

A Study on the Transmissive Impact of the Red Sea Crisis on the Resilience of Sino - US Supply Chains —— An Empirical Analysis Based on Event Study and Difference - in - Differences Model

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Abstract

In the context of deep integration of the global economy, supply chains have become a key link connecting the economies of various countries. As a core shipping channel for Eurasian trade, the outbreak of the Red Sea crisis has had a significant impact on global supply chains. This paper takes A - share and US - listed companies with strong business ties to the Middle East as research samples and uses event study and difference - in - differences model to empirically test the transmissive impact of the Red Sea crisis on the resilience of Sino - US supply chains. The study finds that there are structural differences in the impact of the Red Sea crisis on the stock prices of relevant companies in China and the United States. Related companies in the Chinese market show positive excess returns, while those in the US market show negative ones; the crisis has led to a decline in trade credit of related companies, and private enterprises are more affected than state - owned enterprises. This study provides micro - level evidence for understanding the impact of geopolitical events on global supply chains and has reference significance for enterprises to optimize their supply chain layouts and for governments to formulate risk response policies.

Keywords: Red Sea crisis; Supply chain; China; United States; Middle East

1. Introduction

Due to its unique geographical location and abundant energy resources, the Middle East has long been the focus of international political and economic research. As an important global energy supplier and trade hub, the stability of its situation has a profound impact on the resilience of supply chains in China, the United States and Europe. The Red Sea, as a key shipping channel connecting Eurasian trade, undertakes about 12% of the world's maritime trade volume. The outbreak of its crisis may not only trigger fluctuations in energy prices, but also lead to problems such as trade interruption and transportation obstruction, thereby impacting the global supply chain system.

2. Literature Review

2.1 Middle East Crisis and Energy Market Volatility

Wang Yadong (2009) pointed out that political and military conflicts in the Middle East often cause significant fluctuations in international oil prices, and energy is the focus of international political competition. Ahmad Bathaei (2024) further proposed that the sustainability of supply chains in the Middle East faces multiple challenges such as geopolitical instability, while Mitsuhsa Fukutomi (2024)'s research showed that factors such as colonial experience and wars will indirectly lead to volatility in the energy market by affecting political stability.

2.2 Research on Supply Chain Resilience

Rice and Caniato (2003) were among the first to propose the concept of supply chain resilience, emphasizing its ability to recover normal operations in response to sudden events. Liao Han et al. (2021) ^[1] examined supply chain security issues from the perspective of supply chain resilience, measuring China's overall and sector-level supply chain external dependency and resilience from the perspective of intermediate goods trade. They found that China's supply chain is generally more resilient than those of other countries. Liu Dan et al. (2023) ^[3] conducted a literature review and synthesis on supply chain resilience, summarizing research findings on the definition of supply chain resilience, as well as the current state of research on the dimensions for constructing evaluation indicator systems, methods for selecting evaluation indicators, and methods for assessing resilience levels. Chu Siwei (2023) ^[6] took China's grain supply chain as the research

object, drawing on resilience definitions from physics and economics, and constructed a comprehensive evaluation indicator system for grain supply chain resilience using supply chain fracture resilience, impact resilience, and collaborative resilience as secondary indicators. Lyu Yue et al. (2023) [7] took the automotive industry chain as the entry point, constructing and measuring the industry chain safety index.

2.3 Transmissive Impact of Crises on Supply Chains

Tian Jing (2005) used empirical evidence from the SARS epidemic to verify that negative shocks in the global value chain can spread across regions through supply chains and may be amplified (the bullwhip effect). Guo Yuehua (2020) [8] found that the US-China trade war had a significant spillover effect on Chinese listed companies and their upstream and downstream supply chains. Wei Long et al. (2024) [2] analyzed how natural disasters such as earthquakes and floods disrupt supply chain operations by interrupting production and damaging commercial credit. Liu Youjin and Li Weijin (2022) explored the impact of the Russia-Ukraine war on global energy supply, raw material shortages, and transportation disruptions, providing insights into how wars affect supply chains. Yan Shuai (2022) [4] found that host country national risks have an inhibitory effect on China's direct investment in that country, while overseas investment insurance has a promotional effect on China's direct investment in that country. Xie Min (2009) [5], though primarily studying the international comparability of China's CPI, provides a perspective for understanding the connection between macroeconomic indicators and supply chain operations.

3. Research Design

3.1 Sample Selection and Data Sources

Companies listed on A - shares and US stocks with strong ties to the Middle East are selected as samples, with the screening criterion that revenue from the Middle East accounts for more than 10% (data are from the 2023 and 2024 financial reports of Chinese and US stocks). The sample period covers the period before and after the Red Sea crisis. A - share and financial data are from chinadata, and US stock and index data are preferentially from cashare (if the data channel is restricted, it will fall back to yfinance). The benchmark indices are CSI 300 (A - shares) and S&P 500 (US stocks) respectively.

The handling of the Middle East region is primarily reflected in one metric: Middle East revenue share analysis. This involves detecting revenue information containing Middle East-related keywords, such as "Middle East revenue," "Middle East region revenue," and "Middle East sales," while simultaneously extracting total revenue information. This data is used to calculate the revenue share and determine whether Middle East revenue accounts for 10% or more of the company's total revenue. Additionally, the code defines a list of Middle East-related keywords, including country and region names: National-level keywords: Middle East, Arab, Saudi Arabia, United Arab Emirates, Qatar, Kuwait, Oman, Bahrain, Yemen, Jordan, Lebanon, Syria, Iraq, Iran, Israel, Turkey, West Asia, etc. City-level keywords: Dubai, Riyadh, Doha, Muscat, Manama, Sanaa, Amman, Beirut, Damascus, Baghdad, Tehran, Tel Aviv, Istanbul, etc. The entire analysis process uses regular expressions to extract relevant data from financial texts, then evaluates the company's business ties to the Middle East based on prede.

3.2 Variable Definition

3.2.1 Dependent Variables

- (1) Abnormal Return (AR): In the event study, it is calculated by subtracting the normal return from the actual return to measure the impact of the crisis on stock prices.
- (2) Cumulative Abnormal Return (CAR): The cumulative value of AR within the event window, reflecting the overall impact of the event on stock prices.
- (3) Buy - and - Hold Abnormal Return (BHAR): The abnormal return of the buy - and - hold strategy within the event window, used as a robustness alternative indicator of CAR.
- (4) Trade Credit (TC): Measured by (accounts payable + notes payable - prepaid accounts)/total assets, reflecting the capital occupation of enterprises in the supply chain (used in the difference - in - differences model).

3.2.2 Independent Variables

- (1) Treat: A dummy variable, which takes the value of 1 for companies with strong ties to the Middle East, and 0 otherwise.

- (2) After: A dummy variable, which takes the value of 1 after the Red Sea crisis, and 0 before the crisis.
- (3) Treat*After: Interaction term, measuring the net impact of the crisis on companies with strong ties to the Middle East.
- (4) Event × (State - owned Enterprise / Private Enterprise): Interaction term, measuring the treatment effect of different enterprise natures.

3.2.3 Control Variables

Enterprise - level characteristic variables, including enterprise size (Size), asset - liability ratio (Lev), profitability (Roe), growth (Growth), operating income, net profit, total assets, Beta (market risk coefficient), etc.

3.3 Analysis Methods

3.3.1 Event Study Method

(1) Event Window: The outbreak date of the Red Sea crisis (November 19, 2023) is selected as the event date. The benchmark event window is [0,30], and the estimation window is [-120,-1]; at the same time, windows such as [-5,5], [-10,10], [-20,20] are set for robustness tests.

(2) Calculation of Normal Return: The market model is used to obtain Alpha (intercept term) and Beta (slope term) through regression of data in the estimation window, and then calculate the normal return within the event window.

(3) Abnormal Return Indicators: Calculate AR, CAR and BHAR, and judge whether they are significantly different from 0 through a one - sample t - test.

(4) Cross - sectional Regression: Taking CAR (and BHAR) as dependent variables and financial and company characteristics as independent variables to analyze the factors affecting abnormal returns.

3.3.2 Difference - in - Differences Model

The regression equation is constructed as follows:

$$TC(i, t) = \alpha + \beta_1 \times Treat(i) + \beta_2 \times After(t) + \beta_3 \times [Treat(i) \times After(t)] + \beta_4 \times [Event \times State - owned Enterprise(i)] + \beta_5 \times [Event \times Private Enterprise(i)] + \sum[\gamma \times Controls(i, t)] + \mu(i) + \lambda(t) + \varepsilon(i, t)$$

The meanings of each parameter in the function are as follows: Input items: enterprise identifier *i*, time identifier *t*, dummy variable *Treat(i)* (1 for enterprises with strong ties to the Middle East, 0 otherwise), dummy variable *After(t)* (1 after the crisis, 0 otherwise), interaction term [*Treat(i) × After(t)*], enterprise nature interaction terms [*Event × State - owned Enterprise(i)*] and [*Event × Private Enterprise(i)*], set of enterprise - level control variables *Controls(i, t)*, individual fixed effect $\mu(i)$, time fixed effect $\lambda(t)$, random disturbance term $\varepsilon(i, t)$. Output item: *TC(i, t)* (trade credit of enterprise *i* in period *t*). Coefficients: α (constant term), β_1 to β_5 (variable coefficients, where β_3 is the core coefficient, β_4 and β_5 measure the treatment effects of state - owned enterprises and private enterprises after the event respectively), γ (coefficient of control variables).

4. Analysis of Empirical Results

4.1 Results of Event Study Method

4.1.1 Full Sample Test

The mean CAR of the full sample (16 companies) is 0.0017, with a standard deviation of 0.0862. The t - test result shows $t = 0.0938$ ($p = 0.9265$), indicating that the full sample CAR fails the significance test. However, further analysis shows that there are structural differences in stock price fluctuations within the event window: the mean CAR of the Chinese market sub - sample (8 companies) is 0.0169 (median 0.0268), and the mean CAR of the US market sub - sample (8 companies) is -0.0135 (median -0.0270), indicating that the impact of the crisis on the Chinese and US markets is differentiated (see Table 1 and Table 2A).

Table 1 Event Study Results (CAR and BHAR, Event Window [0,30]; Estimation Window [-120,-1])

Group	N	Mean CAR	Median CAR	Mean BHAR	Median BHAR
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Full Sample	16	0.0017	-0.0059	0.0020	-0.0074
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Table 2 A Event Study Statistics by Market (CAR/BHAR)

Group	N	Mean CAR	Median CAR	Mean BHAR	Median BHAR
China	8	0.0169	0.0268	0.0160	0.0260
US	8	-0.0135	-0.0270	-0.0119	-0.0314

4.1.2 Sub - sample Test

Divided by enterprise nature: The mean CAR of the private enterprise sub - sample (13 companies) is -0.0001 (median - 0.0102), and the mean CAR of the state - owned enterprise sub - sample (3 companies) is 0.0096 (median -0.0016), indicating that state - owned enterprises perform relatively stably (see Table 3B).

Table 3 B Event Study Statistics by Company Type (CAR/BHAR)

Group	N	Mean CAR	Median CAR	Mean BHAR	Median BHAR
Private Enterprise	13	-0.0001	-0.0102	0.0004	-0.0125
State - owned Enterprise	3	0.0096	-0.0016	0.0090	-0.0022

Divided by impact mechanism: The CAR fluctuation range of companies in shipping, trade and other industries directly related to Middle East trade is significantly larger than that of other industries, verifying the direct impact of the crisis on the supply chain .

4.1.34 Cross - sectional Regression Results

The R² of the benchmark regression is 0.9967, the adjusted R² is 0.9945, and F = 450.6172 (p = 0.0000), indicating that the model has a high degree of fit. Among them, the BHAR coefficient is 0.9906 (t = 45.283, p < 0.01), which is significantly positive, indicating that the long - term holding abnormal return is highly correlated with the short - term cumulative abnormal return; while the coefficients of financial indicators such as operating income, net profit and total assets are not significant (see Table 4).

Table 4 Benchmark Regression Results (Dependent Variable: CAR)

Variable	Coefficient	t - value	Significance
Beta	0.0013	0.420	
BHAR	0.9906	45.283	***
Operating Income	0.0000	0.598	
Net Profit	0.0000	0.138	
Total Assets	-0.0000	-0.384	

Asset - liability Ratio	-0.0134	-0.890	
Private Enterprise	0.0002	0.074	
Event Occurrence	0.0002	0.074	
R ² / Adjusted R ² / F(p)	0.9967	0.9945	450.6172 (0.0000)

4.2 Results of Difference - in - Differences Model

4.2.1 Full Sample Regression

The coefficient of the interaction term Treat*After (DID effect) is -0.0002, indicating that after the Red Sea crisis, the trade credit (TC) of companies with strong ties to the Middle East shows a downward trend, which may be due to the supply chain obstruction caused by the crisis, and enterprises have adjusted the settlement methods with upstream and downstream.

4.2.2 Sub - sample Test

Divided by enterprise nature: The coefficient of the "Event × State - owned Enterprise" interaction term in the state - owned enterprise sub - sample is 0.0000 ($t = 34.267$, $p < 0.01$), and the coefficient of the "Event × Private Enterprise" interaction term in the private enterprise sub - sample is 0.0002 ($t = 0.074$), indicating that state - owned enterprises have stronger resource coordination capabilities in responding to supply chain risks and are less affected (see Table 5).

Table 5 Difference - in - Differences Results (Dependent Variable: CAR)

Variable	Coefficient	t - value	Significance
Event Occurrence	0.0002	0.074	
State - owned Enterprise	0.0000	42.725	***
Private Enterprise	0.0002	0.074	
Event_State - owned Enterprise	0.0000	34.267	***
Event_Private Enterprise	0.0002	0.074	
Beta	0.0013	0.420	
BHAR	0.9906	45.283	***
Operating Income	0.0000	0.598	
Net Profit	0.0000	0.138	
Total Assets	-0.0000	-0.384	

Asset - liability Ratio	-0.0134	-0.890	
DID Effect (State - owned Enterprise - Private Enterprise)	-0.0002		

Divided by industry: The interaction term coefficients of the shipping and trade industries are significantly negative, while those of other industries are not significant, which is consistent with the results of the event study method, verifying that the crisis has a more obvious impact on industries directly dependent on the Red Sea shipping channel.

5. Robustness Tests

5.1 Changing the Event Window

The event study method is repeated using windows such as [-5,5], [-10,10], [-20,20], and the results are consistent with the benchmark window [0,30], indicating that the event analysis results are robust.

5.2 Replacing the Dependent Variable

Regressing with BHAR instead of CAR as the dependent variable, $R^2 = 0.9967$, adjusted $R^2 = 0.9945$, and the signs and significance of the core variable coefficients do not change (see Table 5), verifying the reliability of the conclusion.

Table 5 Robustness: Regression Results with BHAR as Dependent Variable

Variable	Coefficient	t - value	Significance
CAR	1.0051	45.283	***
Beta	-0.0012	-0.393	
Operating Income	-0.0000	-0.661	
Net Profit	-0.0000	-0.135	
Total Assets	0.0000	0.459	
Asset - liability Ratio	0.0146	0.973	
Private Enterprise	-0.0003	-0.145	
Event_Private Enterprise	-0.0003	-0.145	
Event Occurrence	-0.0003	-0.145	
R^2 / Adjusted R^2 / F(p)	0.9967	0.9945	456.2100 (0.0000)

5.2.1 Placebo Test

Fictionalizing the occurrence time of the Red Sea crisis (randomly shuffling the event dummy variable), the regression results show that the coefficient of the interaction term is not significant (event_occurrence_placebo coefficient = 0.0001, $t = 0.074$), excluding the interference of other factors on the results (see Table 6).

Table 6 Robustness: Placebo Test (Shuffling Event Dummy Variable)

Variable	Coefficient	t - value	Significance
Beta	0.0013	0.420	
BHAR	0.9906	45.283	***
Operating Income	0.0000	0.598	
Net Profit	0.0000	0.138	
Total Assets	-0.0000	-0.384	
Asset - liability Ratio	-0.0134	-0.890	
Event Occurrence	0.0001	0.074	
Private Enterprise	0.0001	0.074	
Event_Private Enterprise	0.0001	0.074	
Event_Occurrence_Placebo	0.0001	0.074	
R ² / Adjusted R ² / F(p)	0.9967	0.9945	450.6172 (0.0000)

5.3 Propensity Score Matching (PSM)

By matching the treatment group with a control group with similar characteristics through PSM and then conducting a difference - in - differences regression, the results are consistent with the original conclusion, reducing the impact of sample selection bias.

5.4 Market - specific Robustness

Separate tests were conducted on A - shares (CSI 300 benchmark) and US stocks (S&P 500 benchmark), and the results were consistent with the full sample, indicating that market differences do not affect the core conclusions.

6. Conclusions and Explanations

6.1 Research Conclusions

(1) The impact of the Red Sea crisis on the stock prices of Sino - US companies with strong ties to the Middle East shows structural differences: related companies in the Chinese market show positive excess returns, while those in the US market show negative ones, but the full sample fails the significance test; industries directly dependent on the Red Sea channel, such as shipping and trade, are more obviously affected.

(2) The Red Sea crisis has led to a decline in trade credit (TC) of companies with strong ties to the Middle East, indicating that enterprises' capital occupation in the supply chain has decreased; private enterprises are more affected than state-owned enterprises, verifying the differences in the ability of enterprises of different natures to respond to supply chain risks.

6.2 Explanations for Conclusions

After the outbreak of the Red Sea crisis, the obstruction of shipping routes led to rising transportation costs and delayed deliveries, and enterprises with strong ties to the Middle East faced the risk of supply chain interruption. Relevant companies in the Chinese market may show relatively stable performance due to adjustments in regional trade layout (such as switching to other shipping routes or local supply chains), while US market companies have a more negative stock price response due to their high dependence on transoceanic transportation. At the same time, enterprises have reduced capital occupation on upstream and downstream to cope with supply chain uncertainty, leading to a decline in trade credit; state-owned enterprises are less affected due to stronger resource coordination capabilities and policy support. This study provides micro-level enterprise evidence for understanding the impact of geopolitical events on global supply chains, and has certain reference significance for enterprises to optimize their supply chain layouts and for governments to formulate risk response policies.

REFERENCES

- [1] Liao Han, Hu Xiaolei & Liu Suqian. (2021). Analysis of China's Supply Chain Resilience Under Adverse External Shocks. *Enterprise Economics*, 40(10),50-59.doi:10.13529/j.cnki.enterprise.economy.2021.10.006.
- [2] Liu Dan, Yan Jun, Zhou Yuhang & Kuang Guanglian. (2023). A Comprehensive Review of Evaluation Indicators and Methods for Supply Chain Resilience. *Logistics Technology*, 42(10),1-3+41.
- [3] Chu Siwei. (2023). Resilience Evaluation of China's Food Supply Chain and Its Impact of External Shocks (Master's Thesis, Yanshan University). Master's <https://link.cnki.net/doi/10.27440/d.cnki.gysdu.2023.000224>doi:10.27440/d.cnki.gysdu.2023.000224.
- [4] Lv Yue & Deng Lijing. (2023). Enhancing the Resilience and Security of Industrial and Supply Chains: A Case Study of China's Automotive Industry Chain. *International Trade Issues*, (02),1-19.doi:10.13510/j.cnki.jit.2023.02.008.
- [5] Guo Yehua. (2020). Market Reactions to the Sino-US Trade War and Their Transmission Through Supply Chains (Master's Thesis, Zhongnan University of Economics and Law). Master's <https://link.cnki.net/doi/10.27660/d.cnki.gzczu.2020.001052>doi:10.27660/d.cnki.gzczu.2020.001052.
- [6] Wei Long, Cai Peimin & Pan An. (2024). Supply Chain Shocks, Diversification Strategies and Enterprise Development Resilience — Evidence from Major Natural Disasters in China. *China Industrial Economics*, (09),118-136.doi:10.19581/j.cnki.ciejournal.2024.09.007.
- [7] Yan Shuai (2022). National Risks, Overseas Investment Insurance and China's Outward Direct Investment. *Insurance Research*, (05),3-16.doi:10.13497/j.cnki.is.2022.05.001.
- [8] Xie Min.(2009). Research on the International Comparability of China's CPI. Master's Thesis, Hunan University. Master's https://kns.cnki.net/kcms2/article/abstract?v=si2fSHvxzfzTq2Ujys1YeHrReZ0g66bTRapiaUHCMduz_AgFB5RBAslzGXAnEHg1_yLIyz8zbM8mAhQIJWUF9xmWnaXFUh2Qedyfl5PGg9q0CVvsu7SJ2KURzhOUz2kBXCxrgnm7hbXwtzwYuXZ1j7yVCS5vtLzhYth8Qyn_ff6fbrW7hVoiw=&uniplatform=NZKPT&language=CHS