Financial Oil Market Metrics for Geopolitical Crises

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Abstract

Since the onset of the first Persian Gulf War in 1990, a series of geopolitical crises have significantly impacted the oil markets. This research focuses on five market-measurable consequences of these events, using the relevant geopolitical crises as a backdrop: The Comovement between the oil and equity financial markets and its relation to the Oil-price risk premium; the Level of oil implied volatility OVX; and the Impact on the volatility "skew" in oil-options markets. These metrics provide precise benchmarks for financial markets to capture supply-side geopolitical disruptions, contrasting with the signals they reflect during demand-driven recession-and-recovery cycles. In addition, we examine the oil implied term structure of volatility (TSOV) to assess how markets differentiate between short-term and long-term uncertainty during crises, finding that volatility responses are concentrated in certain crises in the near term. We also consider the term structure of correlation between oil prices and equity prices, to see how these contrast across crises. With the beginning of hostilities in the Persian Gulf on March 1st, we consider the geopolitical metrics of the latest crisis in the Middle East. For past crises, we demonstrate how markets distinctly bracket these crises' time intervals, offering a "Message from Markets" that highlights their focus on specific geopolitical shocks. The ongoing 2026 Iran–U.S.–Israel crisis as a real-time application of our framework, using contemporaneous market data to evaluate how these forward-looking financial metrics capture and anticipate evolving geopolitical risk.

Key Words: Oil Futures, Implied Volatility, Geopolitical Crises, Risk Premium, Volatility Skew

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1. Introduction

Geopolitical crises and their impact on oil markets behavior are crucial areas of analysis for both investors and policymakers. Military conflicts, international tensions and political regime changes, esp. in areas with connection to oil production such as the Middle East, have historically triggered sharp movements in oil prices, increased volatility and a reassessment of market risk. While much of the literature focuses on physical supply disruptions and macroeconomic effects, the financial markets' response provides important quantitative signals about how future risks are being perceived and priced — through implied volatility, forward prices and derivative pricing.

Financial markets provide forward-looking signals that complement traditional macroeconomic analyses by reflecting how geopolitical risks are priced in real time through derivatives, implied volatility, and forward curves.

Our reliance on market indicators is based on the notion these represent true market values, not opinions or low-density economic indicators. Thus, to complement other studies' results in the economic sphere, this study will address these gaps through these financial metrics that reflect oil market behavior:

1. **Oil implied volatility (OVX)**: Looking at how market uncertainty, as measured by the OVX index (the oil market's analogue to the stock market's VIX Index), changes during crises.

2. **Volatility skew in oil-options markets**: Studying how the volatility skew (implied volatility as a function of options' moneyness) shifts in response to various geopolitical events~~.~~

3. **Oil-price risk premium:** Quantifying the impact of geopolitical crises on the oil-price risk premium using two approaches:
    (a) the forecast-minus-forward price method, which compares Bloomberg's one-year-ahead WTI crude oil prices analysts' forecasts to the one-year forward price and

(b) the CAPM-based correlation method (which is based on correlating oil and equity market returns).

The analysis focuses on several events over the past three decades: The Iraq War (2003 peak), the Arab Spring (2011 peak), the Russia-Ukraine War (2022 peak), Crimea Annexation (2014), Saudi Aramco Drone Attacks (2019) and the Israel-Gaza conflicts (notably in May 2021 and October 2023). Using Bloomberg data, including the implied vols on the prompt-month 60% and 150% moneyness, the 1-year forward WTI crude oil price, the 1-year forecasted WTI crude oil prices and S&P 500 Index equity data, this research will apply correlation analysis, CAPM modeling and volatility skew analysis to interpret the financial markets' reaction to geopolitical tensions.

The goal of this study is to contribute to previous works by quantifying the length and depth of crises (aka, the "message from markets") and offering insights into how investors and commercial entities can interpret and hedge against geopolitical shocks through forward-looking metrics.

A distinguishing feature of this study is the inclusion of the ongoing 2026 Iran–U.S.–Israel crisis as a live case study. Unlike prior events examined retrospectively, this episode allows us to evaluate how financial oil market metrics respond in real time to unfolding geopolitical developments. By applying the same framework used for historical crises, we assess whether forward-looking indicators such as implied volatility, volatility skew, and risk premia provide early and reliable signals of market stress and anticipated supply disruptions.

This paper is structured as follows. Section 2 presents the relevant literature on oil markets and geopolitical risk. Section 3 outlines the methodology and financial models used, including the CAPM-based and forecast-based approaches to measuring the oil-price risk premium. Section 4 describes the data and the geopolitical events considered in the analysis. Section 5 presents empirical results, including the behavior of implied volatility, volatility skew, correlations, and risk premia across crises. Section 6 applies the framework to the March 2026 geopolitical crisis as a real-time case study. Section 7 concludes with a summary of findings and their implications for interpreting financial market signals during geopolitical events. Additional technical analyses, including the term structure of correlation and jump-diffusion framework, are provided in Appendices A and B.

2. Literature Review

Chen and Demirer (2022) explore how oil beta uncertainty influences global stock returns, deducing that market participants demand a premium for bearing this uncertainty. On a similar note, Smales (2021) documents the volatility spillovers between oil and equity markets during geopolitical events, pointing to structural spillovers of geopolitical uncertainty.

Demirer et al. (2021) contribute to this research area by showing that geopolitical risks improve predictability of oil market returns and volatility, indicating that investors adjust expectations based on regional conflict intensity. Ivanovski and Hailemariam (2022) further prove that time-varying measures of geopolitical crises significantly affect both oil prices and volatility, reinforcing the dynamic relationship between political instability and commodity markets.

In Kilian (2008), he argued that exogenous supply disruptions are less important than global demand in explaining oil price movements. Building on this, Kilian (2009) introduced the distinction between supply shocks, aggregate demand shocks and oil-specific demand shocks, showing how affects GDP, inflation, and employment. Subsequently, Kilian & Murphy (2014) highlighted the role of speculative demand and oil inventories in shaping price fluctuations. Most recently, Kilian & Zhou (2023) explored how oil shocks influence inflation expectations, showing the pass-through to overall inflation is smaller today than in the 1970s thanks to credible monetary policy and diversified energy sources. However, these studies are not financial-market analyses. They do not examine how geopolitical crises are reflected in asset prices, risk-premium dynamics, implied volatility or the forward curve. By contrast, this paper contributes to the *financial* branch of the oil-market literature by analyzing futures-based risk premia, oil–equity comovements, and option-implied volatility structures during geopolitical crises.

Murphy and Ronn (2014) highlight the forward-looking characteristics of options by calibrating a jump-diffusion model. Through this approach, they analyze data from options on crude oil futures, extracting a parameter that distinguishes whether potential jumps in price are spikes or crashes. Their work demonstrates that implied volatility from options markets can reveal expected changes in supply-demand fundamentals and associated price risks, particularly during uncertain times.

Adding to this, Ronn (2021) engages equity, index~~,~~ and commodity options to derive forward-looking betas and conditional CAPM-based expected spot prices for crude oil. By accounting for changing risk exposures over time, this method refines the traditional CAPM model and provides a methodology to obtain real-time market sensitivity about future oil prices under times of uncertainty. Ronn's CAPM framework offers a new way to measure expected returns that reflect changing geopolitical environments and investor risk perceptions. In this, it provides a useful benchmark with which to compare the forecast-prices approach to estimating the oil-price risk premium.

Soini and Lorentzen (2019) also analyze crude oil option pricing and implied volatility structures, highlighting the predictive signals found through volatility analysis. The ratio of long-term to short-term implied volatilities acts like an indicator of uncertainty duration. Building on this, Tse (2016) highlights how volatility skews and asymmetry in futures markets reveal how downside risk is priced differently depending on market environments. Tse explores how assets with high downside risk tend to exhibit negatively skewed returns, reflecting the market's pricing of this risk. The study also highlights that assets with low downside betas (less exposure to market downturns) often serve as hedges, offering lower returns, while those with high downside betas command a risk premium for bearing greater downside risk.

While the CAPM is widely used in asset pricing, its application to oil markets has drawn academic examination. Cifarelli and Paladino (2010) question the suitability of applying a traditional, fixed-parameter CAPM to oil markets, emphasizing that the oil risk premium is better represented as a function that evolves with market volatility. Their analysis highlights the limitations of using fixed-beta models to capture oil price behavior during times of uncertainty. Similarly, Lanza et al. (2005) find that single-factor CAPM models are insufficient to explain oil stock behavior, advocating for multi-factor models that incorporate oil prices, exchange rates and the S&P 500 index. Despite these critiques, this study uses a single-factor CAPM because it enables a computationally feasible approach for calculating expected prices, which can then be directly compared to Investment Analysts' forecasts.

Faff and Brailsford (2000) test a two-factor "market-and-oil" model and find it develops performance for some cases, but they caution against universal adoption due to limited empirical support. This analysis reverses the conventional CAPM application: rather than using oil prices to explain equity returns, it uses S&P 500 returns to estimate the expected price of oil, a setup that reflects a market-wide risk premium signal rather than oil-sector-specific drivers.

Despite these findings, there remains an analytical gap in aligning forward-looking risk metrics with observed geopolitical crises in a systematic and comparative manner. This includes comparing CAPM-derived risk premiums with those inferred from forecasted and forward oil prices, examining the impact of volatility skew and oil-equity comovements as indicators of periods of geopolitical crises.

A central theme of this paper is that not all oil-market indicators convey information with equal timeliness during geopolitical crises. Forward-looking financial metrics, most notably implied volatility and volatility skew in oil options markets, respond contemporaneously to shifts in perceived tail risk and uncertainty. By contrast, correlation measures between oil and equity markets, as well as survey-based price forecasts, are inherently slow-moving, the former reflecting realized comovement. While these non-contemporaneous indicators remain informative for understanding broader market dynamics, our results suggest that forward-looking derivatives-based metrics play a primary role in signaling the onset, intensity, and resolution of geopolitical stress in oil markets.

3. Methodology / Models

Several analytical frameworks will be used to examine the impact of geopolitical crises on oil market behavior. The study focuses on five financial consequences: oil-equity market comovements, oil implied volatility (OVX), oil-price risk premium, the oil volatility skew, and the relationship between correlation and risk premium. Each metric is examined using financial modeling techniques grounded alternatively in the Capital Asset Pricing Model (CAPM), derivative pricing theory and correlation analysis.

3.1 Oil Implied Volatility

The first metric examined is the oil implied volatility index (OVX), which serves as the oil market's analogue to the VIX Index for equities. The OVX measures the market's expectations of 30-day volatility in crude oil prices, based on options pricing for the two near-term WTI crude oil futures contract.

Changes in the OVX provide insight into how market participants adjust their expectations of near-term oil price risk in response to geopolitical events. During periods of heightened geopolitical tension, OVX typically rises, reflecting increased uncertainty regarding potential supply disruptions or demand shocks. Conversely, during periods of relative stability, OVX levels tend to decline as perceived oil market risks diminish.[3]

The analysis tracks the evolution of OVX during major geopolitical crises to identify patterns of volatility escalation and resolution, offering a forward-looking measure of market stress.

3.2 Oil-Equity Market Comovements

To assess comovement we calculate the moving-window correlation between continuously compounded daily returns on oil and SPX to capture the changing movements:

$$\rho = \operatorname{corr}\left[\ln\left(\frac{P_{\mathrm{t}}^{\mathrm{oil}}}{P_{\mathrm{t-1}}^{\mathrm{oil}}}\right), \ln\left(\frac{P_{\mathrm{t}}^{\mathrm{SPX}}}{P_{\mathrm{t-1}}^{\mathrm{SPX}}}\right)\right] \qquad (1)$$

Negative correlations during crises indicate oil prices and equity prices proceeding in a divergent manner, which is what we observe during geopolitical crises. In contrast, positive correlations typically characterize what we observe during economic recessions or recovery.

To assess the reliability of observed correlations and risk premium shifts, for the N = 45 days moving windows we employ to compute correlations, we calculate the t-statistic for correlation coefficients:

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[3] While not unaware of the volatility risk premium which separates implied vols from "expected" volatilities, we ignore that distinction in this study.

$$t = \frac{\rho \sqrt{N-2}}{\sqrt{1-\rho^{2}}} \tag{2}$$

where:

- ρ = sample correlation coefficient
- N = number of observations in dataset

Our analyses will be based on the rule: If the value of t is: | t | > 2, it means it is statistically significant. This criterion is used throughout the analysis to identify meaningful structural changes in correlation or pricing methods during geopolitical events.

3.3 Volatility Skew

To capture differences in implied volatility over different periods of time, we define VolSkew(150%, 60%) as the ratio of implied volatilities at 150% and 60% moneyness, respectively:

$$\text{VolSkew}\,(150\%, 60\%) = \frac{\text{ImpVol}\left(\text{CL1}, \frac{\text{K}}{\text{F}} = 150\%\right)}{\text{ImpVol}\left(\text{CL1}, \frac{\text{K}}{\text{F}} = 60\%\right)}\ , \tag{3}$$

where CL1 is the prompt-month crude-oil futures contract.

Importantly, we interpret a skew ratio greater than 1 as indicating market participants place greater emphasis on the risk of an oil-price spike than on the likelihood of a price crash.

3.4 Oil-Price Risk Premium

We quantify the oil-price risk premium using two approaches:

3.4.1 CAPM-Derived Risk Premium

To make the derivation explicit, we begin from the standard CAPM relationship applied to oil futures returns:

$$\mu_T = \beta_T (\mu_M - r)$$

where β_T denotes the beta of oil futures with respect to the equity market. Using the definition of beta,

$$\beta_T = \frac{Cov(r_T, r_m)}{\sigma_M^2} = \rho_T \ \frac{\sigma_T}{\sigma_M}$$

we can rewrite the expected return as:

$$\mu_T = \rho_T \, \sigma_T \, \frac{\mu_M - r}{\sigma_M}.$$

To estimate the oil-price risk premium, we employ the CAPM framework, adjusted for commodity markets as developed by Ronn (2021). Specifically, the expected return μ_T on a futures contract of maturity T is given by:

$$\mu_T = \rho_T \cdot \sigma_T \cdot \lambda \tag{4}$$

- ρ_T = correlation between crude oil returns and market returns
- σ_T = standard deviation of oil future returns
- λ = Sharpe Ratio of the equity market, which is:

$$\lambda = \frac{\mu_M - r}{\sigma_M} \tag{5}$$

where μ_M is the expected market return, r is the risk-free rate and σ_M is the market return volatility. By definition S_T = F_T, the terminal value of F_T, and so the expected spot price at maturity T, denoted $E(S_T)$, satisfies:

$$E(S_T) = F_{0T} \ \cdot \ \exp\left(\mu_T \cdot T\right) \tag{6}$$

where F_{0T} is the futures price at time 0 for maturity T.

When $\rho_T < 0$ — the “higher oil prices, lower equity prices” typically observed during geopolitical crises, the futures price F_0^T exceeds the expected spot price $E(S_T)$. This implies a positive oil-price risk premium, as oil serves as a hedge against adverse aggregate states. This mechanism is consistent with prior literature linking geopolitical disruptions to supply-side shocks and elevated uncertainty in oil markets (Ronn, 2021; Kilian, 2009; Smales, 2021).

3.4.2 Forward vs Forecasted Risk Premium

To add on to the CAPM-based estimates, we calculate an alternative risk premium using 1-year forward WTI crude price and 1-year forecasted price from Bloomberg.

$$\text{Risk Premium} = \text{Forecast Price} - \text{Forward Price} \tag{7}$$

Using forecasted prices provided by companies reporting such to the Bloomberg system, we can compare this forward-forecast premium with CAPM-derived values, to evaluate consistency across model-based and market-implied expectations.

4. Data

Our study draws upon financial and market data sourced from Bloomberg, including crude oil futures prices, implied volatilities from oil options and equity indices and oil prices forecasted by oil analysts at major firms. These datasets enable the quantitative analysis of key financial metrics: oil market implied volatility (OVX), volatility skew, oil-price risk premiums and the relationship between correlations and risk premiums. The data spans from the early 2000s to the present, covering multiple market cycles and periods of geopolitical stress.

4.1 The Specific Geopolitical Events on which We Focus

The analysis is structured around several major geopolitical events known to have materially impacted oil market behavior. These include:

1. **Persian Gulf Wars** — Gulf War I (1990 - 1991) and Gulf War II (2003)

2. **Arab Spring** — with a particular focus on the peak unrest during Spring 2011

3. **Crimea Annexation (2014)** – Russia's annexation of Crimea led to heightened geopolitical tensions and sanctions, influencing oil market dynamics through anticipated supply risks.

4. **Saudi Aramco Drone Attacks (2019)** – The September 2019 attacks temporarily knocked out over 5% of global oil supply, causing a sharp spike in prices and volatility.

5. **Russia-Ukraine War** — spanning from February 2022 to the present, with a primary focus on developments in 2022

6. **Israel-Gaza Conflict** — emphasizing conflict escalations during 2023

7. **Iran–U.S.–Israel Crisis (2026)** — ongoing geopolitical tensions and military escalations in the Persian Gulf beginning in March 2026. This event is analyzed in real time to assess how forward-looking financial metrics capture evolving geopolitical stress.

These events were selected based on their relevance to oil supply disruptions, market sentiment shifts, and volatility patterns observed in financial instruments tied to oil.

4.2 Derived Data

Several key variables were computed from the raw Bloomberg datasets to support the modeling framework:

Continuously Compounded Returns: Logarithmic returns were calculated for the prompt-month WTI crude oil futures and the S&P 500 Index (SPX) to support the correlation and CAPM-based estimations.

Volatility Skew Ratio: The volatility skew was measured for one-month options, as the ratio of implied volatilities at 150% moneyness to 60% moneyness, providing insights into market expectations of extreme price movements.

Oil Risk Premium: The oil-price risk premium was assessed using two approaches:

(i) The forecast-minus-forward differential based on Bloomberg analysts' forecast WTI crude oil prices to its market-implied forward price

(ii) The CAPM-based method utilizing oil-equity return correlations and market Sharpe ratios, as previously outlined in the Methodology section.

By aligning these derived metrics with the timeline of key geopolitical events, this study examines how oil market behavior responds to geopolitical shocks and what messages these responses convey to the broader market. The following section presents the results of this analysis.

5. Results

This section presents the empirical findings across the key dimensions of oil market behavior during crises. First, we examine shifts in overall implied volatility through the Oil Volatility Index (OVX). Next, we analyze changes in the volatility skew to capture market pricing of extreme outcomes. Finally, we assessed how risk premiums in the oil market evolved using both forward-forecast gaps and CAPM-based measures.

5.1 Implied Volatility Behavior Around Geopolitical Crises

To evaluate the market's performance of risk during times of crises, we examine the behavior of the CBOE Crude Oil Volatility Index (OVX) before, during and after each major event. OVX reflects the market's expectations of 30-day implied volatility for crude oil and serves as a measure of uncertainty.

Table 1: OVX Levels Before, During and After Peak Values

Event	Pre-peak Date	Pre-Peak OVX	Peak Date	Peak OVX	Post-peak Date	Post-Peak OVX
Arab Spring	12-01-2010	30.70	03-07-2011	45.16	04-19-2011	28.47
Crimea Annexation	02-24-2014	16.92	03-14-2014	21.7	04-04-2014	18.28
Saudi Aramco Drone Attacks	08-22-2019	26.54	09-16-2019	30.27	11-18-2019	26.64
Russia-Ukraine	02-09-2022	39.4	03-07-2022	78.91	06-09-2022	42.92
Israel-Gaza	10-02-2023	32.0	10-27-2023	46.64	02-15-2024	29.58

Table 1. OVX levels before, during, and after five major geopolitical crises. The “pre-peak” value reflects implied volatility shortly before the event, while the “peak” corresponds to the highest OVX level during the crisis. Per visual inspection, the “post-peak” value is recorded on the first day OVX returned to a near-term minimum. Data ranges from December 2010 to February 2024.

Figure 1: OVX During the Arab Spring (2010–2011)

Figure 1. The chart shows a clear volatility surge in early 2011 during the onset of the Arab Spring, followed by a decline as market fears eased by April.

The table above summarizes the OVX behavior across five major geopolitical crises, highlighting the implied volatility values at the start, peak and end of each event frame.[4] For each crisis, we define the "post-crisis" date with the first trading day on which OVX returned to or fell below its pre-crisis level.

Among the events, the Russia–Ukraine War saw the most pronounced volatility, with OVX rising from a pre-crisis level of 39.4 (February 9, 2022) to a peak of 78.91 (March 7, 2022), before gradually declining to 42.92 by June 9, 2022. This prolonged elevation signals extended market uncertainty with no quick return to

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[4] Due to data limitations, Bloomberg OVX records only extend back to 2006, making it impossible to analyze Persian Gulf I (1990 - 1991) and Persian Gulf II (2003) within this framework.

pre-crisis levels. In contrast to some of the other geopolitical crises, it would appear the market was relatively "late" to fully internalize the risk of invasion, possibly reflecting early disbelief or optimism that the crisis could be avoided.

The Arab Spring showed a more moderate increase in volatility, with OVX rising from 30.70 (December 1, 2010) to 45.16 at its peak on March 7, 2011, before decreasing to 28.47 by April 19, 2011. Figure 1 further reinforces this interpretation, capturing the evolution of oil volatility throughout the Arab Spring. OVX surged in early 2011, reflecting immediate geopolitical fears tied to unrest in the area, then subsided by April as the risk of contagion to the Persian Gulf lessened.

The Crimea Annexation involved a smaller and shorter-lived response. OVX climbed from 16.92 (February 24, 2014) to 21.70 on March 14, 2014, before settling down to 18.28 by April 4, 2014. The Saudi Aramco Drone Attacks led to a sharp and brief volatility surge — from 26.54 (August 22, 2019) to 30.27 on September 16, 2019. OVX later declined to 26.64 by November 18, 2019. Lastly, the Israel–Gaza conflict in October 2023 triggered a jump from 32.0 (October 2, 2023) to 46.64 by October 27, 2023, with OVX easing to 29.58 by February 15, 2024. These indicate that while all crises induced volatility shocks, the continuation and magnitude of market response varied.

5.2 Oil-Equity Comovements

To evaluate the comovement between oil and equity markets, we compute correlation coefficient between the continuously compounded daily returns of CL13 (one-year ahead crude oil futures) and SPX (S&P 500). This correlation is computed using the log-return formula introduced in Equation (1). While this correlation provides important insights, it is important to recall this is a retrospective, 45-day moving window correlation. Since it lacks the important forward-looking aspect of OVX, its interpretation is necessarily more difficult.

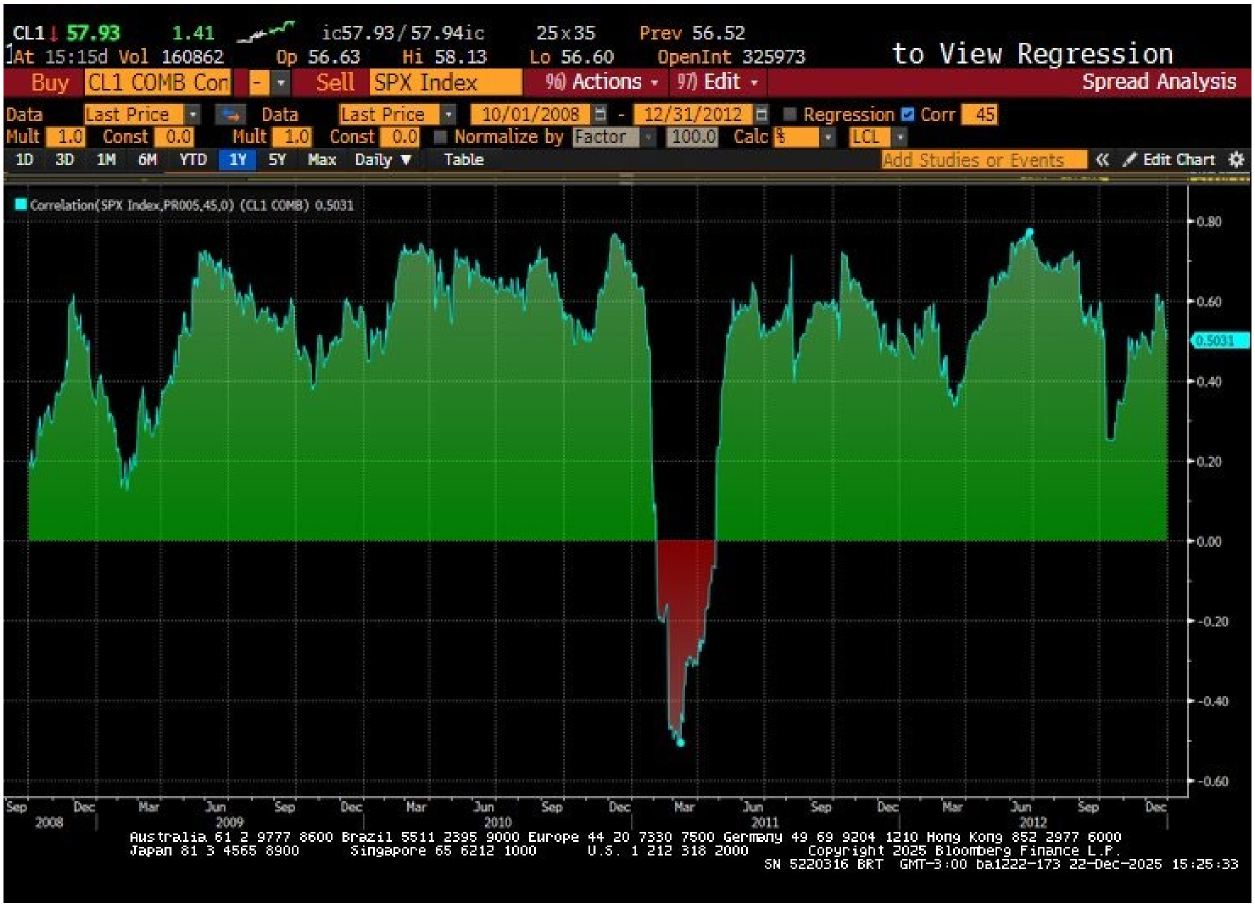
Using the data obtained from Bloomberg, we find:

Table 2: Oil-Equity Correlations with Corresponding t-stat Values

Event	Last Positive Correlation	Last Positive	Peak Crisis	Correlation	t statistic	End of Crisis	First Positive Correlation
Persian Gulf War I	07-31-1990	0.0891	09-24-1990	-0.6265	-5.27	05-01-1991	0.0287
Persian Gulf War II	07-15-2003	0.0391	07-21-2003	-0.0193	-0.13	07-22-2003	0.0275
Arab Spring	11-23-2010	0.1122	01-19-2011	-0.4305	-3.13	03-31-2011	0.0251
Crimea Annexation	03-26-2014	0.0084	04-04-2014	-0.1836	-1.22	06-11-2014	0.0152
Saudi Aramco Drone Attacks	05-30-2019	0.0488	08-08-2019	-0.2896	-1.98	10-10-2019	0.0655
Russia-Ukraine War	02-11-2022	0.0462	03-21-2022	-0.5099	-3.88	05-20-2022	0.0355
Israel-Gaza Conflict	09-21-2023	0.0148	11-02-2023	-0.3389	-2.36	04-08-2024	0.0584

Table 2. 45-day rolling correlations between log returns of WTI crude oil futures (CL13) and the S&P 500 index during major geopolitical crises. For each event window, the table reports the peak negative correlation coefficients (ρ) and the t-statistic for the peaks. Beginning of the crisis is the first negative value immediately after the last positive correlation. Peak crisis is the maximal negative correlation and the end of the crisis is defined as the first positive correlation after the peak. Aggregate data spans from July 1990 to April 2024.

Figure 2: CL-1 SPX 45-Day Rolling Correlation During the Arab Spring


CL1 57.93 1.41 ic57.93/57.94ic 25x35 Prev 56.52

At 15:15d Vol 160862 Op 56.63 Hi 58.13 Lo 56.60 OpenInt 325973

Buy CL1 COMB Con Sell SPX Index

Data Last Price Data Last Price 10/01/2008 - 12/31/2012 ☐ Regression ☑ Corr 45

Mult 1.0 Const 0.0 Mult 1.0 Const 0.0 ☐ Normalize by Factor 100.0 Calc % LCL

Correlation(SPX Index,PR005,45,0) (CL1 COMB) 0.5031

Australia 61 2 9777 8600 Brazil 5511 2395 9000 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 4565 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2025 Bloomberg Finance L.P.
SN 5220316 BRT GMT-3:00 ba1222-173 22-Dec-2025 15:25:33

Figure 2. The decline in the 45-day rolling correlation between crude oil futures (CL1) and the S&P 500 Index (SPX) during early 2011 coincides with the onset of the Arab Spring. This crisis resulted in a short but significant negative correlation, as captured in Bloomberg's correlation.

To assess the evolving comovement between oil and equity markets, a 45-day rolling window is applied to calculate the correlation between CL13 and the S&P 500. This method captures time-varying interactions rather than relying on fixed start/end points, offering a more nuanced view of market behavior throughout each geopolitical crisis.

To test the statistical significance of the correlation, we use the t-statistics equation for correlation included in the table.

The negative correlation indicates a reverse comovement, when the S&P 500 (SPX) rises, crude oil futures (CL13) tend to fall, and vice versa. When the absolute value of the t-statistic exceeds 2, these correlations are statistically significant.

During Persian Gulf War I (1990–1991), the peak 45-day rolling correlation between crude oil futures (CL13) and the S&P 500 index reached −0.6265, with a t-statistic of −5.27, reflecting a strong and statistically significant negative relationship, as oil markets decoupled from equities amidst wartime disruptions. In Persian Gulf War II (2003), the peak correlation was much weaker at −0.0193 with no t-statistic reported, indicating minimal comovement. It seems some geopolitical crises do not result in supply disruption shocks: If tankers keep sailing and OPEC offsets the disruption, then the impact on equities is minimal.

Later events show varied patterns. During the Arab Spring (2011), oil and equity markets diverged, with a peak correlation of −0.4305 and a t-statistic of −3.92, suggesting a statistically significant inverse relationship as regional unrest influenced supply expectations. While the overall correlation between crude oil and equity returns remained modestly positive, the 45-day moving correlation reveals a short-term but sharp dip into negative territory in early 2011 (Figure 2).

The Crimea Annexation (2014) presented a smaller negative correlation of −0.1836 and a t-statistic of −1.22, reflecting weak and statistically insignificant divergence. Similarly, the Saudi Aramco Drone Attacks (2019) showed a peak correlation of −0.2896, but no statistic is significant.

The Russia–Ukraine War (2022) displayed the most pronounced negative comovement in recent crises, with a peak correlation of −0.5099 and a t-statistic of −3.85, highlighting strong decoupling of oil and equity markets due to major supply risks. The Israel–Gaza Conflict (2023) followed a similar pattern, with a correlation of −0.3389 and a t-statistic of −2.36, indicating a moderately significant inverse relationship.

Correlation between oil and equity markets and survey-based price forecasts contribute to a useful context but play a comparatively secondary role in crisis identification. Correlation estimates depend sensitively on rolling-window length and contract maturity and tend to adjust only after market conditions have already shifted. Similarly, price forecasts reflect expectations across horizons and respondents and may lag abrupt changes in perceived risk. Our findings therefore suggest that while these measures complement the analysis, they do not substitute for forward-looking option-implied metrics when assessing real-time geopolitical risk in oil markets.

5.3 Volatility Skew

Table 3: Volatility Skew Ratio Data with Corresponding Dates

Event	**Pre-Crisis Left-Skewed**	**Left Skew Ratio**	**Peak Right Skewed Date**	**Peak Right Skew Ratio**	**Post-Crisis Left-Skewed**	**Left Skew Ratio**
Saudi Aramco Drone Attacks	08-15-2019	0.741	10-11-2019	1.261	11-06-2019	0.914
Russia-Ukraine	01-03-2022	0.722	02-14-2022	1.508	07-12-2022	0.943
Israel-Gaza	09-15-2023	0.864	10-13-2023	1.365	11-01-2023	0.994

Table 3. Observed dates and corresponding skew ratios for left- and right-skewed implied volatility regimes during three major geopolitical crises. The “Right Skewed” date marks the onset of market pricing for large upside oil risk (skew ratio > 1), while the “Post-Crisis Left-Skewed” date reflects the first return to a more typical downside-risk skew (skew ratio < 1), relative to the pre-crisis baseline. All implied volatilites are based on one-month options (CL1) using moneyness-defined strikes (150% and 60%). Pre-crisis to post-crisis dates span August 2019 to November 2023. Data limited to post-2015 due to Bloomberg availability.

Although each crisis exhibited a distinct peak in volatility skew, right-skewed pricing did not persist throughout the crisis window. In all three cases, right skew was present in only about half the days, suggesting dynamic risk fluctuation over the course of each crisis.

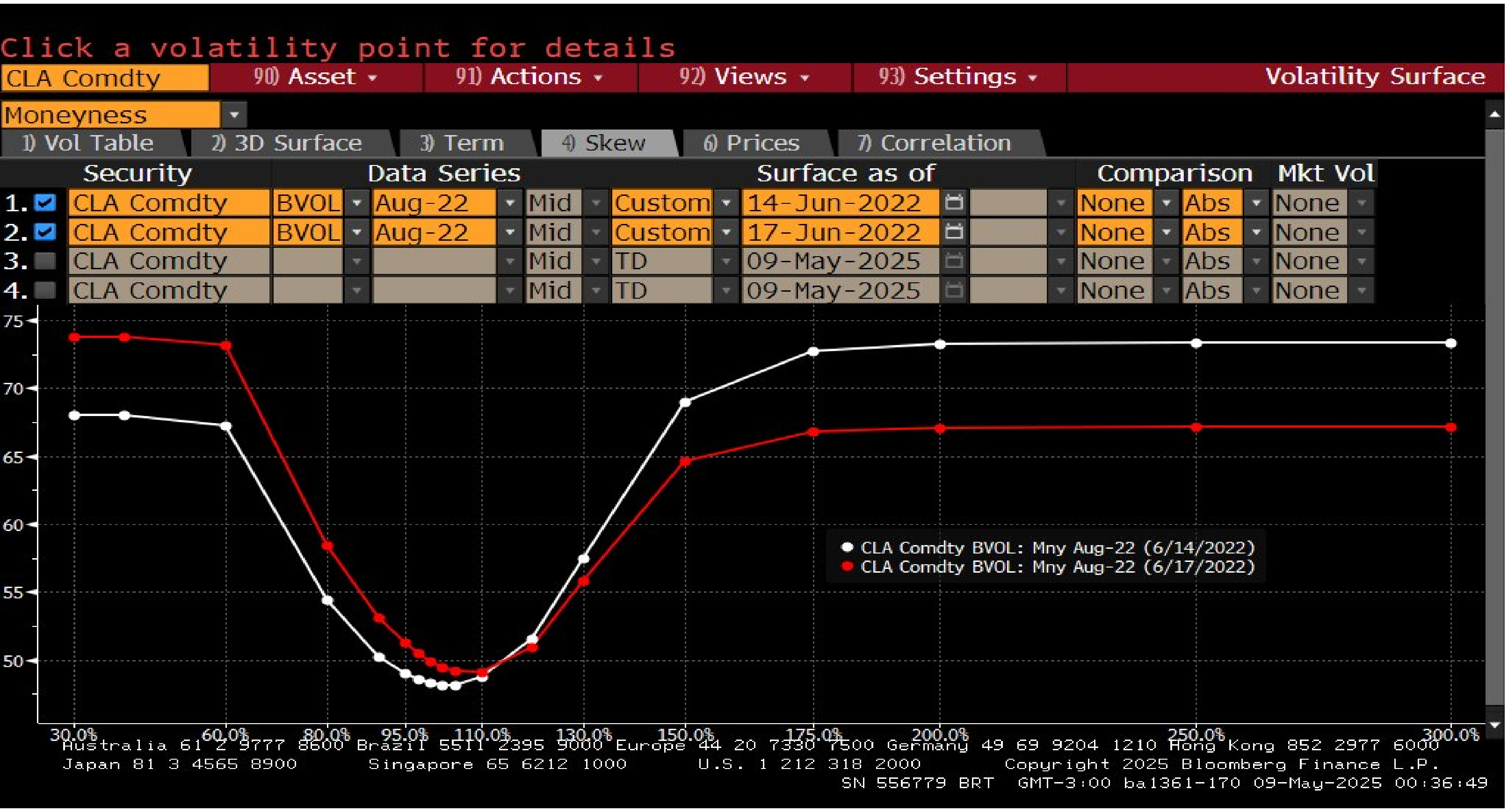
The table traces the evolution of implied volatility skew across key geopolitical crises by calculating the ratio of implied volatility at 150% and 60% moneyness. This volatility ratio captures acuteness to nervousness of the oil markets. A skew ratio of less than 1 (left skew) reflects heightened concern about price declines but relative stability. In contrast, a skew ratio greater than 1 (right skew) suggests that the market is at greater risk to price surges.

During the Russia–Ukraine War, markets were initially left-skewed on January 3, 2022 (ratio = 0.722) but transitioned to peak right-skew by February 14 (ratio = 1.508), likely in response to imminent invasion risks. Since this was just before the onset of hostilities, it would appear the market was expressing disbelief the invasion would actually occur. The skew returned to left leaning by July 12 (ratio = 0.943), suggesting a normalization of expectations and reduced panic pricing, even though the ongoing war.

Similarly, during the Israel–Gaza conflict, the market flipped from left skew (0.864 on September 15, 2023) to peak right skew (1.364 on October 13) and reverted to left skew by November 1 (0.994), signaling that initial volatility fears had subsided. The Saudi Aramco drone attacks followed a comparable arc: Skew rose from 0.741 (left) on August 15, 2019, to a peak of 1.261 (right) on October 11, before falling back below 1 by November 6 (0.914). Due to Bloomberg data limitations, skew analysis could not be extended to earlier crises such as the Crimea Annexation, Arab Spring or Persian Gulf Wars. Still, across recent events, volatility skew proves to be a sensitive, timely and forward-looking market indicator of shifting investor sentiment.

Figure 3: Volatility Skew of WTI Crude Oil Options

Around the Russia-Ukraine War



	Security	Data Series			Surface as of			Comparison		Mkt Vol
1. ☑	CLA Comdty	BVOL	Aug-22	Mid	Custom	14-Jun-2022		None	Abs	None
2. ☑	CLA Comdty	BVOL	Aug-22	Mid	Custom	17-Jun-2022		None	Abs	None
3. ☐	CLA Comdty			Mid	TD	09-May-2025		None	Abs	None
4. ☐	CLA Comdty			Mid	TD	09-May-2025		None	Abs	None

Australia 61 2 9777 8600 Brazil 5511 2395 9000 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 4565 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2025 Bloomberg Finance L.P.
SN 556779 BRT GMT-3:00 ba1361-170 09-May-2025 00:36:49

Figure 3. Implied volatility skew for WTI crude oil options as of June 14, 2022 (white) and June 17, 2022 (red), comparing market-implied volatilities across moneyness levels for the August 2022 expiry. The smile-shaped curved plots implied volatility across different moneyness levels.

These shifts in skewness highlight how implied volatility responds to geopolitical risk and provide insight into how investors hedge asymmetric risk in uncertain environments. The left skew ratios are dominant in the early phases of crises when uncertainty is high, and right skew ratios appear when markets anticipate price shocks.

These transitions capture how volatility skew sends a message: left skew tends to dominate the early stages of a crisis when uncertainty is highest, while right skew appears when markets begin pricing in known risk, like supply shocks. Figure 3 visually demonstrates the real time snapshot of how pricing absorbs and reflects risk via changing skew. The importance we assign to the vol skew is that it “brackets” the beginning *and ending of* the crisis, even if the crisis itself – such as Ukraine – has yet to abate.

Beyond indicating elevated uncertainty, the term structure of implied volatility provides a natural mechanism for bracketing geopolitical events in time. We observe that upside volatility skew widens sharply ahead of and during major geopolitical disruptions, reflecting heightened demand for upside protection and short-dated insurance. As events stabilize or resolve, this skew gradually normalizes. In this sense, volatility skew offers a forward-looking temporal marker that both anticipates and delimits crisis periods, an informational role that is not captured by correlation measures or price forecasts alone.

5.4 Term Structure of Volatility

The behavior of the oil implied term structure of volatility (TSOV) across crises shows a clear and consistent pattern. Short-maturity implied volatility reacts strongly to geopolitical shocks, rising sharply at the onset of each event. In contrast, long-maturity implied volatility, particularly those we observe readily at the two-year horizon, exhibit very little movement over the same periods. This indicates that markets treat crises primarily as short-term disruptions rather than as changes to long-run uncertainty about oil prices. Such stability at long horizons is consistent with a mean-reverting Ornstein–Uhlenbeck (OU) process for oil prices: Even when instantaneous volatility increases during a crisis, a corresponding rise in the speed of mean reversion can leave long-term term volatility largely unaffected[5]. As a result, the TSOV typically steepens because the front-end rises

---

[5] Without modeling stochastic volatility, we can see this result analytically from an Ornstein–Uhlenbeck process for spot prices. Thus, consider the following process for spot oil prices P_t:

$$d \ln P_t = \text{kappa} (\text{mu} - \ln P_t)\, dt + \text{sigma}\, dW_t$$

Under this process, the T = 2 annualized variance (1 / T) Var (ln P_t), sigma_T^2, is given by

$$\text{sigma}^2{}_T = \text{sigma}^2 * (1 - \exp\{- 2\, \text{kappa} * T\}) / (2 * \text{kappa} * T).$$

Thus, for a fixed horizon T = 2, any increase in sigma^2 can be offset by a corresponding increase in the mean-reversion parameter kappa, leaving the annualized variance $\text{sigma}^2{}_T$ unchanged.

without a rise in long-term vols. This evidence suggests that the implied volatility term structure reflects transitory stress in the near term and therefore offers limited insight into the market's expectations regarding the duration of geopolitical crises.

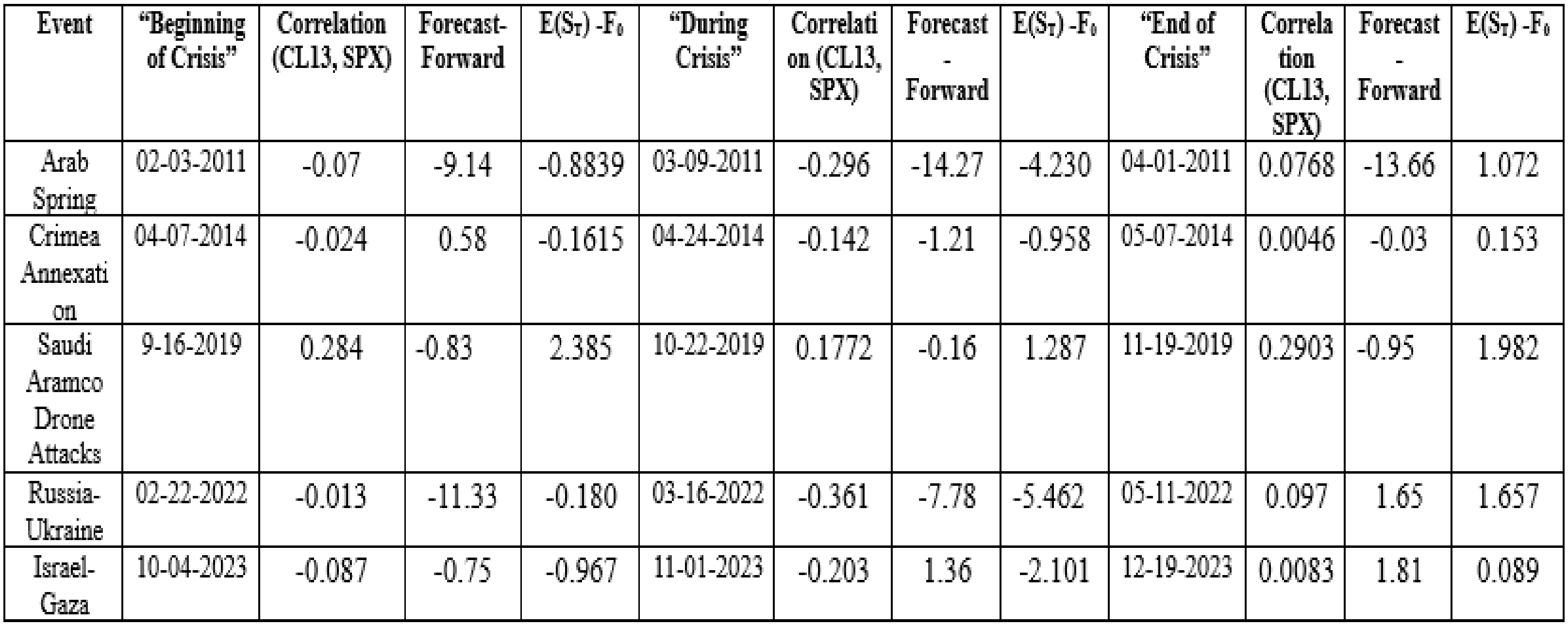
5.5 Oil Price Risk Premium

We quantify the oil-price risk premium using two approaches:

5.5.1 Forecast -Forward Oil Risk Premium

To assess the oil-price risk premium using a market-based approach, this analysis compares the 1-year forecasted WTI crude price to the 1-year forward price obtained from Bloomberg. The table below summarizes the risk premium at two key points for each geopolitical crisis: the date marking the beginning of the crisis, when uncertainty is typically high and the premium often turns negative; and the end of the crisis window, when market conditions begin to normalize.

Table 4: Forecast-Forward Risk Premium, Correlation and $E(S_T)$-F_0



Event	"Beginning of Crisis"	Correlation (CL13, SPX)	Forecast-Forward	$E(S_T)$ -F_0	"During Crisis"	Correlation (CL13, SPX)	Forecast-Forward	$E(S_T)$ -F_0	"End of Crisis"	Correlation (CL13, SPX)	Forecast-Forward	$E(S_T)$ -F_0
Arab Spring	02-03-2011	-0.07	-9.14	-0.8839	03-09-2011	-0.296	-14.27	-4.230	04-01-2011	0.0768	-13.66	1.072
Crimea Annexation	04-07-2014	-0.024	0.58	-0.1615	04-24-2014	-0.142	-1.21	-0.958	05-07-2014	0.0046	-0.03	0.153
Saudi Aramco Drone Attacks	9-16-2019	0.284	-0.83	2.385	10-22-2019	0.1772	-0.16	1.287	11-19-2019	0.2903	-0.95	1.982
Russia-Ukraine	02-22-2022	-0.013	-11.33	-0.180	03-16-2022	-0.361	-7.78	-5.462	05-11-2022	0.097	1.65	1.657
Israel-Gaza	10-04-2023	-0.087	-0.75	-0.967	11-01-2023	-0.203	1.36	-2.101	12-19-2023	0.0083	1.81	0.089

Table 4. Correlation at the beginning, during and end of five geopolitical crises. The risk premium is calculated as the difference between Bloomberg's 1-year forecasted price and the 1-year forward futures price. The risk premium is recalculated using the CAPM model. Crisis start dates reflect the onset of declining trends in the forecast–forward risk premium, indicating elevated market uncertainty in response to geopolitical events. End dates correspond to the first

trading day on which the premium returned to positive values, suggesting a return to normalized market expectations. Event windows cover February 2011 to December 2023.

The start date corresponds to the point at which the correlation starts declining, indicating rising uncertainty. The end date was determined when the correlation transitioned from negative to positive, indicating market normalization.

The results of the forecast–forward futures price reveal clear shifts in the oil risk premium during the progression of each geopolitical crisis. For the Arab Spring, the crisis began with a mild negative correlation of −0.07, which deepened to −0.296 during the peak, before flipping to a slightly positive +0.0768 by April 1, 2011. Consistent with this pattern, the forecast–forward premium fell from −9.14 to −14.27, then modestly improved to −13.66, while the CAPM-based premium declined from −0.8839 to −4.230 before rising to +1.072, echoing the stabilization implied by the correlation reversal.

During the Russia–Ukraine War, oil-equity correlations were consistently negative, starting at −0.013 and falling to a deep −0.361 by mid-March 2022, before recovering to +0.097 by May. Correspondingly, the forecast–forward premium sank from −11.33 to −13.78, before rebounding to +1.65. Meanwhile, the CAPM premium deteriorated from −0.180 to −7.462, then climbed to +1.657, suggesting that investors initially priced in sharp risk aversion before expectations improved alongside the correlation rebound.

In contrast, the Crimea Annexation featured only mildly negative correlations throughout (from −0.024 to −0.142), with a final shift to a slightly positive +0.0046 by early May 2014. The forecast–forward premium moved modestly from +0.58 to −1.21, then stabilizing at −0.03, while the CAPM premium dipped slightly but remained close to zero, ranging from −0.1615 to −0.958 and ending at +0.153.

The Saudi Aramco Drone Attacks did not provide negative correlations and was instead marked by positive and increasing oil-equity correlations throughout the crisis window from +0.284 to +0.290. Despite the brief risk spike, the forecast–forward premium remained subdued (from −0.83 to −0.16, back to −0.95), while the CAPM premium consistently stayed positive (+2.385 to +1.287, ending at +1.982).

Finally, the Israel–Gaza conflict began with a negative correlation of −0.087, which deepened to −0.203, before turning slightly positive (+0.0083) by year-end. This trajectory mirrors the modest increase in the forecast–forward premium—from −0.75 to −1.36, then up to +1.81. The CAPM premium, however, remained negative throughout (−0.967 to −2.101, ending at +0.089).

The variation in results infers that oil-equity correlations are a powerful measure of market prices. The duration and magnitude of these correlation regimes, rather than price levels alone, appear to drive the perceived oil risk premium

Figure 4: Oil Price Forecasts and Forward Prices during the 2022 Ukraine Crisis

NYMEX WTI $/BBL As Of 03/08/22 Ticker Type Actual

○ Quarterly Forecast ● Yearly Forecast

Firms ○ Standard ● Custom Rank All Updated Last 6 Months

Consensus	Spot	As Of	Q1 22	Q2 22	Q3 22	Q4 22	Q1 23	Q2 23
Median		03/03/22	83.00	77.00	75.00	74.20	73.75	72.00
Mean		03/03/22	82.87	80.58	77.11	75.98	76.89	76.26
High		03/03/22	98.00	98.00	93.00	102.10	111.40	117.00
Low		03/03/22	72.50	65.00	65.00	60.00	61.00	61.00
Forward	123.70	03/08/22	103.18	112.03	102.12	97.28	92.23	89.98
Diff (Median - Curr)			-20.18	-35.03	-27.12	-23.08	-18.48	-17.98

Firm	Rank	As Of	Q1 22	Q2 22	Q3 22	Q4 22	Q1 23	Q2 23
Landesbank Baden-Wuerttemberg		03/03/22	98.00	98.00	93.00	88.00	83.00	78.00
Capital Economics Ltd	3	03/02/22	92.67	97.00	89.50	80.00	76.13	72.38
Goldman Sachs Group Inc/The		02/28/22	127.00	127.00	127.00	127.00	110.00	110.00
Banco Santander SA		02/21/22	86.32	82.44	78.56	74.68		
Commerzbank AG		02/15/22	87.00	82.00	77.00	77.00	72.00	72.00
Westpac Banking Corp		02/07/22	85.43	87.38	80.91	71.20	64.72	61.17
MUFG Bank	2	02/01/22	85.10	94.70	87.80	102.10	111.40	117.00
Rabobank International		02/01/22	89.28	89.55	90.00	90.48	91.08	91.38
Emirates NBD PJSC		01/28/22	72.50	70.00	65.00	60.00		
Intesa Sanpaolo SpA	5	01/24/22	73.00	65.00	66.00	68.00	68.00	68.00
Market Risk Advisory Co Ltd		01/06/22	73.00	70.50	69.00	71.50	70.40	70.70
MPS Capital Services Banca per...		12/27/21	77.00	70.00	67.00	66.00		
Natixis SA		12/13/21	77.50	74.50	72.50	72.50	72.50	69.50
Australia & New Zealand Bankin...		10/25/21	81.20	75.60	73.40	74.20	77.40	82.00
BNP Paribas SA		10/19/21	83.00	75.00	75.00	77.00	75.00	72.00
ABN AMRO Bank NV		10/14/21	82.00	77.00	72.00	67.00	61.00	61.00
Deutsche Bank AG		07/29/21	67.00	57.00	62.00	62.00		
Toronto-Dominion Bank/Toronto		03/30/21	62.00	62.00	64.00	64.00		
Barclays PLC	1	03/22/21	69.00	63.00	68.00	71.00		
CTMB		03/12/21	60.00					

(Last Price: Most Recent Forecast, Prior Forecast, Excluded From Consensus)

Australia 61 2 9777 8600 Brazil 5511 2395 9000 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 4565 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2022 Bloomberg Finance L.P.
SN 556779 BRT GMT-3:00 G677-496-171 28-Jul-2022 13:10:07

Figure 4. Bloomberg one-year-ahead WTI crude oil price forecasts (median analyst consensus) and corresponding one-year forward prices during the Russia–Ukraine conflict in 2022. The persistent divergence between forecasts and forward prices illustrates the forecast-minus-forward risk premium embedded in futures markets during periods of heightened geopolitical uncertainty.

5.5.2 CAPM-based Oil Risk Premium

To complement the forward-minus-forecast approach, a CAPM-based oil-price risk premium was also computed. The premium is calculated using the following steps:

$$\mu_T = \rho_T \cdot \sigma_T \cdot \lambda$$

We used the correlation between the CL data and SPX to get a correlation of ρ_T.

We used Bloomberg's 1 year at the money (100% moneyness) implied volatility for CL futures which was $\sigma_T = 0.287$

The Sharpe ratio is assumed to be a constant, derived by long-term averages, at 0.448 Using these derived variables, we can calculate the expected spot price. The expected spot price – forward values can also be found in Table 4.

5.5.3 Comparing Both Approaches of Risk Premium

To evaluate whether the financial oil market's forward-looking expectations align with equity market sentiment, we compute a series of concurrence and correlation measures between the sign and magnitude of the risk premium (Forecast – Forward) and the oil-equity correlation. Table 6 reports these results across key the data available, disaggregated by the sign of the risk premium and filtered by statistical significance thresholds. The analysis focuses on whether oil markets reflect broader investor risk sentiment through consistent directional alignment (concurrence) and whether forecast-based and model-based estimates of the expected spot price [$E(S_t)$] move together.

Table 5: Summary of Overall Concurrence and Correlation Between Risk Premium and Expected Spot Price

	Concurrence Agreement (%)	**Correlations**	**p-value under Normal Distribution**
Entire data base	51.8	0.1280	0.0064
T-stat > 2	52.2	0.0783	0.0141
Forecast > forward	50.3	0.220	0.3540
Forecast > Forward (T-stat > 2)	51.4	-0.0603	0.0874
Forecast < Forward	61.9	0.2992	1.79E-09
Forecast < Forward (T-stat > 2)	78.7	0.2797	3.43E-07

Table 5. Summary statistics on the directional concurrence and correlation between forecast-based and model-based oil risk premiums. The concurrence metric measures the percentage of time the sign of the forecast-forward premium aligns with the sign of the oil-equity correlation. Correlation values reflect the strength of similarity between forecast-forward and expected spot price premiums $E(S_t)$ – F, both overall and conditional on statistical significance. Full dataset includes 4,537 daily observations spanning January 2010 to April 2024.

The results in Table 5 reveal an overall concurrence of 51.8% between the sign of the forecast–forward and the sign of oil-equity correlations, suggesting that market-implied expectations align with equity sentiment slightly more than half the time. When conditioning on statistically significant periods, this alignment slightly improves to 52.2%, though the correlation between the two premium measures remains weak (0.0783).

When the forecast exceeds the forward price, the concurrence drops to 50.3%, while the correlation increases to 0.2200, indicating that market optimism is only partially reflected in the CAPM-based model. This divergence becomes more evident when filtered by statistical significance, with concurrence at 51.4% and the correlation turning slightly negative (−0.0603).

In contrast, when the forecast is below the forward price, the agreement improves to 61.9%, and the correlation strengthens to 0.2992, implying greater consistency between the two approaches. This consistency further increases under statistically significant conditions, with 78.7% agreement and a similarly strong positive correlation (0.2797).

Using a binomial test with normal approximation, we find that the overall concurrence rate of 51.8% is statistically significant ($p = 0.0064$). Notably, the concurrence rises to 61.9% and 78.7% when correlations are positive and statistically significant, respectively, both highly significant at the 1% level.

In contrast, when forecasts exceed forward prices, the concurrence rates are near 50% and not statistically different from random, suggesting that market forecasters respond more strongly to the direction and significance of correlation than to price level alone.

Notably, the weakest correlations between the forecast–forward premium and the model-based premium $E(S_t) - F$ occur in cases where the oil-equity correlation is positive. This is consistent with the theoretical result, that a negative correlation is sufficient for a negative risk premium, but a positive correlation is not sufficient for a positive risk premium: Under the CAPM, a negative correlation between oil prices and the market is sufficient for a negative oil-price risk premium because oil then has a negative beta and acts as a hedge against bad market states, but a positive correlation is not sufficient for a positive premium because oil may also carry *systematic* risk — meaning a positive beta that actually covaries with priced market shocks — rather than merely moving with equities for idiosyncratic or non-priced reasons.

During geopolitical crises, there appears to be stronger agreement between the forecast-based and model-based measures, both in terms of direction and magnitude, regardless of whether the oil-equity correlation is statistically significant. This consistency implies that such periods offer clearer signals to the market.

In principle, we should be careful of the term structures of both correlation and volatility skew. For instance, Corr (CL1, SPX), Corr (CL2, SPX), etc., can exhibit distinct dynamics across maturities, just as the magnitude and shape of the volatility skew are heavily depending on the maturity of the instrument in question.

One distinct problem with the forecast prices is their forecasts are stale and not contemporaneous with the date of analysis. Moreover, the correlation values are not always simultaneous or forward-looking. These issues warrant skepticism in interpreting both market-based and model-derived signals.

The stronger alignment between forecast-forward premiums and CAPM-derived premiums occurs when correlation is negative and |t-stat| exceeds 2. The only exception occurs during the somewhat mystifying summer of 2008, when oil prices continued rising notwithstanding the increasing slippage of equity prices into the Great Recession.

The Ukraine crisis stands out clearly in the data, however, unexpectedly, the Arab Spring does not develop the same clarity….A closer look at the correlation between oil-equity markets during the Arab Spring reveals a more significantly negative comovement, suggesting that the use of a one-year-ahead CAPM horizon may be too long to capture and that we should potentially focus on more near-term CAPM.

The skepticism with respect to the staleness of forecast prices raises an important methodological point: during periods when forecasts are "stale", CAPM-based calculations may offer a more responsive measure of expected price direction.

A negative equity beta implies that oil delivers higher payoffs in adverse aggregate states, thereby acting as a hedge and implying a negative oil-price risk premium. In this sense, a negative beta is sufficient to sign the premium as negative. However, this condition is not necessary. Oil may also hedge other priced sources of risk—such as inflation, volatility, or disaster risk—even when its equity beta is positive. Consequently, a positive correlation with the equity market is not sufficient to imply a positive oil-price risk premium, as these alternative hedging channels may dominate the equity component. Thus, while a negative equity beta provides a clear indication of a negative premium, a positive beta does not preclude it. This interpretation is consistent with our empirical findings, where negative equity beta is associated with the negative oil-price risk premium observed in the forecaster-based measures.

5.6 Term Structures of Volatility and Correlation

A central element of the empirical analysis involves constructing forward-looking financial metrics that capture how uncertainty and market comovements evolve during geopolitical crises. To examine how volatility responds across, the study analyzes volatility skew across several maturities using implied volatilities at 60% and 150% moneyness. While the prompt-month contract provides a measure of near-term asymmetric risk, incorporating additional maturities along the volatility term structure allows assessment of whether geopolitical shocks generate front-loaded, short-lived changes in downside and upside risk pricing. If skew rises sharply for near-term options but remains muted for longer-dated maturities, this suggests markets interpret the crisis as temporary. By contrast, a sustained elevation of skew across the curve indicates expectations of prolonged uncertainty. Analyzing volatility skew across maturities therefore provides a deeper perspective on how geopolitical events affect the duration, asymmetry, and intensity of market-implied risk.

In parallel, the study develops a framework for rolling oil–equity correlations that explicitly tests sensitivity to window length and futures-contract maturity. Correlations between crude-oil returns and equity returns are computed over both 45-day and 120-day moving windows. The 45-day window captures high-frequency market reactions to geopolitical events, whereas the 120-day window smooths transient fluctuations and reflects more structural comovement. Using both windows allows direct evaluation of whether the sign, strength, and persistence of oil–equity correlations depend on the horizon used.

To further evaluate horizon dependence, the correlation analysis also incorporates futures contracts of different maturities, particularly CL6 (6-month) and CL13 (13-month) contracts. Testing both maturities allows assessment of whether geopolitical crises affect near-term pricing more strongly than longer-dated valuations, or whether correlations are consistent across the term structure.
If correlations derived from CL6 and CL13 differ systematically, this indicates that the sensitivity of oil pricing to equity-market conditions varies with maturity; if they move similarly, this suggests a more unified market response across horizons.

By testing the robustness of these signals across horizons and contract maturities, the study assesses the stability of correlation signs, the comparative strength of comovements, and the persistence of volatility asymmetries, thereby refining the interpretation of the financial “message from markets” during periods of geopolitical stress.

6. March 2026 Crisis: Real-Time Application of Financial Oil Market Metrics

This section applies the framework developed in this study to the ongoing March 2026 geopolitical crisis, providing a real-time evaluation of how financial oil market metrics capture evolving uncertainty and supply risk.

Implied Volatility (OVX)

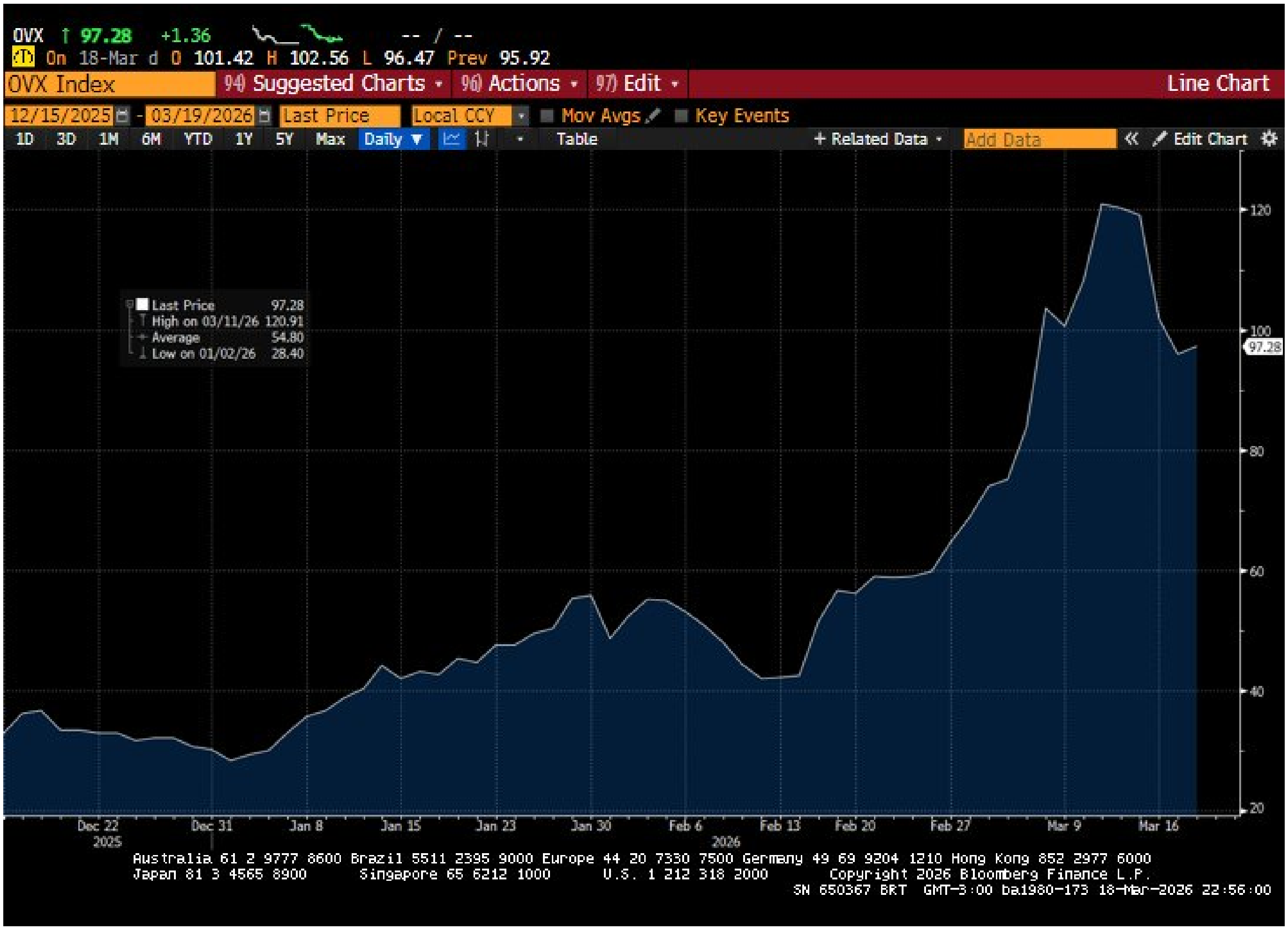
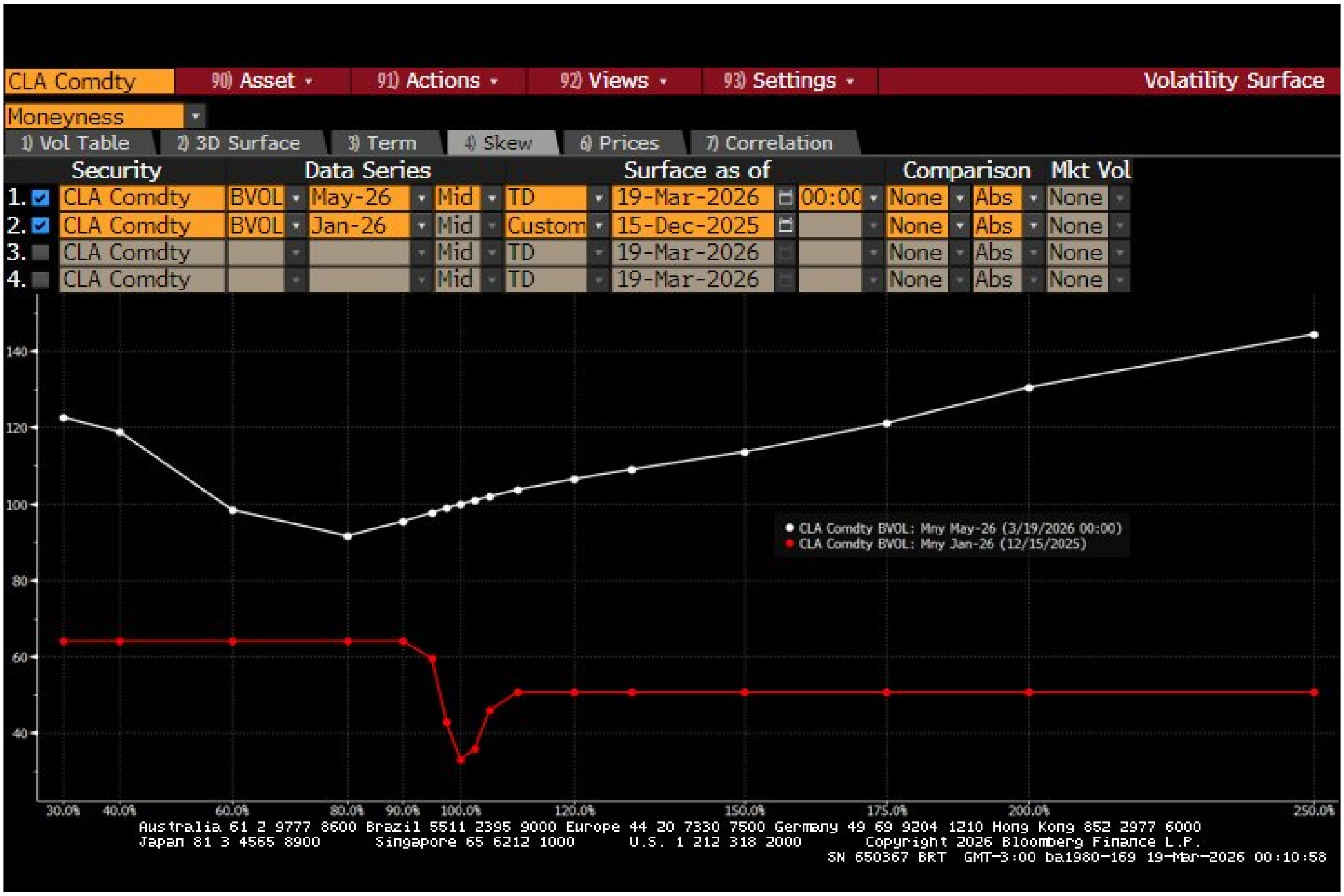


Figure 5. Crude Oil Volatility Index (OVX) from December 2025 to March 2026. The index rises sharply from approximately 30 in early January to a peak above 120 in March, before moderating to around 97. The spike reflects a substantial increase in forward-looking uncertainty in oil markets, while the persistence of elevated levels indicates that uncertainty remains unresolved despite partial stabilization in prices.

The OVX index rises sharply from levels near 30 in early January to a peak above 120 in March, before slightly decreasing to around 97. This substantial increase reflects a dramatic rise in market uncertainty associated with the crisis. As of today, the OVX remains significantly elevated to pre-crisis level indicating that uncertainty persists despite partial stabilization in prices.

Volatility Skew



	Security	Data Series				Surface as of		Comparison		Mkt Vol
1. ☑	CLA Comdty	BVOL	May-26	Mid	TD	19-Mar-2026	00:00	None	Abs	None
2. ☑	CLA Comdty	BVOL	Jan-26	Mid	Custom	15-Dec-2025		None	Abs	None
3. ☐	CLA Comdty			Mid	TD	19-Mar-2026		None	Abs	None
4. ☐	CLA Comdty			Mid	TD	19-Mar-2026		None	Abs	None

Figure 6. Implied volatility surface for WTI crude oil options (CL1), shown across moneyness levels. The figure highlights the steepening of the volatility skew, with implied volatility for out-of-the-money call options (150% moneyness) significantly exceeding that of out-of-the-money put options (60% moneyness). The skew ratio (150% / 60%) exceeds 1 prior to the observable onset of the crisis, indicating that markets were pricing elevated upside tail risk before the sharp increase in oil prices. This asymmetry reflects expectations of supply-driven price spikes rather than downside risk.

The implied volatility surface exhibits a pronounced right-skewed structure, with substantially higher implied volatilities for out-of-the-money calls relative to puts. This indicates that market participants assign greater probability to large upward price movements than to downward corrections. Compared to the pre-crisis period, the skew steepens considerably, reflecting heightened concern over supply-driven price spikes.

Notably, the volatility skew ratio (150% / 60%) exceeds 1 prior to the observable onset of the crisis, indicating that option markets were pricing greater upside tail risk before the sharp increase in oil prices. This early shift in skew precedes both the rise in implied volatility and the price dislocation, highlighting the forward-looking nature of option-implied measures. Such asymmetric pricing of risk is consistent with geopolitical disruptions in oil markets, where uncertainty is dominated by potential shortages rather than demand collapse.

Slope of the Oil Curve

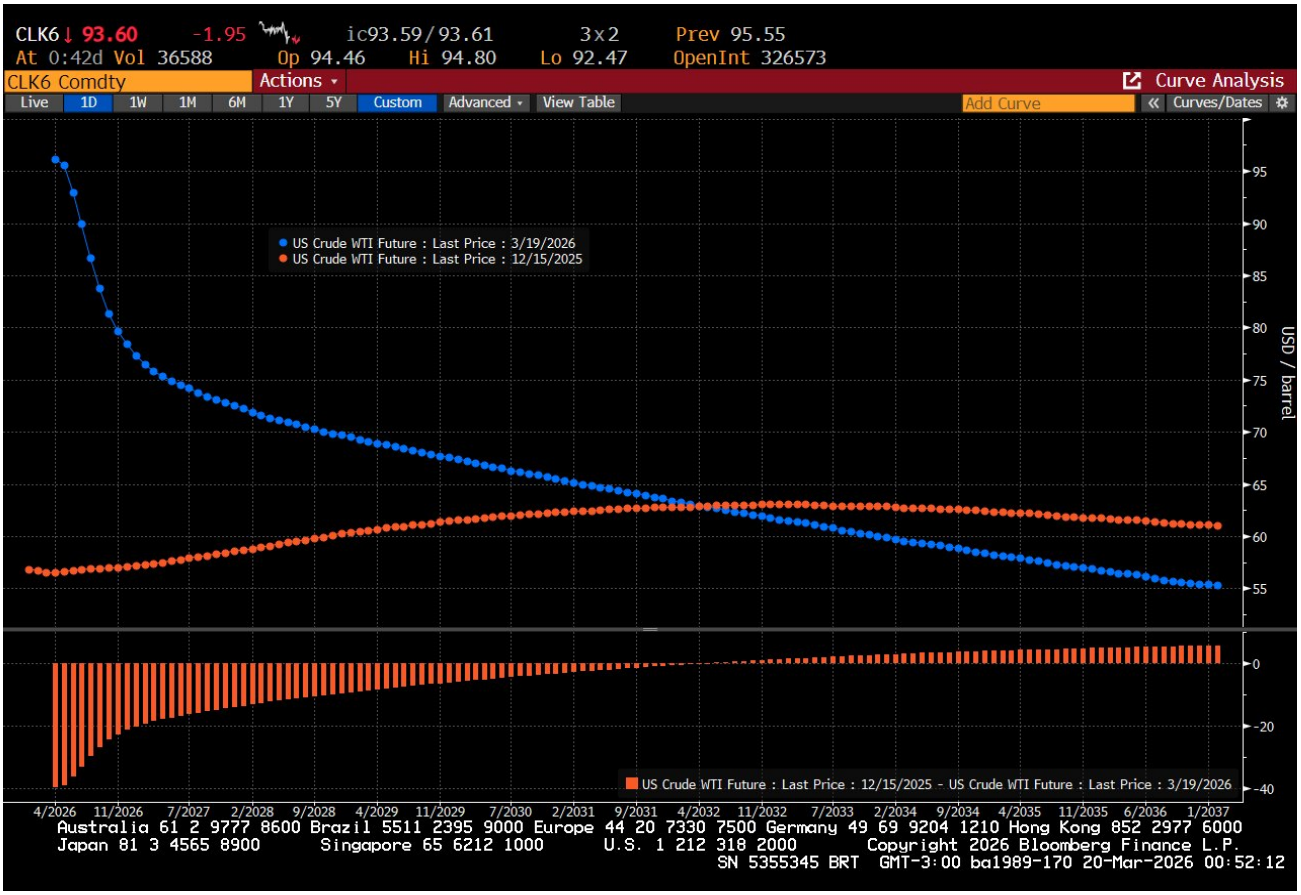


Figure 7. Term structure of WTI crude oil futures comparing pre-crisis (December 2025) and crisis-period (March 2026) curves. The crisis-period curve exhibits pronounced backwardation,

with front-month prices near $95–$100 and longer-dated contracts declining toward the mid-$50 range. This steep downward slope reflects severe short-term supply tightness, while the lower long-dated prices suggest that markets expect the disruption to be temporary rather than persistent.

Crude oil prices increase sharply over the sample period, rising from approximately $55 to above $95, with a peak near $100 in mid-March 2026. This rapid acceleration suggests a sudden repricing rather than a gradual demand-driven adjustment. Consistent with this behavior, the futures curve displays pronounced backwardation, with near-term contracts trading significantly above longer-dated maturities.

While front-month prices approach $95–$100, longer-dated contracts decline toward the mid-$50 range. This steep downward slope indicates severe short-term supply tightness, while the relatively lower long-dated prices suggest that markets expect the disruption to be temporary rather than persistent.

Correlation with Equity Markets

SPX ↓ 6624.70 -91.39 6582.83 / 6655.20
On 18-Mar d O 6697.16 H 6705.18 L 6621.66 Prev 6716.09

Buy SPX Index Sell CL1 COMB Com

Data Last Price Data Last Price 12/15/2025 - 03/19/2026 ☐ Regression ☑ Corr 45

Mult 1.0 Const 0.0 Mult 1.0 Const 0.0 ☐ Normalize by Factor 100.0 Calc % LCL

Correlation(CL1 COMB Comdty,PR005,45,0) (SPX) -0.2565

Australia 61 2 9777 8600 Brazil 5511 2395 9000 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 4565 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2026 Bloomberg Finance L.P.
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Figure 8. Rolling correlation between daily log returns of WTI crude oil (CL1) and the S&P 500 (SPX) using a 45-day window. The correlation turns negative during the crisis, reaching approximately −0.25, indicating that oil prices move inversely to equity markets. This shift reflects a transition from a demand-driven regime to a supply-driven regime, where oil acts as a hedge against adverse macroeconomic conditions.

The rolling correlation between oil prices and equity markets turns negative during the crisis, reaching approximately −0.25. This shift indicates that oil is no longer moving in tandem with broader macroeconomic conditions but instead behaves as a hedge against adverse aggregate states. The breakdown of positive correlation suggests a transition from a demand-driven environment to a supply-driven regime, in which oil price increases are associated with economic stress rather than growth. As of today, the correlation is still negative and hasn't turned to pre-crisis conditions.

Term Structure of Volatility (TSOV)

The term structure of implied volatility shows elevated short-term volatility relative to longer maturities, indicating that uncertainty is concentrated in the near term. While volatility remains elevated across the curve, the decline in implied volatility at longer horizons suggests that market participants expect the effects of the disruption to dissipate over time. This pattern is consistent with a temporary supply shock rather than a structural shift in long-term oil market fundamentals.

Oil Price Risk Premium

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NYMEX WTI $/BBL | Browse | As Of 03/18/26 | Ticker Type Actual

● Quarterly Forecast ○ Yearly Forecast ○ Quarterly and Yearly Forecast

Firms ● Standard ○ Custom Rank All Updated Last 6 Months

Consensus	Spot	As Of	Q1 26	Q2 26	Q3 26	Q4 26	Q1 27	Q2 27
Median		03/17/26	61.00	61.48	61.40	60.66	61.78	61.50
Mean		03/17/26	62.56	64.87	62.86	61.75	62.70	63.00
High		03/17/26	77.00	92.50	80.00	78.00	76.25	75.25
Low		03/17/26	50.68	50.68	52.00	51.00	51.00	53.00
Forward	96.32	03/18/26	78.16	90.32	81.34	76.14	73.17	71.46
Diff (Median - Curr)			-17.16	-28.85	-19.94	-15.49	-11.39	-9.96

Firm	Rank	As Of	Q1 26	Q2 26	Q3 26	Q4 26	Q1 27	Q2 27
BMI, a Fitch Solutions company		03/17/26	74.00	64.00	65.00	67.00		
Standard Chartered		03/16/26	73.00	92.50	80.00	75.50	73.00	74.00
Intesa Sanpaolo SpA		03/13/26	70.00	75.00	63.00	59.00	59.00	60.00
JPMorgan Chase & Co	7	03/13/26	56.00	55.00	52.00	51.00	51.00	53.00
Julius Baer Group Ltd		03/13/26	69.10	70.00	59.50	57.50	57.50	60.00
Landesbank Baden-Wuerttemberg	8	03/12/26	72.00	72.00	72.00	67.00	67.00	62.00
Goldman Sachs Group Inc		03/11/26	77.00	76.00	70.00	67.00	67.00	67.00
Rabobank		03/11/26	76.00	83.00	80.00	78.00	76.25	75.25
HSBC Holdings PLC		03/10/26	77.00	84.00	74.00	69.00	67.00	67.00
Barclays PLC		03/05/26	66.59	77.00	70.67	67.67		
Citigroup Inc	1	03/02/26	64.00	59.00	59.00	59.00		
Morgan Stanley	4	03/02/26	53.50	76.00	66.00	61.00	61.00	61.00
BloombergNEF		02/26/26	62.50	59.50	57.00	53.00		
Bank of America Merrill Lynch		02/17/26	56.00	57.00	58.00	57.00	58.00	59.00
MPS Capital Services Banca per…		02/16/26	62.00	58.00	55.00	55.00		
Westpac Banking Corp	6	02/16/26	62.84	63.95	62.34	60.38	58.71	56.31
walletinvestor.com/commodity-…		02/09/26	70.06	69.14	66.81	60.93	62.57	65.68

(Last Price: Most Recent Forecast, Prior Forecast, Excluded From Consensus)

Australia 61 2 9777 8600 Brazil 5511 2395 9000 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 4565 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2026 Bloomberg Finance L.P.
SN 650367 BRT GMT-3:00 ba1980-173 18-Mar-2026 22:58:17

Figure 9. Comparison of WTI crude oil futures prices and Bloomberg consensus forecasts of future spot prices. Futures prices remain elevated in the $90–$100 range, while expected future prices are concentrated between $60 and $70, implying a negative risk premium of approximately −$15 to −$30. This indicates that investors are willing to pay a premium for oil exposure, consistent with its role as a hedge during periods of geopolitical stress.

The oil price risk premium is observed to be negative, as futures prices exceed consensus expectations of future spot prices. Bloomberg forecast data indicate expected prices in the $60–$70 range, while futures prices remain near $90–$100, implying a premium of approximately −$15 to −$30. This negative risk premium suggests that investors are willing to pay for exposure to oil, consistent with its role as a hedge during periods of geopolitical stress and supply uncertainty.

7. Conclusions

In this study, we have identified and evaluated several key financial metrics that can be used to quantify the impact of geopolitical crises in the oil market. Specifically, we looked at Comovement with the equity markets; forecast of oil prices; the OVX Index and the volatility skew. Each of these captures different messages of market behavior under stress.

Of these, OVX and the volatility skew are particularly notable for being purely forward-looking. Their ability to rise sharply at the onset of a crisis and return to baseline as conditions normalize makes them effective tools for bracketing the beginning and end of oil-related geopolitical crisis.

The dynamic when comparing CAPM-derived expected spot prices with analysts' forecasts is interesting. The two approaches appear to align reasonably well when geopolitical risk is elevated, and the implied risk premium is negative, however, this alignment is not present during positive premium periods. This divergence may be indicative analysts are not quite as acute on positive values.

As indicated previously, the term structures of both oil-equity correlation and volatility skew warrant close attention. These structures may well be indicative of additional information regarding the depth, severity and intensity of the crises.

Together, these findings reinforce the value of integrating multiple financial metrics to form a cohesive, forward-looking picture of how geopolitical shocks are absorbed and reflected in oil markets. They also highlight the subtle ways in which risk is priced and how these signals can be interpreted to guide policy and investment decisions.

Additional technical details supporting these results are provided in Appendices A and B.

Appendix A: Term Structure of Correlation as a Quantitative Metric of Geopolitical Spillovers

During the Arab Spring, we observe that short-horizon correlations between oil prices and equity markets become strongly negative, while longer-horizon correlations remain comparatively less affected. At face value, this would appear to be the “natural” phenomenon, where short-term effects are more pronounced than longer-dated ones. This is consistent with the notion the episode was perceived primarily as an immediate supply-side shock, creating near-term economic uncertainty without materially altering longer-run expectations about global growth.

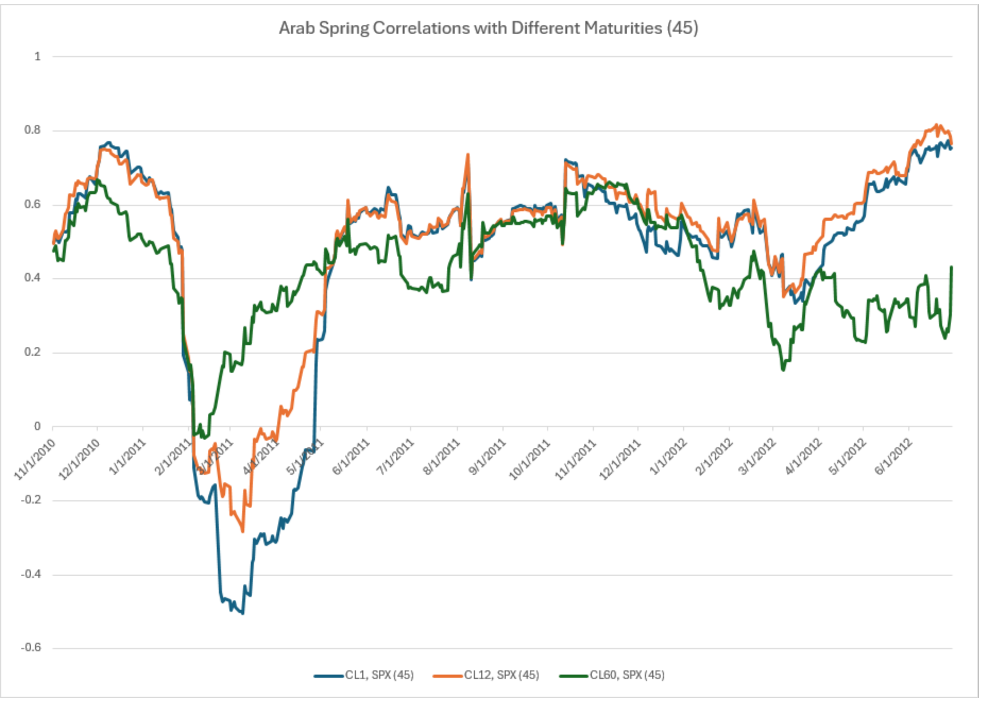

Figure A.1 Rolling 45-day correlations between crude oil futures (CL1, CL3, and CL6) and the equity market (SPX) during the Arab Spring period. The figure highlights a sharp breakdown in correlations at the onset of the crisis, particularly for shorter maturities, followed by a gradual recovery. The stronger decline in front-month contracts suggests that near-term oil prices were more sensitive to geopolitical shocks, consistent with the market pricing immediate supply-side disruptions.

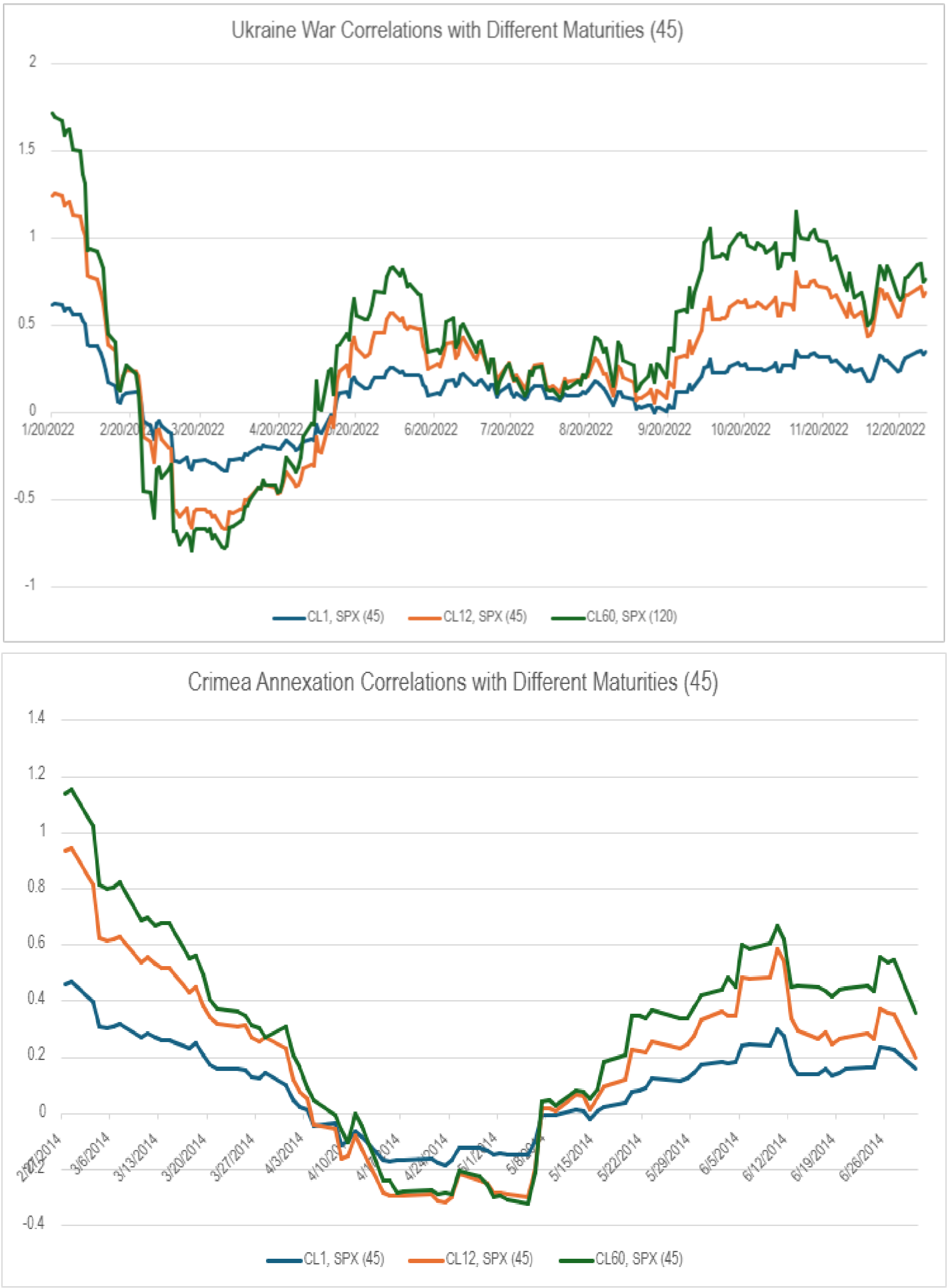

Figure A.2 Rolling correlations between crude oil futures (CL1, CL3, and CL6) and the equity market (SPX) during the Russia–Ukraine war (top panel) and the Crimea Annexation (bottom panel), based on 45-day windows. In both episodes, correlations decline sharply at the onset of the geopolitical shock, indicating a temporary decoupling between oil and equity markets. The effect is more pronounced in shorter maturities during the Russia–Ukraine conflict, reflecting heightened sensitivity of near-term oil prices to immediate supply disruptions. Over time, correlations gradually recover, consistent with a transition from supply-driven shocks to broader macroeconomic dynamics.

In contrast, the Crimea annexation and the Russia–Ukraine crisis displays the opposite pattern: correlations at longer maturities become more negative than those at short maturities. In terms of the intuition, we provided in the “Arab Spring” case, this phenomenon is more difficult to interpret. These conflicts were interpreted by markets as more persistent and systemically important disruptions, with implications for medium- to long-term macroeconomic conditions rather than only short-run volatility. These differing shapes of the correlation term structure provide insight into how markets differentiate between crises viewed as transitory and those expected to have more durable economic consequences.

One possible explanation for these distinct observed correlation term structures is the nature of the crisis: When the crisis reflects supply-disruption shocks, the front-end correlation most negative. In contrast, if and when demand-destruction or recession-risk shocks are predominant, long-dated correlations are more negative.

Appendix B: Jump-Diffusion Analysis

The jump-diffusion calibration provides an additional perspective on market reactions beyond elevated volatility. As in Murphy and Ronn (2008), the parameter captures the expected magnitude and direction of discrete price jumps, isolating the risk of abrupt repricing rather than gradual uncertainty. Around the onset of the 2022 Russia–Ukraine conflict, rises noticeably, indicating that market participants were pricing the possibility of sudden supply-driven moves and a potential shift in pricing regimes. While implied volatility reflects dispersion in expected outcomes, the jump component captures tail risk; the concern that prices may adjust unevenly following geopolitical developments. Taken together, the behavior of volatility and supports the broader interpretation of the paper: oil markets embed forward-looking assessments of geopolitical risk, with the jump component reflecting the probability of structural shocks, particularly evident during the early stages of the 2022 Russia–Ukraine conflict.

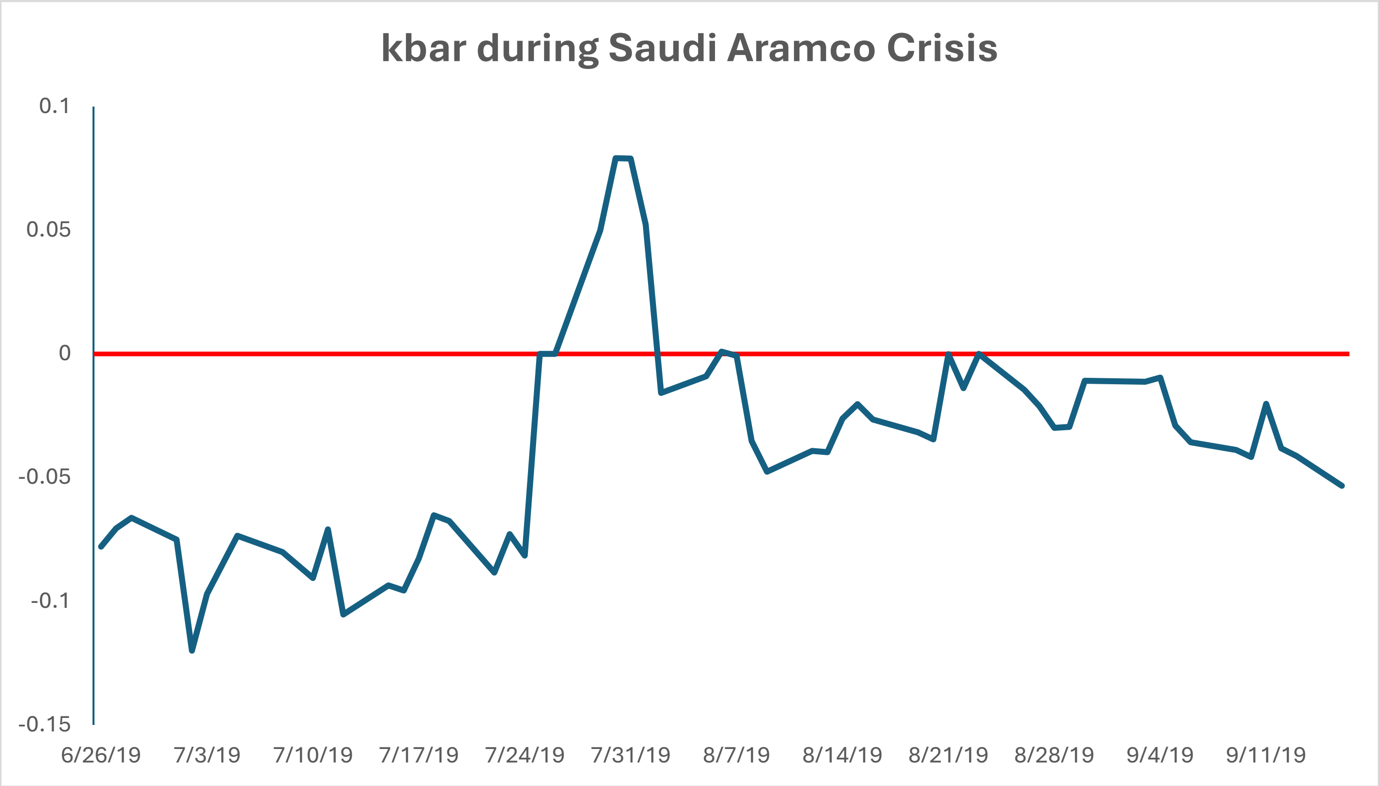

Figure B.1 Time series of the jump-diffusion parameter ($\bar{k}$) during the 2019 Saudi Aramco drone attack crisis. The sharp increase in $\bar{k}$ around late July reflects a rise in the expected magnitude of discrete upward price jumps, indicating that markets were pricing in sudden, supply-driven disruptions. Following the initial shock, the parameter declines and stabilizes below zero, suggesting a reassessment of tail risk as market conditions normalized.

Figure B.2 Time series of the jump-diffusion parameter ($\bar{k}$) during the 2022 Russia–Ukraine crisis. The sharp spike in $\bar{k}$ around early March reflects a significant increase in the expected magnitude of upward price jumps, consistent with markets pricing in sudden supply disruptions and extreme tail risk. Following the initial shock, $\bar{k}$ gradually declines toward zero and turns slightly negative, indicating a normalization of jump risk as uncertainty becomes more diffuse and incorporated into broader market expectations.

Hedge-Implications:

The results of this study have direct implications for hedging strategies in oil-exposed portfolios. The pronounced widening of downside volatility skew during geopolitical crises indicates that market participants place a premium on near-term downside protection precisely when price uncertainty is greatest. Hedgers relying solely on static futures positions or correlation-based diversification may therefore underestimate tail risk during such periods.

By contrast, option-based strategies that account for changes in implied volatility and skew, such as dynamic put spreads or delta-hedged option positions, may offer more effective protection against abrupt geopolitical shocks. More broadly, our findings highlight the importance of monitoring forward-looking derivatives markets when designing hedges in environments characterized by geopolitical risk.

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