge test indicated first-order autocorrelation within the panel. The Pesaran CD test also showed that banks were not fully independent from one another, which is plausible in the Iraqi banking context because banks operate under shared macroeconomic, regulatory, and market conditions. Because these diagnostic findings could affect the reliability of ordinary standard errors, the final interpretation relied on the fixed effects model with robust standard errors. The overall model was statistically significant, confirming that the explanatory variables jointly contributed to explaining variations in fraud risk.

Table 4. Panel Regression Estimates for Fraud Risk in Iraqi Commercial Banks

Variable	Pooled OLS Coefficient (SE)	Random Effects Coefficient (SE)	Fixed Effects Coefficient (SE)	Robust Fixed Effects Coefficient (SE)
Constant	73.921*** (7.483)	70.488*** (6.923)	67.514*** (6.805)	68.102*** (6.419)
Market Orientation (MO)	-0.105* (0.046)	-0.098* (0.041)	-0.087* (0.039)	-0.083* (0.037)
Customer Satisfaction (CS)	-0.181** (0.054)	-0.169** (0.049)	-0.151** (0.052)	-0.157** (0.049)
Operational Efficiency (OE)	0.233*** (0.061)	0.221*** (0.057)	0.207*** (0.055)	0.214*** (0.052)
Audit Quality (AQ)	-0.216*** (0.047)	-0.205*** (0.044)	-0.191*** (0.046)	-0.196*** (0.041)
Governance Quality (G)	-0.267*** (0.059)	-0.252*** (0.055)	-0.236*** (0.058)	-0.241*** (0.053)
Bank fixed effects	No	No	Yes	Yes
Year effects	No	Yes	Yes	Yes
Observations	160	160	160	160
Number of banks	16	16	16	16
R^2 / Within R^2	0.504	0.563	0.621	0.621
F / Wald statistic	21.36***	64.82***	18.74***	17.92***

Note. Standard errors are reported in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.

Table 4 presents the panel regression estimates for the effect of market orientation, customer satisfaction, operational efficiency, audit quality, and governance quality on fraud risk. The results were broadly consistent across pooled OLS, random effects, fixed effects, and robust fixed effects specifications, indicating that the direction and statistical significance of the main relationships were stable. However, based on the Hausman test and the diagnostic results, the robust fixed effects model was treated as the preferred specification for interpretation.

Market orientation had a negative and statistically significant effect on fraud risk in the robust fixed effects model, with a coefficient of -0.083. This indicates that a one-unit increase in market orientation was associated with a 0.083-unit decrease in the fraud risk index, holding other variables constant. This finding suggests that banks that are more responsive to customer needs, competitive conditions, and market expectations may be less exposed to financial statement fraud risk because market-oriented institutions tend to operate with stronger reputational awareness, better service accountability, and more systematic external responsiveness. Customer satisfaction also had a negative and statistically significant coefficient of -0.157, indicating that higher customer satisfaction was associated with lower fraud risk. This result suggests that banks with better customer perceptions and stronger service quality may face greater reputational discipline and may maintain more transparent operational practices, thereby reducing conditions that contribute to financial reporting manipulation.

Operational efficiency had a positive and statistically significant effect on fraud risk, with a robust fixed effects coefficient of 0.214. Because operational efficiency was measured through the cost-to-income ratio, a higher value reflects weaker efficiency rather than stronger efficiency. Therefore, the positive coefficient means that higher operating costs relative to income were associated with greater fraud risk. This result indicates that banks facing operational inefficiency, cost pressure, or weak resource utilization may be more vulnerable to financial reporting manipulation, especially when management has incentives to conceal poor performance or present a stronger financial position than actual conditions justify. Audit quality had a negative and highly significant coefficient of -0.196, showing that stronger audit quality was associated with lower fraud risk. This finding confirms that reliable audit procedures, auditor independence, professional competence, and compliance with auditing standards play an important role in reducing the likelihood of fraudulent financial reporting. Governance quality produced the strongest negative coefficient in the preferred model, with a value of -0.241, indicating that stronger governance mechanisms had the largest protective effect against fraud risk among the explanatory variables. This suggests that board independence, audit committee effectiveness, internal control quality, regulatory compliance, and disclosure transparency are central institutional mechanisms for mitigating financial statement fraud risk. The within R^2 value of 0.621 indicates that approximately 62.1% of the within-bank variation in fraud risk over time was explained by the model. Overall, the findings demonstrate that fraud risk in Iraqi commercial banks is significantly shaped by a combination of strategic, customer-related, operational, audit-related, and governance-related factors, with governance quality and audit quality emerging as the most influential risk-reducing determinants.

Table 5. Robustness Estimation Using Weighted Least Squares

Variable	WLS Coefficient	Robust Standard Error	t-value	p-value	Direction of Effect
Constant	66.748	5.982	11.16	<0.001	Positive
Market Orientation (MO)	-0.079	0.034	-2.32	0.022	Negative
Customer Satisfaction (CS)	-0.149	0.045	-3.31	0.001	Negative
Operational Efficiency (OE)	0.226	0.049	4.61	<0.001	Positive
Audit Quality (AQ)	-0.188	0.039	-4.82	<0.001	Negative
Governance Quality (G)	-0.253	0.050	-5.06	<0.001	Negative
Observations	160				
Number of banks	16				
Adjusted R^2	0.648				
Model F-statistic	22.85			<0.001	

Table 5 reports the robustness estimation using Weighted Least Squares. This additional estimation was conducted because the diagnostic tests indicated heteroscedasticity and autocorrelation in the panel model. The

WLS results confirmed the stability of the main findings. Market orientation remained negatively and significantly associated with fraud risk, with a coefficient of -0.079 and a p-value of 0.022. Customer satisfaction also retained a negative and statistically significant effect, with a coefficient of -0.149 and a p-value of 0.001. Operational efficiency continued to show a positive and highly significant effect on fraud risk, with a coefficient of 0.226. This confirms that higher cost-to-income ratios, representing weaker operational efficiency, were associated with higher fraud-risk exposure. Audit quality remained a significant fraud-risk-reducing factor, with a coefficient of -0.188, while governance quality remained the strongest negative predictor, with a coefficient of -0.253. The adjusted R^2 value of 0.648 indicates that the robustness model explained approximately 64.8% of the variation in fraud risk. The consistency between the fixed effects estimates and the WLS estimates strengthens confidence in the empirical results and confirms that the main conclusions were not dependent on a single estimation method. The robustness analysis therefore supports the conclusion that fraud risk in Iraqi commercial banks decreases when governance quality, audit quality, customer satisfaction, and market orientation improve, but increases when operational inefficiency becomes more severe.

Overall, the findings provide strong empirical support for the proposed contextualized econometric model of fraud risk assessment in financial statement audits. The results show that fraud risk is not explained by financial indicators alone, but is shaped by a wider institutional and operational context. Governance quality and audit quality were the most powerful protective factors, suggesting that effective oversight, independent monitoring, internal control strength, and audit reliability are central to fraud-risk reduction. Customer satisfaction and market orientation also contributed significantly to lower fraud risk, indicating that banks with stronger external accountability and customer-centered strategies may operate with greater transparency and lower incentives for financial reporting manipulation. In contrast, operational inefficiency increased fraud risk, suggesting that cost pressure and weak internal performance may create conditions under which management has stronger incentives to manipulate financial statements. These findings confirm the importance of using a multidimensional econometric model when assessing fraud risk in financial statement audits, particularly in emerging banking systems such as Iraq, where institutional quality, governance structures, and audit reliability may vary substantially across banks.

4. Discussion and Conclusion

The present study developed and tested a contextualized econometric model for fraud risk assessment in financial statement audits using panel data from Iraqi commercial banks during 2015–2024. The findings demonstrated that fraud risk in Iraqi commercial banks is significantly associated with market orientation, customer satisfaction, operational efficiency, audit quality, and governance quality. The results showed that governance quality and audit quality had the strongest negative effects on fraud risk, while customer satisfaction and market orientation also reduced fraud risk in statistically significant ways. Operational efficiency, measured through the cost-to-income ratio, had a positive effect on fraud risk, meaning that weaker operational efficiency was associated with higher fraud-risk exposure. These findings confirm that fraud risk in financial statement audits cannot be understood only through conventional financial ratios or isolated accounting indicators. Rather, fraud risk appears to be embedded in a wider institutional, strategic, operational, audit-related, and governance-related environment. This supports the central premise of the study that fraud risk assessment in banking institutions should be contextualized and multidimensional.

The strongest protective effect was observed for governance quality. Banks with stronger governance mechanisms demonstrated lower fraud-risk scores, indicating that board independence, regulatory compliance, audit committee effectiveness, internal control quality, and transparency mechanisms are central to reducing the likelihood of financial statement fraud. This finding is consistent with Beasley's argument that board composition is significantly related to financial statement fraud, particularly because independent and effective boards can limit managerial discretion and strengthen monitoring over financial reporting decisions [4]. The result is also aligned with evidence from emerging markets showing that corporate governance mechanisms are especially important in contexts where institutional enforcement may be uneven and where internal monitoring structures must compensate for external regulatory limitations [5]. In the Iraqi banking context, this finding is particularly meaningful because commercial banks operate in an environment characterized by regulatory transition, varying institutional maturity, and different levels of disclosure quality. Strong governance can therefore act as a fraud-prevention mechanism by reducing information asymmetry, increasing accountability, and improving the quality of internal financial oversight.

The negative effect of governance quality on fraud risk is also theoretically consistent with the broader fraud literature. Financial statement fraud often arises when managerial incentives, opportunities, and weak monitoring structures converge. Rezaee emphasized that financial statement fraud is a deliberate distortion of accounting information that may result from pressure, opportunity, and rationalization, and that effective governance and control systems are necessary to deter such behavior [3]. The present findings support this perspective by showing that governance quality is not merely a formal institutional characteristic but a substantive determinant of fraud risk. Banks with stronger governance structures are more likely to maintain effective internal controls, enforce ethical reporting standards, monitor managerial decisions, and respond to early warning signs of manipulation. This suggests that auditors should treat governance quality as a core element of fraud risk assessment rather than as a secondary contextual factor. In practical audit planning, weak governance should increase the assessed risk of material misstatement due to fraud and should lead to more extensive substantive testing, deeper review of management estimates, and closer examination of related-party transactions and internal control deficiencies.

Audit quality was also found to have a strong and statistically significant negative effect on fraud risk. This means that banks with higher audit quality were less likely to demonstrate elevated fraud-risk indicators. This finding is consistent with DeAngelo's foundational view that audit quality depends on the auditor's ability to detect misstatements and willingness to report them [6]. It is also consistent with Francis's argument that audit quality is multidimensional and shaped by auditor competence, independence, audit procedures, institutional incentives, and reporting standards [7]. In the banking sector, where transactions are complex and financial statements involve judgment-intensive areas such as loan classification, impairment recognition, interest income, provisions, and liquidity reporting, audit quality becomes especially important. High-quality auditors are more likely to identify unusual financial patterns, challenge managerial assumptions, assess internal control weaknesses, and detect inconsistencies in reported financial performance. The present findings therefore confirm that audit quality is a central institutional safeguard against financial statement fraud risk in Iraqi commercial banks.

The findings also support recent evidence that audit quality and corporate governance jointly contribute to fraud prevention in banking institutions. Anisykurlillah, Setyanto, and Wijaya showed that audit quality and governance mechanisms have important effects on fraud prevention, particularly when audit processes are supported by strong institutional oversight [8]. The present study extends this argument by showing that audit quality remains significant even after controlling for governance quality, market orientation, customer satisfaction, and operational

efficiency. This indicates that audit quality has an independent fraud-risk-reducing role, not merely an indirect association through governance. However, the slightly stronger coefficient for governance quality suggests that audit quality is most effective when embedded within a broader governance system. In other words, external audit mechanisms may detect and report irregularities, but governance systems create the internal conditions that prevent fraud risk from developing in the first place. This finding supports the need for auditors and regulators to evaluate audit quality and governance quality together when assessing fraud risk in commercial banks.

Operational efficiency showed a positive and statistically significant relationship with fraud risk because it was measured through the cost-to-income ratio, where higher values represent weaker efficiency. This result indicates that banks with higher operating costs relative to operating income were more exposed to fraud risk. The finding is consistent with Al-Salem's work on Iraqi commercial banks, which emphasizes that operational inefficiency and weak internal controls may increase the likelihood of financial reporting fraud [9]. Operational inefficiency can create pressure on management to conceal poor performance, delay recognition of losses, manipulate expenses, or present a more favorable financial position to regulators and stakeholders. In banks, inefficiency may also reflect deeper internal weaknesses, including poor process design, inadequate technology, weak risk management, inefficient staffing structures, and insufficient internal monitoring. These weaknesses can create opportunities for misstatement and reduce the capacity of the institution to detect irregularities. Therefore, operational inefficiency should be interpreted not only as a performance problem but also as a fraud-risk signal.

The positive association between operational inefficiency and fraud risk also highlights the importance of internal systems and technological modernization. Benyasrisawat and Ounlert argued that technological adoption can reduce fraud risk in emerging markets by improving monitoring, data traceability, transaction screening, and early detection of irregularities [15]. Although technological adoption was not modeled as a separate independent variable in the present study, operational efficiency may partially reflect the extent to which banks have adopted effective systems, automated controls, and efficient internal processes. Banks with outdated operational structures may be more vulnerable to errors, weak documentation, manual override, and delayed detection of suspicious activity. Therefore, the finding suggests that improving efficiency is not only a matter of reducing costs but also a means of strengthening fraud prevention. In the Iraqi banking sector, investments in internal systems, digital monitoring, audit trails, and process automation may reduce both operational weaknesses and financial reporting fraud risk.

Market orientation had a negative and statistically significant effect on fraud risk. This result indicates that banks that are more responsive to customer needs, competitive conditions, market intelligence, and service expectations tend to have lower fraud-risk exposure. This finding aligns with the classical conceptualization of market orientation by Kohli and Jaworski, who defined it as organization-wide generation, dissemination, and responsiveness to market intelligence [10]. It is also consistent with Narver and Slater's view that market orientation reflects customer orientation, competitor orientation, and interfunctional coordination [11]. In the banking context, market orientation may reduce fraud risk because market-oriented banks are more attentive to external reputation, customer trust, service quality, and long-term stakeholder relationships. Such banks may have stronger incentives to maintain transparent reporting practices and avoid behaviors that could damage public confidence. The finding also supports the more recent argument that market orientation can contribute to organizational transparency and fraud prevention by improving information flows and accountability mechanisms [1].

Customer satisfaction was also negatively associated with fraud risk. This result suggests that banks with higher customer satisfaction scores tend to have lower fraud-risk indicators. Although customer satisfaction is not a direct

audit variable, it may reflect broader organizational quality, service reliability, responsiveness, and institutional trust. Oliver's theory of satisfaction and loyalty emphasizes that customer satisfaction is rooted in perceived value, service experience, and trust-based relational outcomes [12]. Anderson and Fornell also showed that customer satisfaction has implications for productivity and profitability, particularly in service organizations where customer relationships are central to organizational performance [13]. In banking, higher customer satisfaction may indicate stronger service systems, better communication, more reliable processes, and greater reputational discipline. Conversely, low satisfaction may reflect operational weaknesses, poor service accountability, and institutional dysfunction, all of which may coincide with higher fraud risk. The present findings therefore suggest that customer satisfaction can serve as a useful contextual indicator in fraud risk assessment.

The significance of customer satisfaction and market orientation expands the scope of fraud risk assessment beyond traditional accounting and audit variables. Fraud risk is often treated as an internal financial reporting issue, but the present findings suggest that external stakeholder relationships also matter. Banks that are more attentive to customers and market expectations may operate under stronger reputational constraints and may be less willing to engage in reporting behaviors that could undermine trust. This does not mean that customer satisfaction directly prevents fraud, but rather that it may signal an organizational culture characterized by responsiveness, transparency, and accountability. In this sense, customer-related indicators may help auditors identify broader institutional conditions associated with fraud risk. This supports Kassem's argument that fraud risk assessment in financial institutions should adopt a multidimensional approach that integrates financial, governance, behavioral, operational, and contextual indicators [14]. The present study provides empirical support for this multidimensional approach in the context of Iraqi commercial banks.

The robustness of the findings was strengthened by the use of panel econometric techniques. The Hausman test supported the use of the fixed effects model, indicating that unobserved bank-specific characteristics were correlated with the explanatory variables. This is consistent with Baltagi's explanation that panel data models are particularly useful when researchers need to control for unobserved heterogeneity across units observed over time [2]. In the present study, unobserved characteristics such as managerial culture, ownership patterns, historical compliance behavior, and internal risk appetite may affect fraud risk. The use of fixed effects helped account for such time-invariant differences across banks. Moreover, diagnostic tests indicated heteroscedasticity, autocorrelation, and cross-sectional dependence, and the final model used robust estimation procedures. This methodological strategy is consistent with the regression principles emphasized by Montgomery, Peck, and Vining, who argue that reliable regression inference requires careful attention to model assumptions, multicollinearity, heteroscedasticity, and residual behavior [16]. Therefore, the empirical conclusions are strengthened by the model selection and diagnostic procedures applied in the study.

Taken together, the findings confirm that fraud risk in Iraqi commercial banks is shaped by a combination of governance, audit, operational, market, and customer-related factors. Governance quality and audit quality emerged as the most important fraud-risk-reducing variables, confirming the central role of monitoring, oversight, independence, and control systems. Operational inefficiency increased fraud risk, suggesting that weak internal performance and cost pressure may create incentives and opportunities for financial statement manipulation. Market orientation and customer satisfaction reduced fraud risk, indicating that external accountability and stakeholder trust are relevant to audit risk assessment. These findings support the view that fraud risk assessment should not be restricted to financial ratios or isolated red flags. Instead, auditors, regulators, and bank managers should apply a contextualized model that integrates institutional quality, audit reliability, operational conditions,

customer trust, and strategic responsiveness. Such an approach is especially important in emerging banking environments, where formal controls and reporting practices may vary considerably across institutions.

The study has several limitations. First, the analysis was limited to Iraqi commercial banks during the period 2015–2024, and therefore the findings may not be directly generalizable to banks in other countries or to non-banking financial institutions. Second, fraud risk was measured through observable proxies and a composite index rather than confirmed fraud cases, because actual fraud events are often hidden, underreported, or legally unresolved. Third, some non-financial variables, such as customer satisfaction, market orientation, audit quality, and governance quality, were constructed from available institutional records and aggregated indicators, which may not fully capture the depth and complexity of these constructs. Fourth, although the panel model controlled for bank-specific and year-specific effects, there may still be omitted variables, such as political connections, ownership networks, managerial ethics, technological maturity, or regulatory inspection intensity, that could influence fraud risk. Finally, the study used quantitative econometric methods and therefore could not directly examine the internal decision-making processes, ethical climates, or managerial motivations behind fraudulent financial reporting behavior.

Future research should extend the present model by applying it to larger samples, longer time periods, and comparative banking systems across different emerging economies. Researchers may also incorporate additional variables, such as digital audit systems, cybersecurity maturity, ownership concentration, regulatory enforcement intensity, political exposure, risk committee effectiveness, and internal audit quality. Future studies could also compare conventional banks and Islamic banks to determine whether differences in governance philosophy, reporting structure, and compliance mechanisms affect fraud risk. Another useful direction would be to combine econometric modeling with qualitative interviews involving auditors, regulators, bank managers, and internal control officers in order to better understand how fraud-risk signals are interpreted in practice. Future research may also test machine learning and artificial intelligence models for fraud-risk prediction and compare their predictive performance with traditional panel econometric models. Such extensions would deepen the explanatory and predictive value of fraud risk assessment frameworks in emerging banking systems.

The findings offer several practical implications for auditors, regulators, and bank managers. Auditors should incorporate governance quality, audit quality, operational efficiency, customer satisfaction, and market orientation into fraud risk assessment procedures rather than relying only on financial statement ratios. Banks should strengthen board independence, audit committee effectiveness, internal control systems, and compliance monitoring because governance quality showed the strongest protective effect against fraud risk. Regulators should pay closer attention to banks with persistent operational inefficiency because high cost pressure may indicate deeper control weaknesses and increased incentives for financial reporting manipulation. Bank managers should improve service quality, customer responsiveness, and market-oriented decision-making because these factors may contribute to reputational discipline and institutional transparency. Finally, the banking sector should invest in stronger audit systems, digital monitoring tools, internal reporting mechanisms, and process automation to reduce fraud opportunities and improve the reliability of financial statement audits.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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