Economics Bulletin

Volume 45, Issue 2

Effect of geopolitical and environmental disruptions on maritime trade security

Necati Altemur
Şebinkarahisar Vocational School Giresun University

Ibrahim Halil Ekşi
Gaziantep University

William Ginn
Labcorp, AI

Jamel Saadaoui
University Paris 8, IEE, LED

Abstract

This study examines the impact of global trade disruptions using a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, focusing on the Red Sea Crisis, which has disrupted key maritime ports including the Bab el-Mandeb Strait, the Suez Canal and the Cape of Good Hope, and the severe drought constraining traffic through the Panama Canal. By analyzing cargo ship transit data before, during, and after these events, the study quantifies the effects of both geopolitical and environmental disruptions on global trade dynamics. The findings reveal displacement and increased volatility in trade patterns, highlighting the far-reaching impacts of such crises on international commerce. These results emphasize the need for geopolitical stability and environmental resilience in key trade routes, a conclusion that is also relevant for policymakers.

Citation: Necati Altemur and Ibrahim Halil Ekşi and William Ginn and Jamel Saadaoui, (2025) "Effect of geopolitical and environmental disruptions on maritime trade security", *Economics Bulletin*, Volume 45, Issue 2, pages 836-841
Contact: Necati Altemur - necati.altemur@giresun.edu.tr, Ibrahim Halil Ekşi - eksihalil@gmail.com, William Ginn - william.ginn.oba@said.oxford.edu, Jamel Saadaoui - jamelsaadaoui@gmail.com.
Submitted: September 12, 2024. **Published:** June 30, 2025.

1. Introduction

The Red Sea, a critical maritime corridor, plays a pivotal role in global trade, facilitating the movement of goods between Asia, Africa, and Europe. It is one of the busiest and most strategic shipping lanes in the world, with a significant portion of international maritime trade passing through it. However, the region's geopolitical instability has made it susceptible to conflict, which can disrupt trade flows and impact global economic stability.

The Red Sea Crisis, which began October 19, 2023, and is still ongoing in May 2025, in addition to the drought at the Panama Canal ("PC")[1] has triggered widespread global disruptions and has become a central concern in international trade. The crisis, marked by heightened geopolitical tensions, and drought have the potential to significantly disrupt trade activities in the region. Given the importance of the Red Sea in global trade, understanding the extent and nature of these disruptions is crucial for developing effective strategies to mitigate their impact. The conflict has exposed vulnerabilities in the transportation of goods beyond the sovereign borders, heightening the risk of multiple global implications, including trade maritime insecurity.

According to Carney (2016), economic conditions can be adversely affected by three key dimensions of uncertainty—geopolitical risk, economic uncertainty, and policy uncertainty—collectively referred to as the "uncertainty trinity." Geopolitical risk (GPR), in particular, poses significant threats to global supply chains (Caldara et al., 2024; Asadollah et al., 2024), which can trigger a range of destabilizing economic effects, including lower output, rising inflation, declining equity returns and a stronger monetary policy reaction (Ginn, 2024; Ginn and Saadaoui, 2024, 2025).

A disruption in a critical shipping region might block important trade routes, resulting in longer delivery times and higher transportation expenses, which would lead to an adverse supply chain shock. There is a notable gap in the quantitative assessment of these impacts. This study seeks to fill this gap by employing a GARCH model to analyze trade pattern volatility associated with the crisis.

This paper explores the trade effects of conflict in the Red Sea and the concurrent drought affecting the PC. The Suez Canal ("SC"), which connects Europe and Asia, handles approximately 12% of global cargo and 30% of container trade (Guo et al., 2022). The Bab el-Mandeb Strait ("BMS") is a key chokepoint, while the Cape of Good Hope ("CGH") offers a costly and time-consuming alternative when access through Suez is disrupted. Similarly, the PC, linking the Atlantic and Pacific Oceans, plays a critical role in facilitating trade between Asia and the Americas. Disruptions in any of these chokepoints can have far-reaching implications for global trade and economic conditions. We offer an original empirical investigation of the effects of crisis on maritime trade patterns via GARCH model. The empirical findings reveal a new transmission mechanism, linking the onset of military conflict and drought with global trade security. The challenges of transporting goods amidst wartime conditions and environmental crises have emerged as pressing international issues.

The rest of the paper is structured as follows: Section 2 describes the data. Section 3 discusses the empirical results. Section 4 concludes.

[1] See https://www.imf.org/en/Blogs/Articles/2023/11/15/climate-change-is-disrupting-global-trade.

2. Data

In this paper, we analyze daily cargo ships by port from January 1, 2019 to August 11, 2024, obtained from the IMF.[2] The dataset includes information from four major ports (CGH, BMS, PC, SC). We provide descriptive statistics in Table 1.

Table 1: Descriptive Statistics

	Mean	StD	Min	Max
CGH	39.55	13.07	2	136
BMS	39.03	10.71	7	71
PC	17.93	4.02	6	32
SC	39.97	10.04	2	70

The port data is converted to natural logarithms, and a first-order moving average was applied to eliminate seasonality. To assess whether the time series data exhibits stationarity, the augmented Dickey-Fuller (ADF) and Zivot-Andrews (ZA) tests were employed. The results of the ADF test (Table 2) indicate non-stationarity for all ports except BMS. However, the ZA test (Table 3) confirms stationarity for all ports, considering structural breaks. Figure 1 shows that all four ports display statistically significant shifts in trade patterns, the magnitude and persistence of the effects differ. Notably, the Panama Canal data shows signs of a relatively quicker rebound following the structural break, suggesting that the drought-related disruption may have been more transitory. In contrast, the Red Sea-related ports experienced more prolonged disruptions, consistent with sustained geopolitical conflict.

Table 2: ADF Test

	Level		First difference	
	Statistic	p-value	Statistic	p-value
CGH	-5.09***	0.01	-22.76***	0.01
BMS	-1.18	0.91	-21.22***	0.01
PC	-4.13***	0.01	-21.59***	0.01
SC	-3.14*	0.09	-20.47***	0.01

Note: *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.

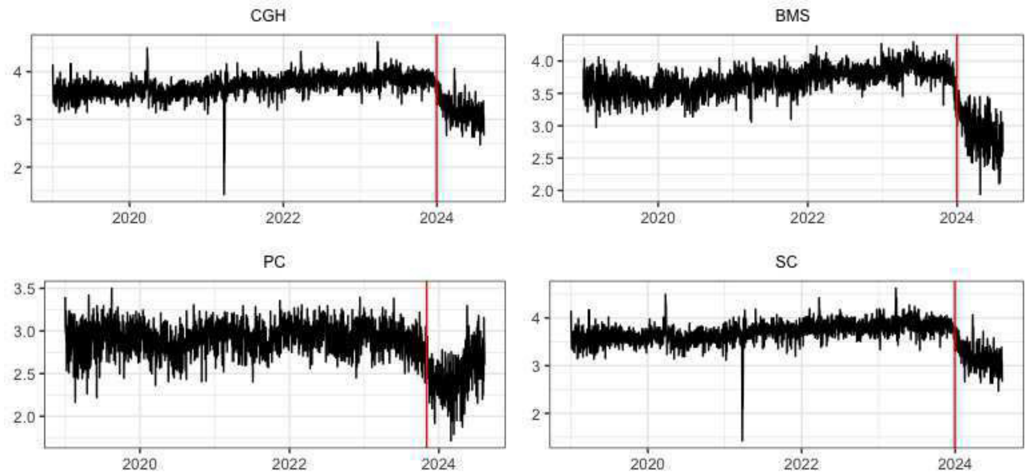
Table 3: ZA Test

	Statistic	p-value	Break Date
CGH	-33.74***	0.01	12/15/2023
BMS	-35.50***	0.01	12/31/2023
PC	-39.32***	0.01	11/2/2023
SC	-33.56***	0.01	12/30/2023

Note: *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.

[2] See https://portwatch.imf.org/.

Figure 1: Log of Daily Cargo Ship data by Port



Source: IMF. Vertical lines indicate break date based on ZA test.

To determine the applicability of the GARCH model, the presence of the Autoregressive Conditional Heteroskedasticity (ARCH) effect was evaluated using the ARCH LM test. The results (Table 4) confirm the presence of the ARCH effect across all ports, justifying the use of the ARFIMA-GARCH model.

Table 4: ARCH LM Test

	Chi-squared	p-value
CGH	111.02***	0.00
BMS	838.09***	0.00
PC	210.9***	0.00
SC	537.35***	0.00

Note: *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.

3. Methodological Approach

We employ an ARFIMA-GARCH model to examine the impact of the crisis and drought events on the mean and volatility of ship cargo data. The ARFIMA component captures long memory, while the GARCH component models conditional volatility.

The mean equation, including a dummy variable (D_t) to account for the event, is given by:

$$\Phi(L)(1-L)^d(y_t - \mu - \gamma D_t) = \Theta(L)\epsilon_t \tag{1}$$

where y_t is the observed time series at time t, μ is the mean, $\Phi(L)$ and $\Theta(L)$ are the AR and MA polynomials, $(1-L)^d$ is the fractional differencing operator, D_t is the event dummy (1 during the event, 0 otherwise), and ϵ_t is the error term.

The GARCH(1,1) variance equation is:

$$\sigma_t^2 = \omega + \alpha\epsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \delta D_t \tag{2}$$

where σ_t^2 is the conditional variance. ω, α, β, and δ are the coefficients of the intercept, ARCH, GARCH and event terms, respectively.

Traditional event studies typically rely on a single, predetermined event date. However, in this study, we introduce flexibility by utilizing port-specific structural break dates identified through the ZA test. This approach is preferred over using a single date due to the unpredictable nature of the conflict and the complexities of international trade logistics.

Given the ongoing Red Sea conflict and concurrent Panama Canal drought, which have affected port data since late 2023, a long-term event study is particularly suitable.[3] This methodology enables us to observe how the market gradually incorporates information related to these ongoing events over an extended period. Extending the event window is appropriate given the potential for conflict- and drought-related effects on port data—such as disruptions or changes in shipping patterns—that may not be immediately apparent and could evolve over time.

4. Empirical Results

The ARFIMA-GARCH model facilitates a way to analyze the event's impact on both mean and volatility. The dummy variable D_t isolates the event's effect, while the ARFIMA and GARCH components address long memory and volatility dynamics, respectively. Accordingly, the estimated coefficients γ and δ assesses whether the event induces a significant shift in the mean (Equation (1)) and volatility (Equation (2)), respectively.

Table 5 presents the estimation results for the ARFIMA-GARCH model across the four ports under consideration. The results indicate a significant impact of both the Red Sea Crisis and the Panama Canal drought on the mean and volatility of trade. Specifically, the event variable (D_t) has a positive and statistically significant effect, indicating increased volatility during the crisis and drought periods. Based on the empirical findings, we can conclude that the Red Sea Crisis and drought disrupted international trade patterns, where the mean is negative (positive) for CGH (BMS, PC and SC), where the effect is statistically significant. We further find that the disruptions increased volatility in all ports examined (the effect is significant for all ports except CGH).

5. Conclusion

This study provides empirical evidence of the significant impact of geopolitical and environmental disruptions on global trade, focusing on the Red Sea Crisis and the Panama Canal drought. By applying an ARFIMA-GARCH model to port-level data, the study highlights how these events increase trade volatility and disrupt established trade routes.

This paper contributes to a narrow literature on geopolitical risk literature. Accordingly, we offer an original empirical investigation of the effects of crisis on maritime trade patterns via GARCH model. The empirical findings reveal a new transmission mechanism, linking the concurrent Red Sea Crisis and drought with global trade security. The findings underscore the importance of geopolitical stability—defined as the sustained absence of conflict in strategic maritime corridors—and environmental resilience, referring to the adaptive capacity of infrastructure like the Panama Canal to function under environmental stressors such as drought. Future research could expand this work by introducing cross-country analysis, assessing financial market spillovers, freight-rate pricing effects and modeling simulated scenarios using climate and geopolitical simulations to evaluate policy

[3] As MacKinlay (1997) suggests, extending the event window is appropriate when there is a risk of information leakage before the event or if the market requires time to fully process the information.

Table 5: Empirical Results

	CGH	BMS	PC	SC
μ	3.5292***	3.6005***	2.9107***	3.5666***
	(0.0466)	(0.0677)	(0.0341)	(0.0819)
AR(1)	0.5780***	0.9993***	0.9941***	0.9984***
	(0.0571)	(0.0014)	(0.0047)	(0.0008)
MA(1)	−0.8760***	−0.9393***	−0.9405***	−0.9572***
	(0.0253)	(0.0195)	(0.0281)	(0.0049)
d	0.5000***	0.0173	0.0000	0.0293***
	(0.0745)	(0.0389)	(0.0494)	(0.0006)
γ	0.4128***	−0.3340***	−0.2451***	−0.3445***
	(0.0453)	(0.0739)	(0.0606)	(0.0629)
ω	0.0063***	0.0003***	0.0001*	0.0115***
	(0.0019)	(0.0001)	(0.0000)	(0.0027)
α	0.1635***	0.0200***	0.0065**	0.1902***
	(0.0268)	(0.0035)	(0.0020)	(0.0336)
β	0.7049***	0.9675***	0.9889***	0.3685**
	(0.0600)	(0.0028)	(0.0005)	(0.1239)
δ	0.0012	0.0009**	0.0003***	0.0143**
	(0.0014)	(0.0003)	(0.0001)	(0.0044)
R^2	0.4017	0.7281	0.4493	0.5539

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

responses to future crises. Policymakers must consider these factors when developing strategies to mitigate the impact of such disruptions, ensuring that critical trade routes remain secure and resilient in the face of future crises.

References

Asadollah, O., Carmy, L. S., Hoque, M. R. and Yilmazkuday, H. (2024), 'Geopolitical risk, supply chains, and global inflation', *The World Economy* **47**(8), 3450–3486.

Caldara, D., Conlisk, S., Iacoviello, M. and Penn, M. (2024), 'Do geopolitical risks raise or lower inflation', *Federal Reserve Board of Governors* .

Carney, M. (2016), 'Uncertainty, the economy and policy', *Bank of England* **16**.

Ginn, W. (2024), 'Global supply chain disruptions and financial conditions', *Economics Letters* **239**, 111739.

Ginn, W. and Saadaoui, J. (2024), 'Do supply chain disruptions matter for global economic conditions?', *The World Economy* .

Ginn, W. and Saadaoui, J. (2025), 'Monetary policy reaction to geopolitical risks in unstable environments', *Macroeconomic Dynamics* **29**, e90.

Guo, J., Guo, S. and Lv, J. (2022), 'Potential spatial effects of opening Arctic shipping routes on the shipping network of ports between China and Europe', *Marine Policy* **136**, 104885.

MacKinlay, A. (1997), 'Event studies in economics and finance', *Journal of Economic Literature* **35**(1), 13–39.