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US-China Tension, Geopolitical Risks and Oil Price Uncertainty: Evidence From Fourier-QARDL Approach

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This study investigates the influence of US-China conflict and geopolitical risks on oil price uncertainty by employing the Fourier-QARDL methodology and analysing monthly data from January 1993 to January 2024. The results indicate that political tensions and instability have a substantial impact on increasing oil price volatility, with asymmetric effects being more notable during periods of heightened conflict. Quantile analysis demonstrates that extreme price fluctuations are particularly responsive to these risks, highlighting the critical role of geopolitical factors in energy market uncertainty and emphasizing the necessity for comprehensive risk management strategies.

I. Introduction

Oil markets are highly sensitive to political factors for several key reasons: supply is concentrated in a limited number of countries, oil infrastructure is frequently targeted by political and violent actions, and the commodity's inherent volatility increases its susceptibility to disruptions. Ongoing conflicts such as the war in Ukraine and instability in the Middle East have elevated the risk of supply disruptions to levels not seen in the past decade. The potential impact on both supply and prices, however, varies significantly in terms of likelihood and severity.

Geopolitical risk broadly encompasses incidents including armed conflict (Franko, 2024), terrorism (Song et al., 2022), sanctions (Konovalova & Abuzov, 2023), and trade disputes (Incekara & Incekara, 2024), each capable of interrupting oil production, transportation, or consumption. These events may cause anything from minor disturbances to substantial market volatility. For example, the Russia-Ukraine war in 2022 led to sharp price increases driven by supply chain interruptions and sanctions (Franko, 2024; Liu, 2023), while persistent instability in oil-producing regions often curtails output and drives up global prices (Song et al., 2022).

The effects of supply disruptions differ across regions and types of crude oil (Franko, 2024). Interruptions occurring within geopolitically significant areas or along major supply chains tend to result in pronounced market fluctuations. The vulnerability of particular grades of oil depends on prevailing trade routes and the specific locations of these disruptions. Even relatively minor shocks can have

far-reaching consequences for the tightly interconnected global oil market, leading to widespread price increases.

Hamilton (2009), Kilian and Lee (2014), and Kilian and Murphy (2014) introduced the concept of “fear of disruption,” which emphasizes the influence of geopolitical concerns on oil markets. This framework suggests that perceived threats such as conflicts, sanctions, or diplomatic tensions—often prompt market participants to act preemptively by stockpiling oil and incorporating risk premiums into prices, even in the absence of actual supply disruptions. Such anticipatory behavior underscores the market's sensitivity to uncertainty, where mere expectations can precipitate price spikes and enhanced volatility. Strategic rivalries, notably between the US and China or risks to key maritime routes, frequently trigger these responses, highlighting the critical role of perception alongside physical supply-demand fundamentals.

The evolving relationship between the United States and China, characterized by both cooperation and rivalry, holds significant implications for global oil dynamics. As major consumers and producers, their trade disputes (Wu, 2012), technological competition, and broader geopolitical strategies contribute appreciably to market uncertainty. Heightened tensions particularly regarding Taiwan or the South China Sea add measurable risk premiums to oil prices (Mamman et al., 2024), thereby fueling volatility, speculative trading, and reductions in investment activity (Ozkan et al., 2024).

A substantive body of research documents the non-linear nature of this relationship (Jiang et al., 2024). Sharp escalations in US-China tensions tend to drive up oil prices

due to heightened supply concerns (Cotet & Tsui, 2013), whereas prolonged periods of low tension exert minimal influence as markets adapt (Okonkwo et al., 2024). Furthermore, the magnitude of these effects fluctuates with global economic conditions: they are amplified during periods of strong demand (Ding et al., 2022) and diminished during slowdowns, when weaker consumption balances out supply risks (Cunado et al., 2020).

A comprehensive understanding of these complex dynamics is essential for policymakers, investors, and companies seeking to navigate the intricacies of the global energy market. The contributions of this study are twofold. First, we analyze how geopolitical tensions affect oil price uncertainty by employing uncertainty indices derived from advanced textual extraction methods applied to major news sources. Second, we extend the QARDL model (Cho et al., 2015) by integrating Fourier's trigonometric approach to address potential structural changes within the series.

The remainder of this study is structured as follows: Section II details the data and methodology, Section III presents the empirical findings, and Section IV offers concluding remarks.

II. Data and Methodology

This study utilizes 374 monthly observations (covering the period from January 1993 to February 2024) of oil price uncertainty (Abiad & Qureshi, 2023), US-China tensions (Rogers et al., 2024), and geopolitical risk (Caldara & Iacoviello, 2022), all obtained from the Economic Policy Uncertainty website. All variables are expressed in natural logarithms and adhere to international standards.

To investigate both the long- and short-term dynamics among oil price uncertainty, US-China tensions, and geopolitical risks, we employ the Fourier Quantile ARDL model, which extends the QARDL methodology (Cho et al., 2015) by incorporating Fourier trigonometric terms. Specifically, we define $X_t = (luct_t, lgpr_t)$ as the vector of integrated regressors $lopu_t$ as the dependent variable, and $d(t)$ as the deterministic term:

$$d(t) = \omega_1 + \alpha_1 \sin\left(\frac{2\pi k}{N}\right) + \alpha_2 \cos\left(\frac{2\pi k}{N}\right)$$

Here, k represents the frequency used to approximate the unknown number of structural changes occurring at unspecified points, t denotes the trend term, and N is the sample size. The AIC criterion is employed to determine both the optimal lag length and the ideal value of k , which is searched within the interval $k = [0.01, \dots, 3]$. Fractional frequencies are utilized to identify permanent (standing) breaks, while integer frequencies reveal temporary breaks.

The Fourier-QARDL can be expressed as follows:

$$\begin{aligned} Q_{(\tau),lopu} = & \mu(\tau) + d(t) + \sum_{j=1}^p \phi_j(\tau) lopu_{t-j} \\ & + \sum_{j=1}^q \theta_j(\tau) luct_{t-j} \\ & + \sum_{j=1}^q \lambda_j(\tau) lgpr_{t-j} + \varepsilon_t(\tau) \end{aligned} \quad (1)$$

where $\mu(\tau) = \text{lopu}_t - Q_{lopu}(\frac{\tau}{\varepsilon_{t-1}})$, $\tau = (0.25, 0.5, 0.75, 0.9)$ the quantiles. (p) and (q) represent the lag length determined by AIC criteria. Equation (1) is further extended to the following VECM form:

$$\begin{aligned} \Delta lopu_t = & \mu + d(t) + \rho lopu_{t-1} + \alpha_1 luct_t + \alpha_2 lgpr \\ & + \sum_{j=1}^p \phi_j lopu_{t-j} + \sum_{j=1}^{q_1} \theta_j luct_{t-j} \\ & + \sum_{j=1}^{q_2} \lambda_j lgpr_{t-j} + \varepsilon_t \end{aligned} \quad (2)$$

where $\Delta lopu_t$ gives the first difference, p , q_1 and q_2 are the lag orders. ρ , α_1 and α_2 represent the lagged dependent variable and the regressors parameters. The long-run effect of US-China tension index and the geopolitical risk index on oil price uncertainty are obtained by $\varphi_1 = -\frac{\rho}{\alpha_1}$ and $\varphi_2 = -\frac{\rho}{\alpha_2}$. Additionally, $\sum_{j=1}^{q_1} \theta_j$ and $\sum_{j=1}^{q_2} \lambda_j$ donate short-run effects of the US-China conflict and the geopolitical risk on oil price uncertainty. ε_t represents the error term.

The estimation proceeds in three steps: (1) test variable stationarity using the Quantile-ADF test (Koenker & Xiao, 2004); (2) if variables are a mix of $I(0)$ and $I(1)$, estimate Equation (2) via quantile regression, selecting lag length based on AIC or a general-to-specific criterion; and (3) calculate the long-run effects of US-China tensions and geopolitical risks on oil price uncertainty.

III. Empirical results

The results of the Quantile unit root test, shown in Table 1, indicate that the null hypothesis of a unit root is rejected at the 1% significance level for all series except for $luct$. This suggests that the variables have a mixed order of integration, with both $I(1)$ and $I(0)$ present, and no variables of order $I(2)$.

Table 2 presents evidence of long-term relationships across the full range of quantiles, thereby substantiating the appropriateness of the QARDL model for analyzing the association among geopolitical risk, US-China tensions, and oil price uncertainty.

The results of the Fourier-QARDL model, as shown in Table 3, indicate that rising geopolitical risk significantly increases oil price uncertainty in the short run. This underscores the close connection between geopolitical factors and global energy markets, which depend heavily on resources from politically unstable regions prone to conflict, sanctions, and volatility. Such disruptions can severely impact supply chains, leading to price volatility and shortages. For example, conflicts in the Middle East or sanctions on oil producers like Russia and Iran have historically resulted in sharp price swings, posing economic challenges for exporting and importing countries alike, with importers facing higher costs and inflation.

The short-run effects of US-China rivalry are especially pronounced, highlighting the influence these two economic powers exert on global markets. As both the United States and China are key players in international trade and major drivers of oil demand, escalating tensions between them can have far-reaching consequences for oil markets. Tariffs and trade restrictions imposed during periods of height-

Table 1. Quantile-ADF test

Variable	ρ	0.25	0.5	0.75	0.9
<i>lopu</i>	$t_n(\rho)$	-1.057	-2.696**	-4.279***	-4.384***
	CV1%	-3.1203	-3.1503	-3.1099	-3.0096
	CV5%	-2.4821	-2.5252	-2.4672	-2.3565
	CV10%	-2.1423	-2.1878	-2.1271	-2.0073
<i>luct</i>	$t_n(\rho)$	-1.681	-2.173	-2.036	-0.701
	CV1%	-3.1272	-3.1732	-3.1572	-3.0966
	CV5%	-2.4921	-2.558	-2.5352	-2.448
	CV10%	-2.1526	-2.2235	-2.1987	-2.1073
<i>lgpr</i>	$t_n(\rho)$	-5.333***	-5.187***	-3.673***	-2.352*
	CV1%	-2.0682	-3.1385	-3.1254	-3.1132
	CV5%	-2.41	-2.5083	-2.4895	-2.4719
	CV10%	-3.0702	-2.1694	-2.15	-2.1318

Note: ***, **, and * denotes statistical significance at 1%, 5%, and 10% levels, respectively. The results indicate that the analyzed series exhibit a combination of integration orders.

Table 2. Quantile cointegration test (Furno (2021))

ρ	0.25	0.5	0.75	0.9
$t_n(\rho)$	-5.97567***	-7.652155***	-8.369585***	-6.402961***

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively, based on the asymptotic critical values of the t-statistic from Koenker and Xiao (2004). The findings indicate evidence of a long-term relationship between the model's variables across all quantiles.

Table 3. Fourier-QARDL results

ρ	0.25	0.5	0.75	0.9
Short-run				
Constant	-0.67625	-0.72410***	-0.20731	0.01840
$\phi_{lopu_{t-1}}$	0.37898***	0.42350***	0.46481***	0.32313***
$\phi_{lopu_{t-2}}$	0.25119***	0.20473***	0.07037	0.10877**
γ_{lgpr}	0.04161	0.16988*	0.15250*	0.23079***
γ_{luct}	0.59966***	0.55744***	0.47338***	0.44169***
Long-run				
β_{lgpr}	0.112511	0.456961	0.328085	0.40626 *
β_{luct}	1.621437 ***	1.499438	1.018431***	0.77748***

Note: This table presents the results of the Fourier-QARDL analysis examining the impact of the US-China conflict and geopolitical risks on oil price uncertainty. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

ened rivalry may slow global economic growth, reduce oil demand, and increase price volatility. Additionally, both countries have substantial strategic oil reserves, and their decisions to release or retain these reserves can directly affect global oil supplies.

In the long term, the analysis indicates that ongoing conflict between the United States and China remains the main factor shaping oil price uncertainty. This persistent influence reflects not only the structural interdependence of the world economy but also the strategic importance of energy policy in the context of great power competition. Uncertainty around future trade relations, supply chain security, and geopolitical stability continues to create market uncertainty and drive oil price volatility. Unlike temporary

geopolitical crises, the US-China rivalry is a prolonged and systemic source of market instability that is likely to influence global energy markets for years to come.

Table 4 presents the results of the Wald tests for parameter constancy in the FQARDL model, assessing whether coefficients remain stable across quantiles of oil price uncertainty. The tests fail to reject the null hypothesis of parameter constancy for all variables in both the short and long run, indicating no significant asymmetries across quantiles. This suggests a consistent relationship between oil price uncertainty and its key drivers geopolitical risks and US-China tensions regardless of the level of uncertainty. Unlike models that show heightened effects at the distributional extremes, these results point to a uniform

Table 4. Wald test

Wald $_{\phi_{\text{lopu}_t-1}}$	Wald $_{\phi_{\text{lopu}_t-2}}$	Wald $_{\gamma_{\text{lgpr}}}$	Wald $_{\gamma_{\text{luct}}}$	Wald $_{\beta_{\text{lgpr}}}$	Wald $_{\beta_{\text{luct}}}$
11.23867	1.965368**	6.08627	6.481232	3.668962	110.7654

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The test does not reject symmetry across quantiles, suggesting that there are no significant asymmetric effects of geopolitical risks or US-China tensions on oil price uncertainty.

transmission of geopolitical shocks across market conditions. The lack of variation across quantiles implies a degree of linearity in how geopolitical influences affect uncertainty, reflecting either the maturity of the oil market in absorbing and pricing such risks or a baseline sensitivity in which even moderate tensions consistently trigger market responses.

IV. Conclusion

This study applies the Fourier-QARDL approach to examine the interplay between US-China tensions, geopolitical risks, and oil price uncertainty. The findings reveal that

heightened political tensions between the US and China, alongside broader geopolitical risks, contribute to greater uncertainty in oil prices. These results are significant, as they suggest that geopolitical tensions especially between the US and China can serve as leading indicators for upcoming fluctuations in oil prices. Such insights are valuable for policymakers and investors seeking to develop effective strategies in response to financial volatility.

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