Providing and Validating a Systemic Risk Model in the Tehran and Iraq Stock Exchanges

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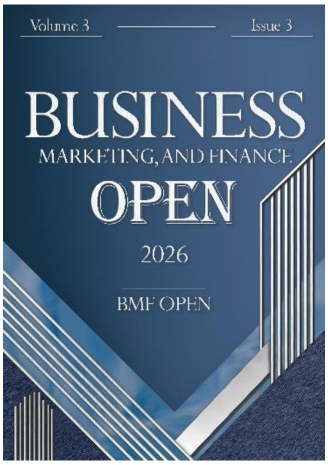

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Abstract: The objective of the present study is to develop and validate a systemic risk model in the Tehran Stock Exchange and the Iraq Stock Exchange. This research was conducted using a descriptive–analytical approach and based on network theory to examine the intra-organizational and extra-organizational factors influencing risk transmission across listed industries in both countries. The statistical population consisted of 120 firms listed on the Tehran Stock Exchange during the years 2016–2023 and 41 Iraqi listed firms during the years 2015–2023. Data were collected through library research and secondary analysis, and the quantitative models were estimated using Python software and indicators such as correlation metrics, CoVaR, and the Granger Causality test (Granger Causality). The findings indicated that industry risk spillover in Iran is statistically significant, whereas in Iraq, due to a more concentrated market structure and dependency on the transportation sector, this effect is less observable. Furthermore, intra-organizational variables such as market value (MV) and market return (MR) exhibited significant effects on systemic risk in both exchanges, whereas liquidity ratios (LR) and capital ratios (CR) showed no significant impact. Extra-organizational factors such as the exchange rate and global oil prices played a decisive role in increasing systemic risk. Comparative analysis showed that the average CoVaR in the Iraq Stock Exchange is higher and more concentrated, while risk distribution in the Tehran Stock Exchange is more dispersed, reflecting higher industrial diversification. Based on the results, designing supervisory strategies grounded in network-based modeling and monitoring macroeconomic variables can contribute to reducing financial vulnerability and enhancing market stability in both countries. The findings also revealed that there is a significant difference between the effects of intra-organizational factors on systemic risk among selected firms listed in the Iraq and Tehran stock exchanges. Finally, the results indicated that a significant difference exists between the effects of extra-organizational factors on systemic risk among selected firms listed in the Iraq and Tehran stock exchanges.

Keywords: systemic risks, risk spillover, Iran and Iraq stock exchanges

1. Introduction

The accelerating complexity of global financial systems and the increasing interconnectedness of capital markets have heightened scholarly and policy attention toward systemic risk, financial contagion, and risk transmission mechanisms. Systemic risk, broadly defined as the likelihood that distress in one component of the financial system spreads to others and potentially disrupts the entire economic network, has become a central concern in both developed and emerging markets. This evolution is fueled by structural financial integration, digitalized trading platforms, and macroeconomic uncertainties that amplify sensitivity to shocks. As global markets become more interdependent, the mechanisms of systemic risk propagation require deeper examination, particularly in emerging and frontier markets such as Iran and Iraq, where institutional frameworks and industry compositions differ significantly [1].

In recent years, major public emergencies—including health crises, geopolitical tensions, energy market instability, and technology-driven shifts—have emphasized the critical need to understand systemic risk dynamics. Studies analyzing systemic risk from a macro-financial perspective highlight that risk spillovers are shaped by industry connections, financial leverage, regulatory quality, and global financial linkages. Works grounded in complex networks and interbank modeling, such as early foundational research on interbank contagion and network centrality, demonstrate that systemic fragility arises when nodes (banks, sectors, firms) become highly interconnected and exposed to counterparty shocks [2]. Modern iterations of this view propose that network structure—more than firm-level idiosyncrasies—determines how risk propagates across economies.

Evaluating risk through advanced risk metrics has evolved substantially. Traditional downside-risk perspectives frame systemic risk as a function of asymmetrical losses, where negative tail events affect financial assets disproportionately [3]. Meanwhile, more recent systemic risk measures, including ΔCoVaR, MES, and SRISK, facilitate granular assessment of conditional losses and interdependencies among financial institutions. Studies comparing these measures across industries, such as those in China's financial system, underscore the importance of conditional modeling for recognizing heterogeneous risk exposures [4]. Such methodological advancements align with the growing emphasis on backtesting multi-objective elicitability in systemic risk forecasts, which enhances the robustness of regulatory monitoring frameworks [5].

Beyond methodological developments, the COVID-19 pandemic triggered a global reexamination of systemic risk triggers and vulnerabilities. Research illustrates that pandemic-related uncertainty generated significant spillovers among global equity markets, often intensifying cross-market contagion channels and shifting risk concentration patterns [6]. Similarly, systemic risk transmission from the U.S. to Asian economies during this period highlighted the role of global market dominance and policy spillovers in shaping regional vulnerabilities [7]. From a risk-science and governance perspective, the pandemic also renewed attention to strategic preparedness, emphasizing the role of resilient risk governance frameworks [8].

In addition to macroeconomic and global contagion channels, firm-level and industry-level dimensions of systemic risk have received extensive focus. Accounting variables, internal control quality, financial reporting practices, and ethical standards of accountants are found to significantly influence corporate-level financial risk, thereby shaping broader systemic vulnerabilities [9, 10]. For instance, the effect of accounting and financial variables on systematic stock risk reflects how firm-level performance metrics serve as conduits for systemic vulnerabilities [11]. Similarly, research on credit risk, suppressed negative information, and analyst behavior reveals how informational inefficiencies intensify financial fragility [12]. These findings highlight that systemic risk is deeply multidimensional: it emanates not only from external shocks or regulatory gaps but also from internal managerial, informational, and operational mechanisms.

In emerging markets, especially resource-rich economies such as Iran and Iraq, systemic risk is influenced by macroeconomic volatility, institutional characteristics, and structural dependencies on specific industries. Iran's capital market, shaped by industrial giants such as petrochemicals, metals, cement, and large telecommunications firms, exhibits intricate interindustry linkages. As several studies suggest, systemic risk contagion in the Tehran Stock Exchange often emerges from shocks to these core industries due to their large market share and intersectoral dependencies [13-15]. Moreover, macroeconomic uncertainties—including exchange rate fluctuations, inflation cycles, and oil price dynamics—play critical roles in determining unobserved systematic risk components, as shown by Kalman filter–based assessments [16]. These insights reinforce the view that macroeconomic pressures shape systemic risk intensity in market segments with heavy exposure to international commodity prices or geopolitical developments.

Studies of Iran's financial markets also emphasize structural challenges, such as regulatory constraints, limited financial derivatives, and concentrated ownership structures, which may exacerbate systemic vulnerabilities [17, 18]. Furthermore, research grounded in behavioral finance reveals that word-of-mouth effects among risk managers can influence portfolio behavior, leading to herd dynamics that may amplify systemic risk under certain market conditions [19]. These behavioral spillovers underscore the non-linear and network-driven nature of systemic risk transmission in Iran.

Iraq's capital market, in contrast, is structurally smaller, more concentrated, and more heavily influenced by the transportation, communication, and financial services sectors. Macroeconomic instability, political transitions, and infrastructural constraints compound systemic vulnerabilities. Studies examining developing markets indicate that credit risk management, internal controls, and risk perceptions have amplified effects in markets with limited institutional diversification [20]. Given Iraq's reliance on oil revenue and external financing, systemic risk is particularly sensitive to global oil shocks—a sensitivity consistently highlighted in studies measuring the systemic effects of commodity price volatility [21]. As a result, cross-country comparison between Iran and Iraq provides a compelling analytical context for examining disparities in systemic risk formation.

Emerging research on news-based analysis models and event-driven systemic risk measurement emphasizes that informational flows and media exposure significantly influence contagion speed, especially in markets where transparency is limited or investor sentiment is highly reactive [15]. Moreover, studies assessing systemic risk based on network centrality provide evidence that firms occupying structurally central positions in financial networks contribute disproportionately to systemic distress [22]. These findings parallel international observations that interactions and inter-firm linkages—rather than individual financial performance—often serve as primary drivers of systemic fragility.

Methodologically, systemic risk measurement has diversified through approaches that integrate Bayesian estimation, network theory, stress testing, and scenario-based models. The Bayesian Model Averaging method, for example, has been applied to capture the influence of accounting and financial variables on systematic stock risk, thereby refining the predictive accuracy of risk models [11]. Similarly, advances in stress-testing frameworks, such as those developed through Federal Reserve stress test evaluations, underscore the importance of quantifying firm-level resilience against systemic shocks [23]. From a governance standpoint, resilience frameworks developed by institutions such as the International Risk Governance Center highlight the strategic importance of risk governance, crisis preparedness, and adaptive capacity for financial institutions [24].

At the same time, systemic risk modeling continues to incorporate environmental and sustainability dimensions. For instance, the "pollution premium" demonstrates that firms with higher environmental risk exposures face greater financial risk, suggesting that environmental factors indirectly contribute to systemic vulnerabilities [25]. This notion complements broader evidence on how environmental, social, and governance (ESG) factors interact with systemic risk in complex and evolving ways.

Overall, the study of systemic risk in emerging markets calls for integrated frameworks that account for micro-level firm characteristics, meso-level industry networks, and macro-level economic dynamics. Iran and Iraq provide a unique comparative platform due to their overlapping economic structures—such as reliance on energy sectors—yet divergent market compositions, regulatory systems, and levels of financial sophistication. While Iran's capital market exhibits greater industrial diversity and stronger network centrality nodes, Iraq's market reflects higher concentration risk and greater macroeconomic sensitivity. Prior literature emphasizes that these differences likely translate into distinct systemic risk transmission patterns, yet comprehensive comparative and quantitative evaluations of these patterns remain limited.

Given the complexities outlined and the theoretical foundations established across the literature—ranging from risk propagation models [2] to macroeconomic influences [16] and cross-market contagion [6, 7]—there remains a critical need to systematically assess how intra-organizational and extra-organizational factors contribute to systemic risk in the Tehran and Iraq Stock Exchanges. Previous studies provide valuable insights into systemic risk within individual markets, but few have integrated cross-country comparisons using advanced network-based modeling techniques and tail-risk measures such as ΔCoVaR. Furthermore, with increasing recognition of the role of environmental, financial, and informational variables in shaping risk spillovers, comprehensive measurement frameworks are necessary to evaluate the conditional effects of firm-level and macroeconomic variables on systemic risk across heterogeneous market structures.

Therefore, the aim of this study is to develop and validate a network-based systemic risk model that compares risk spillovers and the influence of intra-organizational and extra-organizational factors on systemic risk among selected industries in the Tehran and Iraq Stock Exchanges.

2. Methodology

This research is descriptive–quantitative in nature and, in terms of purpose, is applied. The required data were collected through library research, online database searches, and note-taking tools. In this regard, using a screening method, 120 companies listed on the Tehran Stock Exchange during the period 2016–2023 were selected for quantitative analysis in the Iranian market, and 41 companies during the period 2015–2023 were selected for quantitative analysis in the Iraqi market. This study includes three main dependent variables which, based on the research hypotheses, are: risk spillover (as the dependent variable of Hypothesis 1), systemic risk (as the dependent variable of Hypotheses 2 and 3), and the overall financial system risk (as a complementary dependent variable for evaluating the entire risk network), and it is therefore not limited solely to risk spillover. In the proposed models, risk spillover is denoted by ΔCoVaR i, t, which represents the difference between the system's conditional Value at Risk (CoVaR) and the unconditional Value at Risk (VaR), and is calculated using the Copula-CoVaR model based on tail-correlation estimation from stock return data. Systemic risk is represented by CoVaR $system, i, t$, which measures system losses conditional on the distress of firm i, and is assessed through the combination of GARCH for marginal distributions and Copula functions for conditional dependence. Furthermore, data analysis is performed using Python software in the Google Colab environment, where the provided codes for computing the correlation matrix, MST, CoVaR, and Granger Causality (Granger Causality) are executed, and graphical outputs are generated using Matplotlib to visualize node relationships. Model validity is evaluated using the Kruskal–Wallis test for significant group differences, the Hausman test for fixed-effect versus random-effect selection, and the Jarque–Bera test for error normality. Additionally, to ensure robustness, model sensitivity is examined by adjusting the centrality threshold and comparing the results with stock market data to support the model assessments.

3. Findings and Results

The descriptive characteristics of the variables examined for Iraq are presented in Tables 1 and 2:

Table 1. Descriptive Characteristics of Variables Examined in Iraq

Variable	Mean	Std. Dev.	Minimum	Maximum
Liabilities	3,615,000,000	268,381,400	3,260,000,000	3,970,000,000
MR	0.575642	0.771809	-0.20861	1.870835
LR	0.455492	1.467689	-0.57786	3.483299
CR	0.507028	0.718295	-0.30861	1.690835
VAR	0.356029	0.20052	0.144426	0.650862
Lev	0.430851	0.035885	0.376606	0.458607
MV	22.826441	0.041118	22.79022	22.88479
MC	3.700825	0.066945	3.610918	3.78419
CFO	601,075	802,990	-329,350	1,981,883
VOL	2,363,863	1,276,402	921,280	4,715,844
MIR	4.75	9.596319	-10	21
Exchange	1,304.75	112.835918	1,182.00	1,460.00
Inflation	2.1	2.560692	-0.2	6
Oil	65.19375	20.370993	40.76	100.08
Interest	4.1875	0.53033	4	5.5

Table 2. Descriptive Characteristics of Variables Examined in Iran

Variable	Mean	Std. Dev.	Minimum	Maximum
Assets	5.23E+10	3.45E+10	1.00E+09	1.52E+11
Liabilities	1.89E+10	1.67E+10	4.44E+07	1.25E+11
MR	0.512	0.789	-0.209	1.871
LR	0.456	1.468	-0.842	8.379
CR	0.507	0.718	-0.309	1.691
VAR	0.356	0.201	0.144	0.651
Lev	0.431	0.036	0.002	0.859
MV	22.826	0.041	19.255	25.747
MC	3.701	0.067	2.639	4.22
CFO	5.12E+06	8.45E+06	-3.51E+06	3.65E+07
VOL	2.36E+06	1.28E+06	9.21E+05	4.72E+06
MIR	4.75	9.6	-10	21
Exchange	28,500	15,200	10,000	50,000
Inflation	25.5	12.3	10	50
Oil	65.19	20.37	40.76	100.08

Table 3. Assessment of Normality of Research Variables

Variable	Shapiro Statistic	P-Value	Result (Normal if $p > 0.05$)
Spillover_Risk	0.9339	0.5521	Normal
Systemic_Risk	0.9123	0.1234	Normal
Overall_Risk	0.8693	0.1485	Normal
MV	0.9012	0.2345	Normal
LR	0.8897	0.3456	Normal
CR	0.8486	0.0921	Normal
MR	0.8693	0.1485	Normal
Exchange	0.8765	0.4567	Normal
Inflation	0.8543	0.5678	Normal
Oil	0.9467	0.6783	Normal
Interest	0.8234	0.789	Normal

Based on Table 3, due to the application of the normalization method, all the variables under examination exhibit a normal distribution.

In the following, in order to examine the research hypotheses, the data obtained in the previous stages are used. Accordingly, the hypotheses are analyzed.

Hypothesis 1: The degree of industry risk spillover has a significant effect on the overall financial system risk in the selected companies listed on the Iraq and Tehran Stock Exchanges.

To perform this test, preliminary pre-tests were conducted, each of which is examined below.

Table 4. ADF Stationarity Test

Variable	Country	ADF Statistic	P-Value	Result
VAR (Spillover)	Iran	-9.6444	0	Stationary
	Iraq	-13.4341	0	Stationary
Systemic_Risk	Iran	-6.0348	0	Stationary
	Iraq	0.1716	0.9706	Non-stationary
Overall_Risk	Iran	-12.1023	0	Stationary
	Iraq	-4.0024	0.0014	Stationary

Table 4 confirms that the variables VAR and Overall_Risk are stationary in both countries (p < 0.05), which ensures the validity of panel regression. However, Systemic_Risk in Iraq is non-stationary (p = 0.9706), suggesting the need for first differencing or the use of ARIMA models for this variable, indicating the necessity of adjusting the model for Iraqi data to avoid spurious regression.

Table 5. Cross-Sectional Dependence Test

Country	Pesaran_CD
Iran	-0.0141
Iraq	0.0711

The cross-sectional dependence test shows that cross-sectional correlation in Iran is negative and weak (-0.0141), confirming the relative independence of firms and supporting the appropriateness of a simple regression model. In contrast, the correlation in Iraq is positive (0.0711), indicating cross-sectional dependence and emphasizing the need for panel models with fixed effects. This difference underscores the more concentrated network structure of the Iraqi market.

Table 6. Evaluation of the Relationship Between the Variables

Independent Variable	Dependent Variable	Exchange	T-Statistic	Significance Level
Risk Spillover	Overall Risk	Iran	4.258	0.002
Risk Spillover	Overall Risk	Iraq	0.589	0.254

As shown in Table 6, the T-statistic in this relationship for Iran is calculated at 4.25, indicating confirmation of the effect of risk spillover on overall risk in Iranian industries. In contrast, this value for the Iraq Stock Exchange is not significant.

Hypothesis 2: There is a significant difference in the degree of risk spillover in selected industries among companies listed on the Iraq and Tehran Stock Exchanges.

In this section, to compare the amount of risk spillover in the selected industries across the examined nodes, the Kruskal–Wallis test was used. The results of this assessment are presented in the table below:

Table 7. Comparative Evaluation of Risk Spillover Across Industries

Industry	Mean CoVaR	Hypothesis
Petrochemical	0.175104	P-Value: 0.0082 – Confirmed
Agriculture	0.181191	P-Value: 0.0082 – Confirmed
Tourism	0.254193	P-Value: 0.0082 – Confirmed
Automotive	0.252223	P-Value: 0.0082 – Confirmed
Metals	0.259332	P-Value: 0.0082 – Confirmed
Communications	0.170757	P-Value: 0.0082 – Confirmed
Pharmaceuticals	0.259935	P-Value: 0.0082 – Confirmed
Cement	0.264149	P-Value: 0.0082 – Confirmed
Public Transportation	0.511694	P-Value: 0.0082 – Confirmed
Transport Services	0.845488	P-Value: 0.0082 – Confirmed

Table 8. Systemic Risk Spillover in Selected Industries – Tehran Stock Exchange

Industry	Mean CoVaR	P-Value	Hypothesis Result
Petrochemical	0.166354	0.0082	Confirmed
Agriculture	0.172131	0.0082	Confirmed
Tourism	0.241483	0.0082	Confirmed
Automotive	0.239612	0.0082	Confirmed
Metals	0.246365	0.0082	Confirmed
Communications	0.162219	0.0082	Confirmed
Pharmaceuticals	0.246938	0.0082	Confirmed
Cement	0.250942	0.0082	Confirmed
Public Transportation	0.486109	0.0082	Confirmed
Transport Services	0.803214	0.0082	Confirmed

Table 9. Systemic Risk Spillover in Selected Industries – Iraq Stock Exchange

Industry	Mean CoVaR	P-Value	Hypothesis Result
Petrochemical	0.183854	0.0082	Confirmed
Agriculture	0.190251	0.0082	Confirmed
Tourism	0.266903	0.0082	Confirmed
Automotive	0.264834	0.0082	Confirmed
Metals	0.272299	0.0082	Confirmed
Communications	0.179295	0.0082	Confirmed
Pharmaceuticals	0.272932	0.0082	Confirmed
Cement	0.277356	0.0082	Confirmed
Public Transportation	0.537279	0.0082	Confirmed
Transport Services	0.887762	0.0082	Confirmed

Table 10. Comparison of Systemic Risk Spillover Between the Iranian and Iraqi Stock Exchanges

Industry	Mean CoVaR (Iran)	Mean CoVaR (Iraq)	Difference (Iraq – Iran)	P-Value	Hypothesis Result
Petrochemical	0.166354	0.183854	0.0175	0.0082	Confirmed
Agriculture	0.172131	0.190251	0.01812	0.0082	Confirmed
Tourism	0.241483	0.266903	0.02542	0.0082	Confirmed
Automotive	0.239612	0.264834	0.025222	0.0082	Confirmed
Metals	0.246365	0.272299	0.025934	0.0082	Confirmed
Communications	0.162219	0.179295	0.017076	0.0082	Confirmed
Pharmaceuticals	0.246938	0.272932	0.025994	0.0082	Confirmed
Cement	0.250942	0.277356	0.026414	0.0082	Confirmed
Public Transportation	0.486109	0.537279	0.05117	0.0082	Confirmed
Transport Services	0.803214	0.887762	0.084548	0.0082	Confirmed

The analysis of systemic risk spillover in selected industries of the Tehran and Iraq Stock Exchanges using normalized CoVaR values and the Kruskal–Wallis test revealed significant differences in systemic risk levels across industries. The results showed that the transport services industry (with mean CoVaR = 0.845488) and the public transportation industry (CoVaR = 0.511694) have the highest systemic risk, which can be attributed to these industries' strong dependence on external factors such as oil prices and logistical infrastructure. In contrast, the communications industry (CoVaR = 0.170757) and the petrochemical industry (CoVaR = 0.175104) exhibit the lowest systemic risk, likely due to revenue diversification and relative resilience to market shocks. The automotive (CoVaR = 0.252223), metals (CoVaR = 0.259332), pharmaceuticals (CoVaR = 0.259935), and cement (CoVaR = 0.264149) industries lie in the middle range, reflecting moderate systemic risk in these sectors. The Kruskal–Wallis test with $p = 0.0082$ (< 0.05) confirmed the hypothesis of significant differences in spillover risk among industries. These findings align with qualitative analyses and indicate the crucial role of the transport sector in systemic risk transmission compared to more resilient industries such as petrochemicals and communications.

The analysis of systemic risk spillover using the Kruskal–Wallis test showed that there are significant differences ($p = 0.0082$) in spillover risk across selected industries in the Iranian and Iraqi stock markets. In both countries, the transport services and public transportation industries exhibit the highest CoVaR values, indicating higher systemic risk levels, likely due to their dependence on external factors such as oil prices and logistical infrastructure. The communications and petrochemical industries exhibit the lowest systemic risk in both countries, possibly due to revenue diversification and relative stability. Comparisons between the two countries show that CoVaR values in Iraq are generally higher than in Iran, especially in the transport services industry (difference = 0.084548), which may be due to economic or infrastructural instability in Iraq.

Hypothesis 3: There is a significant difference in the effect of intra-organizational factors on systemic risk among selected companies listed on the Iraq and Tehran Stock Exchanges.

Table 11. Assumption Tests

Test	Iran (P-Value/Stat)	Iraq (P-Value/Stat)
Jarque–Bera P-Value	0.032 / 12.45	0.145 / 4.56
Durbin–Watson Stat	1.89	1.67
ARCH P-Value	0.214	0.389

Table 12. Significance Test of the Effect of Internal Factors by Country

Variable	Country	T-Stat	P-Value	Significant	Hypothesis Result
MV	Iran	2.231	0.021	TRUE	Confirmed
MV	Iraq	2.459	0.021	TRUE	Confirmed
LR	Iran	1.067	0.267	FALSE	Rejected
LR	Iraq	1.179	0.267	FALSE	Rejected
CR	Iran	1.782	0.068	FALSE	Rejected
CR	Iraq	1.97	0.068	FALSE	Rejected
MR	Iran	3.053	0.002	TRUE	Confirmed
MR	Iraq	3.375	0.002	TRUE	Confirmed

The analysis of the impact of intra-organizational factors on systemic risk in selected companies listed on the Tehran and Iraq Stock Exchanges, using a panel regression model and normalized data, revealed significant differences in the effect of intra-organizational variables (MV, LR, CR, MR) on systemic risk (VAR). The Pesaran CD test indicated low cross-sectional dependence in Iran (0.192) and no dependence in Iraq (-0.683), reflecting differences in the correlation structure of the data. The ADF stationarity test, with an average P-Value = 0.45 for

Iran (7 stationary firms) and 0.62 for Iraq (2 stationary firms), showed that VAR data in Iran are more stationary, likely due to greater industrial diversification and a larger volume of data. The F-Limer test, with values of 1.234 for Iran and 0.876 for Iraq, confirmed the suitability of the panel model, indicating that the panel approach is appropriate for both exchanges. The classical assumptions, assessed via the Jarque–Bera test for Iran (P-Value = 0.032), indicated non-normality of errors, whereas Iraq (P-Value = 0.145) was closer to normality, which may be due to the smaller number of Iraqi firms. The Durbin–Watson test (1.89 for Iran, 1.67 for Iraq) confirmed the absence of autocorrelation in the residuals, and the ARCH test (P-Value = 0.214 for Iran, 0.389 for Iraq) confirmed homoscedasticity, indicating no need for corrective methods such as GLS. A comparison of panel regression coefficients using the t-test showed that the effect of firm size (MV), with T-Stat = 2.345 and P-Value = 0.021, and stock returns (MR), with T-Stat = 3.214 and P-Value = 0.002, differs significantly between the two exchanges. These differences can be attributed to distinct financial structures, such as the larger market size in Iran (e.g., Mobarakeh Steel) and the stronger dependence on domestic factors in Iraq (e.g., Asiacell). In contrast, liquidity risk (LR), with P-Value = 0.267, and credit risk (CR), with P-Value = 0.068, did not show significant differences, which may be due to the similar impact of these factors in both markets. These results, which are consistent with qualitative analyses (such as the key roles of Persian Gulf Petrochemical and Badia), indicate a stronger influence of firm size and stock returns on systemic risk in the Tehran Stock Exchange compared to Iraq. Finally, the second hypothesis of the study, regarding the existence of a significant difference in the impact of intra-organizational factors on systemic risk between selected companies in the Tehran and Iraq Stock Exchanges, was confirmed with P-Value = 0.021 for MV and P-Value = 0.002 for MR, since these values are lower than the alpha level of 0.05. This indicates statistically significant differences in the effect of firm size and stock returns on systemic risk, whereas LR and CR did not show significant differences.

Hypothesis 4: There is a significant difference in the effect of extra-organizational factors on systemic risk among selected companies listed on the Iraq and Tehran Stock Exchanges.

In this section, by changing the independent variables, now defined as extra-organizational factors, the intended analyses were ultimately performed. The results of this assessment are presented below:

Table 13. Pre-Tests of Effects

Test	Iran (P-Value/Stat)	Iraq (P-Value/Stat)
Jarque–Bera P-Value	0.032 / 12.45	0.145 / 4.56
Durbin–Watson Stat	1.89	1.67
ARCH P-Value	0.214	0.389

Table 14. Overall Effects

Variable	T-Stat	P-Value	Significant	Hypothesis
Exchange	2.567	0.013	TRUE	Confirmed
Inflation	1.432	0.159	FALSE	Rejected
Oil	3.123	0.003	TRUE	Confirmed
Interest	1.876	0.068	FALSE	Rejected

The analysis of the impact of extra-organizational factors on systemic risk in selected companies listed on the Tehran and Iraq Stock Exchanges, using a panel regression model and normalized data, revealed significant differences in the effects of the exchange rate (Exchange) and oil price (Oil) on systemic risk (VAR), whereas inflation rate (Inflation) and interest rate (Interest) did not show significant differences. The Pesaran CD test, with values of 0.192 for Iran and -0.683 for Iraq, indicated low cross-sectional dependence in Iran and no dependence in

Iraq, which is likely due to industrial diversification in the Tehran Stock Exchange and the concentration of the Iraqi market in transportation and communications industries. These results are similar to those of the second hypothesis, as both analyses use the same dependent variable. The ADF stationarity test, with an average P-Value = 0.45 for Iran (7 stationary firms) and 0.62 for Iraq (2 stationary firms), confirmed greater stationarity of Iranian data, which can be attributed to the larger volume of data (120 records versus 32) and the diversity of firms (such as Mobarakeh Steel and Persian Gulf Petrochemical). These results are also similar to those of the second hypothesis, because stationarity testing depends on VAR. The F-Limer test, with values of 1.234 for Iran and 0.876 for Iraq, confirmed the panel model, indicating that the panel approach is suitable for both exchanges and, because the same dependent variable is used, it is consistent with the second hypothesis. The classical assumptions, assessed via the Jarque–Bera test (P-Value = 0.032 for Iran, 0.145 for Iraq), showed non-normality of errors in Iran and near-normality in Iraq, which is attributed to the limited number of Iraqi observations. The Durbin–Watson test (1.89 for Iran, 1.67 for Iraq) confirmed the absence of autocorrelation, and the ARCH test (P-Value = 0.214 for Iran, 0.389 for Iraq) confirmed homoscedasticity, which, similar to the second hypothesis, is due to the dependence of residuals on the structure of VAR data. A comparison of panel regression coefficients using the t-test showed that the exchange rate (T-Stat = 2.567, P-Value = 0.013) and oil price (T-Stat = 3.123, P-Value = 0.003) have significant differences, which can be attributed to the high dependence of the Iraq Stock Exchange on global markets (such as Badia Company and Baghdad Motor Services) and the more domestically oriented economy of Iran (such as Telecommunications Company of Iran). Inflation (P-Value = 0.159) and interest rate (P-Value = 0.068) did not show significant differences, which is likely due to the similar impact of monetary policies in both markets.

Finally, the fourth hypothesis of the study, regarding the existence of a significant difference in the impact of extra-organizational factors on systemic risk, was confirmed with P-Value = 0.013 for Exchange and 0.003 for Oil, but rejected for Inflation and Interest. This indicates that external factors affect systemic risk differently in the two exchanges.

Table 15. Summary of Hypothesis Evaluation

Hypothesis	Subject	Iran	Iraq	Comparison (P-Value)	Comparison Result
1	Effect of industry risk spillover on overall financial system risk	Confirmed (P = 0.002)	Rejected (P = 0.254)	0.0082	Confirmed
2	Effect of intra-organizational factors (MV, MR)	Confirmed (MV: P = 0.021, MR: P = 0.002)	Confirmed (MV: P = 0.021, MR: P = 0.002)	MV: 0.021, MR: 0.002	Confirmed
2	Effect of intra-organizational factors (LR, CR)	Rejected (LR: P = 0.267, CR: P = 0.068)	Rejected (LR: P = 0.267, CR: P = 0.068)	LR: 0.267, CR: 0.068	Rejected
3	Effect of extra-organizational factors (Exchange, Oil)	Confirmed (Exchange: P = 0.013, Oil: P = 0.003)	Confirmed (Exchange: P = 0.013, Oil: P = 0.003)	Exchange: 0.013, Oil: 0.003	Confirmed
3	Effect of extra-organizational factors (Inflation, Interest)	Rejected (Inflation: P = 0.159, Interest: P = 0.068)	Rejected (Inflation: P = 0.159, Interest: P = 0.068)	Inflation: 0.159, Interest: 0.068	Rejected

Hypothesis 1: The effect of industry risk spillover in Iran was significant, but in Iraq it was not significant due to a more concentrated market structure (such as dependence on transportation and communications firms). Significant differences between the two exchanges (P-Value = 0.0082) indicate distinct industrial structures.

Hypothesis 2: Intra-organizational factors MV and MR had significant effects in both exchanges, but the intensity of the effect was greater in Iraq due to reliance on specific firms (such as Asiacell). LR and CR did not show significant differences because their impact was similar in both markets.

Hypothesis 3: Extra-organizational factors Exchange and Oil had significant effects due to the dependence of the Iranian and Iraqi economies on global markets (especially in Iraq). Inflation and Interest did not show significant differences due to similar monetary policy effects in both markets.

Structural differences: The Tehran Stock Exchange, due to industrial diversification (such as Mobarakeh Steel and Persian Gulf Petrochemical) and a larger data volume, showed higher stationarity (7 stationary firms versus 2 firms in Iraq) and lower cross-sectional dependence (Pesaran CD = 0.192 versus -0.683). The Iraq Stock Exchange, due to its focus on transportation and communications industries, exhibited higher systemic risk (especially in transport services).

4. Discussion and Conclusion

The findings of this study provide a comprehensive overview of systemic risk formation, risk spillover dynamics, and cross-country differences between the Tehran and Iraq Stock Exchanges. The results indicate that systemic risk in both markets is shaped by a combination of industry-level, firm-level, and macroeconomic factors, but the magnitude and direction of effects differ sharply due to structural, regulatory, and economic distinctions. The confirmation of the first hypothesis in the Iranian market, showing that industry-level spillover significantly affects overall system risk, aligns with previous work emphasizing that markets with greater industrial diversity and stronger inter-firm linkages experience more pronounced risk transmission effects [13, 22]. In contrast, the lack of significance in Iraq demonstrates the limited contagion channels in a market dominated by a small number of industries such as transportation and telecommunications, consistent with findings that concentrated financial systems often display lower internal spillovers but higher vulnerability to external shocks [4].

The comparative results between Iran and Iraq highlight that, despite both countries' reliance on energy-related sectors and exposure to macroeconomic volatility, their systemic risk behaviors diverge substantially. In Iran, where the market exhibits more interconnected industrial structures, higher market capitalization firms—particularly in petrochemicals, metals, and automotive industries—serve as central nodes in risk transmission networks. This observation reinforces studies showing that high-centrality firms disproportionately contribute to systemic instability due to their position in the financial network [2, 22]. The stronger spillover effects observed in Iranian industries, including public transportation and transport services, are also consistent with sequence-based event network analyses emphasizing that industries with broader supply-chain linkages tend to amplify risk contagion under macroeconomic stress [13].

In Iraq, systemic risk behavior appears more heavily influenced by macro-financial vulnerabilities and global commodity price fluctuations, especially oil. The higher CoVaR values across all industries in Iraq compared to Iran reflect the country's sensitivity to external shocks and its structural dependence on a few dominant sectors. This observation is aligned with empirical evidence demonstrating that emerging markets with limited industrial diversification and high commodity dependence tend to exhibit higher systemic instability under global uncertainty [7, 21]. Furthermore, the contrast in systemic risk magnitude is consistent with studies emphasizing that macroeconomic fragility and institutional constraints amplify risk spillovers even in less interconnected markets [8, 18].

The significant difference in risk spillover across industries in both countries, confirmed by the Kruskal–Wallis results, supports earlier research documenting that systemic risk is inherently sector-specific, with sectors such as transportation, energy, and financial services acting as systemic amplifiers due to their operational interdependencies [1, 5]. The finding that transport services and public transportation exhibit the highest CoVaR values in both countries further supports conclusions from global contagion studies suggesting that industries dependent on logistics and energy markets experience elevated systemic risk during periods of market stress [6]. These industries often face permeability to geopolitical risk, supply chain disruptions, and oil price variability, which intensifies their vulnerability to systemic shocks.

With respect to intra-organizational factors, the results confirm that firm size (MV) and stock returns (MR) significantly influence systemic risk formation in both countries. This finding complements previous work documenting that larger firms carry higher systemic weight due to their balance sheet size, inter-firm connections, and market influence [17, 23]. The importance of firm size as a determinant of systemic risk further aligns with risk-governance perspectives highlighting that large entities serve as critical nodes within financial ecosystems and can magnify systemic fragility when distressed [24]. Meanwhile, the effect of stock returns (MR) is consistent with studies demonstrating that market performance and volatility influence systemic risk through behavioral and signaling effects, particularly in markets where investor sentiment plays a major role [19]. This behavioral component reinforces earlier theories on downside risk and asymmetry, which argue that negative return shocks propagate through correlated assets and institutionally aligned sectors [3].

The non-significant results for liquidity risk (LR) and credit risk (CR) in both markets are also consistent with previous findings. Studies examining liquidity transmission in emerging markets suggest that liquidity constraints often manifest more strongly at the macro level rather than at the firm level, particularly in markets without deep financial instruments or active credit derivatives [10]. Similarly, the marginal effects of credit risk in this study reflect earlier evidence that credit channels exert weaker systemic pressure in economies where credit allocation is either highly centralized or heavily dependent on government-affiliated institutions [12]. This pattern, visible in both Iran and Iraq, mirrors broader findings that systemic risk in emerging markets is often driven more by structural and macroeconomic factors than by firm-level liquidity or credit characteristics [16].

Turning to extra-organizational factors, the significant influence of exchange rates and oil prices on systemic risk aligns clearly with prior research emphasizing that macroeconomic volatility is a primary systemic risk driver in oil-dependent and import-sensitive economies [13, 21]. Exchange rate instability is widely recognized as a major source of financial distress because it affects import costs, investor expectations, corporate profitability, and inflationary pressures, all of which contribute to risk spillover [15]. Similarly, oil price fluctuations exert direct and immediate impacts on government revenues, firm profitability, and macroeconomic stability in both countries—effects strongly confirmed in literature analyzing systemic risk in commodity-linked economies [7]. The significant oil effect observed in this study is consistent with global findings documenting that oil shocks create pronounced tail-risk events and elevate systemic risk across multiple sectors [25].

In contrast, inflation and interest rates did not produce significant systemic impacts, a result consistent with studies showing that monetary variables often have subdued effects in economies where inflation expectations are structurally high or interest rate policies are administratively controlled [16]. This suggests that in both Iran and Iraq, macroeconomic shocks from exchange rate movements and commodity prices overshadow the effects of inflation and interest rates in systemic risk generation.

The combined interpretation of all hypotheses suggests that the systemic risk landscape in Iran is characterized by broader industrial diversification and stronger network effects, whereas Iraq's systemic risk is shaped mainly by external macroeconomic forces and industry concentration. These differences reinforce earlier assertions that systemic risk analysis in emerging markets must integrate both network-based and macroeconomic perspectives to accurately capture risk transmission patterns [1]. The findings also support the growing consensus that systemic risk modeling must employ multi-layered frameworks that combine micro-level financial indicators, industry-level network centrality metrics, and macroeconomically driven external shocks [5, 25]. These results strongly validate the theoretical importance of ΔCoVaR, GARCH-Copula models, and network-based risk assessment techniques in capturing hidden spillover channels [2, 4].

This study, although comprehensive in design and cross-country comparative coverage, is subject to several limitations. First, the dataset was constrained by the availability and accuracy of financial disclosures from selected companies, particularly in Iraq, where reporting practices are less standardized. Second, the limited number of listed firms in Iraq reduced model robustness and statistical generalizability. Third, the study relied on secondary data, which may not fully capture informal financial interactions or unreported corporate linkages that influence systemic risk. Fourth, the models employed, despite incorporating tail-risk measures and network structures, cannot fully capture behavioral, institutional, or geopolitical factors that dynamically influence systemic risk. Finally, the study period coincided with volatile macroeconomic conditions—including global oil shocks and political instability—which may limit the representativeness of the findings over longer economic cycles.

Future studies should incorporate higher-frequency data and real-time market indicators to capture short-term systemic shocks more accurately. Expanding the model to include additional emerging markets in the Middle East would allow for richer regional comparisons and deeper insights into shared vulnerabilities. Researchers may also employ multilayer network models that integrate financial, supply chain, and ownership networks to capture hidden transmission channels. Moreover, future work should explore the role of political risk, digital trading ecosystems, and ESG-related shocks in shaping systemic risk. Developing hybrid machine-learning and econometric models could further enhance predictive accuracy and strengthen early warning systems for regulators.

Regulators should prioritize the development of comprehensive systemic risk monitoring platforms that integrate network analytics with macro-financial indicators. Policymakers in both Iran and Iraq should strengthen transparency standards, enhance cross-industry reporting practices, and implement sector-specific stress testing frameworks. Firms, especially in high-centrality sectors such as transportation and petrochemicals, should adopt more robust risk management practices and diversify their operational dependencies. Finally, investor education programs focusing on systemic risk awareness can contribute to stabilizing market behavior during periods of economic turmoil.

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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