War-Induced Energy Commodity Price Dynamics : Index Design and Impact Assessment

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Abstract

Purpose : We analyzed the impact of three wars—the Gulf War of 1990–91, the US Invasion of Iraq (2003–2011), and the ongoing Russian invasion of Ukraine (from 2022 onwards)—on energy commodities and used the findings to predict the effect of wars on energy commodities during the ongoing Russia-Ukraine war.

Research Methodology : We employed a novel approach to determining the energy commodity index using equal risk contribution methodology. This index was called the War Energy Commodity Index. It was constructed using monthly prices of six energy commodities—natural gas, Brent Crude, WTI crude, gas oil, heating oil, and RBOB Gasoline—from June 1990 to July 2024. We employed a regression model to assess the impact of the three wars on the War Energy Commodity index using dummy variables for the different war periods and their lagged values.

Findings : The findings indicated that while war-triggered volatility initially affected prices, indices tended to return to their original levels post-war, with only long-term wars demonstrating statistically significant impacts on energy commodity prices.

Practical Implications : Predicting energy commodity prices would be helpful to industry practitioners. Our study encouraged economic agents to invest in commodity indices based on equal risk contribution and index providers to launch an index based on this methodology.

Originality/Value : The index constructed in this paper distributed risk equally among the six energy commodities. To our knowledge, no energy index of this kind has been created. The index provides a predictive model for the Russia-Ukraine warfare.

Keywords : **war crisis, energy prices, index construction, equal risk contribution, regression analysis**

JEL Classification Codes : C13, C43, Q43

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Wars are catastrophic events that lead to social and economic uncertainty. They momentarily impact neighboring countries and the global economic system, vacillating from monetary and financial desolation to loss of production abilities, public income, and wealth. After World War II, the tendencies in the energy sector shifted from coal to crude oil and piped natural gas. Both took a vast proportion of

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Western Europe's domestic and industrial strength (Swart, 1992). The first oil crisis occurred in 1972. Since then, there have been unstable swings in the prices of oil and natural gas. The effect of war on financial markets has been a less researched topic among scholars. Some of the pertinent wars of the twentieth century are the World War I (1914–1918), the World War II (1939–45), the Korean warfare (1950–1953), and the Persian Gulf battle (1990–1991). Some of the wars within the 21st century have been the warfare in Afghanistan (2001–2014), the US invasion of Iraq (2003–2011), the Syrian Civil War (2011–ongoing), and the Russian invasion of Ukraine struggle (2022–ongoing).

Wars are geopolitical threats that have a broader effect than terrorist attacks. Geopolitical threats especially play a significant role in causing the volatility experienced in global oil markets. Oil prices are liable to excessive volatility as considerable rate modifications are commonly required to re-establish equilibrium between demand and supply after geopolitical shocks (Lee et al., 2021; Vijayakumar & Karthikeyan, 2024). Past literature has concentrated on the impact of wars and crises on equity stock markets (Abbassi et al., 2023; Boubaker et al., 2022; Hudson & Urquhart, 2015; Li et al., 2022; Syed et al., 2021; Yousaf et al., 2022). Past literature has tested the effects of warfare on commodity costs (Adekoya et al., 2022; Vasileiou, 2022; Wang et al., 2022). A few have examined the impact of geopolitical dangers, like terror assaults on commodity markets (Antonakakis et al., 2017; Drakos, 2010). A few studies have explored wars' impact on natural gas, e.g., Brown (2003) and Goncharuk et al. (2021). Goncharuk et al. (2021) observed the impact of natural gas on industrial production during the hybrid war between Russia and Ukraine from 2006 to 2019. It is observed that natural gas prices are closely linked to crude oil and coal prices (Gatfaoui, 2016; Nick & Thoenes, 2014). Many authors have tested uncertainty (Bilgin et al., 2018; Sharif et al., 2020) and geopolitical dangers as the driving forces for commodity costs (Antonakakis et al., 2017; Gkillas et al., 2020).

This study focuses on wars impacting crude oil, refined form derivatives, and natural gas. We mainly focus on energy commodities, such as heating oil, gas oil, and gasoline. The two major oil trading benchmarks used for oil trading contracts, futures and derivatives, i.e., West Texas Intermediate crude oil prices (WTI) and Brent blend crude oil prices exhibited extreme uncertainty and co-moved closely throughout two Gulf wars (Yang et al., 2020). Food inflation progressively rose due to the sharp increase in crude oil and natural gas. This ravaged most economies only some days into the onset of the Russian-Ukraine war (Mbah & Wasum, 2022). The research paper examines the volatility driving financial energy commodity prices during war-related crises.

Geopolitical issues, such as sanctions, extra storage of energy sources, and hedging against crises using particular instruments, are specifically visible in the energy commodity market. Analyzing the impact of the crisis on the commodity market has become increasingly important in helping commodity markets adapt to sustainable crisis mitigation. Financial markets can solve their problems quickly and efficiently, making it a practical and relevant solution. The authors, however, noted that effective instrument building can only be achieved by capturing all commodities together in the form of an index, and later, the same index will help investors to plan against the severity of a war event.

Sun's (2022) study on the effects of wars on oil prices has studied the impact of the first and the second Gulf wars on Brent and WTI crude oil prices and the way ahead for these crude oil prices during the ongoing Russian-Ukraine war. However, their study has not examined other oil forms like natural gas, heating oil, RBOB oil, and other variants. Their analysis indicated that crude oil prices will be lower during the ongoing Russian-Ukraine war. However, an impact assessment and trend of the prices or an index has not been made. Since this study does not suggest the possible lower and upper bound of the prices, this research is of limited practical use for traders and speculators to take positions in the commodity markets.

In contrast, our study, which creates a comprehensive index of all six essential energy commodities, measures the index and predicts the following year's prices from July 2024 to July 2025. The study will further provide a valuable guide for traders and speculators. This research article aims to construct a composite energy commodities index and test the impact of wars of varying lengths on energy commodity prices. We look at the preceding wars, such as the Gulf struggle of 1990–1991, which we classify as a short war. We take a protracted conflict, namely the US invasion of Iraq, which lasted from 2003 to 2011. We analyze the impact of those wars of various duration on the commodities markets and use the consequences to predict the effect of the continued warfare due to Russia's invasion of Ukraine on commodity prices.

Literature Review

Past Studies on War

Impact of Longevity on Oil Prices

Augmented oil expenses are the effect of imperiling the supply of energy. Past research advises that geopolitical dangers and threats impact crude oil futures returns (Zhang et al., 2022). The Persian Gulf War in 1991 lasted for one and a half years. The beginning of the war saw oil prices spike by 90% in terms of US prices. However, the prices plummeted fast. It was observed that the price spike dissipated quickly underneath the short-war situation. The world oil rate fell under baseline as soon as the war was over. It has been termed a "war premium" by McKibbin and Stoeckel (2003). According to their study, a short oil price shock and a quick increase in prices of energy commodities from a short war are either small or modest, but they do compound.

Under a protracted war situation, a sustained upward thrust in oil prices has a more negative impact than in a short war scenario (McKibbin & Stoeckel, 2003). Leigh et al. (2003) investigated the price of crude oil during the US invasion of Iraq in 2003. Their study found that a prolonged conflict raised oil prices by around $10 per barrel. These expanded prices implied that markets predicted significant immediate disruptions to burn out quickly, with prices returning to pre-war levels within approximately a year and a half. Consequently, they predicted the oil rate effects of war to cause brief-run economic disruption. Still, they found little evidence that there may be a meaningful lengthy-run oil dividend. Antonakakis et al. (2017) conducted a comprehensive study covering more than 100 years, from 1899 to 2016, to find the effect of geopolitical risks on the oil-stock nexus. They observed that oil prices tend to be more negatively impacted by geopolitical tension in comparison to the stock price indices. Wang et al. (2023) found oil price volatility to be asymmetric. Adverse shocks can cause larger volatility, whereas extreme positive shocks of the same magnitude have enhanced minor effects. Lee et al. (2021) employed a geopolitical threats index to observe threats of war, terrorism, and ethnic and political violence to predict volatility in worldwide oil prices. Their study revealed that geopolitical danger impacts oil returns and volatility. Iglesias and Rivera-Alonso (2022) compared the impact of the longevity of wars and terrorist threats with economic/financial crises on oil prices. They found the Gulf War of 1990–1991 and the 2001 terrorist attacks on the US erratic and produced periods of demand/supply crises of oil disruptions.

Meanwhile, intervals in which the leading cause was economic/financial crises have been associated with better volatility persistence in oil prices. The Gulf Wars substantially influenced the dynamics of oil prices, as both conflicts resulted in price surges and heightened volatility (Lee & Cheng, 2007; Sun, 2022). Oil prices increased twice during the First Gulf War but promptly reverted to their pre-war levels with the restoration of peace (Miller & Zhang, 1996). Price increases were also observed during the Second Gulf War, although the correlation between crude oil and gasoline prices was comparatively weaker than in the first battle (Lee & Cheng, 2007). The price increases caused by the war were temporary, and their long-term effects were not as severe as the early sharp rises indicated (Miller & Zhang, 1996). The consequences of these conflicts have generated turmoil in global petroleum markets, leading Gulf nations to reorganize their development strategies and possibly affecting their long-term economic stability (Looney, 1992).

Studies on the Russia- Ukraine 2022 Warfare on Commodity Prices

Russia is the leading oil and gas manufacturer in the world. The worldwide restrictions have led to an increase in the rate of fuel and oil and limited their production. Oil and gas prices amplified due to Russia's invasion of Ukraine in 2022, causing accelerated global gasoline costs (Pisani-Ferry, 2022). Wang et al. (2022) studied the impact of Ukraine and Russia's war on commodities, mainly crude oil, metals, and soybean. The overall volatility spillover accelerated from 35% to 85%, exceeding the extent seen at some point in the pandemic. Crude oil becomes a net transmitter of spillovers. Excessive volatility in returns is related to high ranges of geopolitical risks. Adekoya et al. (2022) studied the connectedness between oil, bonds, bitcoin, the US dollar, gold, and stocks throughout the Russian-Ukraine conflict. They observed that connectedness is stronger during the war than before it. Oil turns into a net transmitter of spillovers during the war, unlike in the pre-war scenario when it was characterized as a net receiver of spillovers. Oil had a substantial spillover on bitcoins, the US dollar, gold, and equity stocks throughout the war. However, the spillover impact is transitory, as it dies over time.

Vasileiou (2022) explored the impact of the Ukraine-Russia war on the future prices of Brent oil, wheat, and natural gas commodities. The acute situations show an anti-leverage effect in wheat and natural gas, which is an abnormality. The terrible news of the conflict moves the prices of these commodities upwards, and the prices have a positive co-movement with volatility. Inacio Jr. et al. (2023) found that the impact of the Russian-Ukraine war had been more on European than US diesel prices. Estrada et al. (2020) found that the Russian-Ukraine war created significant shocks in natural gas prices. The ongoing conflict between Russia and Ukraine has had a remarkable effect on worldwide oil prices, resulting in substantial surges and instability in the market (Zhang et al., 2023; Zhang et al., 2024). Previous research has demonstrated that geopolitical conflicts, such as the Gulf Wars and the Russia-Ukraine war, can significantly influence the volatility of crude oil prices (Appiah-Otoo, 2023; Sonia & Narwal, 2023; Sun, 2022). The transmission of the war's effect on oil prices occurs through several channels, such as speculative processes, fluctuations in inventory levels, and imbalances between supply and demand (Zhang et al., 2023). Extensive quantitative studies have shown that the conflict between Russia and Ukraine was responsible for more than 70% of the variations in oil prices over the time under investigation. This event led to 52–56% price hikes for WTI and Brent crude oil (Zhang et al., 2024). In order to alleviate these consequences, scholars suggest implementing emergency management systems, expanding foreign oil imports, promoting energy transition, and employing financial instruments for risk mitigation (Appiah-Otoo, 2023; Zhang et al., 2024).

Preparedness of Commodities Markets in the Course of Post and Pre-War

Iran-Iraq cooperation within the oil and fuel zone took shape after the 2003 battle as relations improved between the two countries, with the assumption of power and the aid of a Shia-led government in Baghdad. The two Persian Gulf countries recognized the significance of the joint development of cross-border oil fields (Aishwarya, 2017). EU has been operating on decreasing its dependency on Russia for its natural gas needs. They formed a commission in 2014 in response to possible disruption, expanded their natural gas stocks and switched to alternative fuels within a brief period, and grew similar cooperation with gasoline suppliers and transmission gadget operators to identify possible resources for short-term extra resources (Prisecaru, 2022). In 2019, oil and gas imports from Russia to the EU were worth Euro 200 billion each, twice the forex reserves in G7 countries at the end of 2021 (Pisani-Ferry, 2022). An embargo on Russian oil imports drove up prices in the global marketplace, hence inducing the delivery shock, which may be mitigated by undertaking alternative trade with supplementary suppliers.

Recent research has examined how the conflict between Russia and Ukraine has affected the financial and commodity markets. The conflict has substantially impacted the prices of energy, metal, and agricultural commodities, while the consequences have varied among different markets (Chishti et al., 2023). Significant price volatility and heightened volatility were observed in energy markets in crude oil and natural gas (Li et al., 2022). The conflict has also impacted the efficacy of commodities markets, making some markets more efficient while leaving others to be more efficient (Adu & Idakwoji, 2024). European stock markets exhibited heightened responsiveness to changes in commodity prices during the conflict (Li et al., 2022).

Existing World Energy Indices

The authors have compiled a list of available world energy indices in Table 1. Each index is unique in its choice of commodities and construction methodology. The authors propose a new World Energy Commodity index based on the advantages of its construction and choice of assets inspired by the available indices.

Table 1. ***World Energy Commodity Indices***

S. No.	Index Name	Definition	Inception	Energy Commodities Included in the Index	Methodology
1	Thomson Reuters Core Commodity Index (CRB)	19 Commodities sorted into four groups, with different weightings: **Energy: 39%,** Agriculture: 41%, Precious Metals: 7%, and Base/ Industrial Metals: 13%.	1957 Reconstructed in 2005	Crude Oil Heating Oil Natural Gas RBOB Gasoline	Arithmetic average of commodity futures prices with monthly rebalancing. Price-weighted methodology.
2	Rogers International Commodity Index-Energy (RICI)	The value of a basket of 38 commodity's future contracts includes agricultural, energy, and metal products.	1998	Brent Crude Oil Gas Oil Heating Oil Natural Gas RBOB Gasoline	The sum of adjusted Daily Contract Prices (DCP) multiplied by their respective Monthly Contract Weights (MCW). Price-weighted methodology.
3	Bloomberg Commodity Index (BCI)	The Bloomberg Commodity Indexes comprise exchange-traded commodity futures contracts of 20 commodities.	1999	Gas Oil Heating Oil Natural Gas (NG.) Crude (Brent) Crude (WTI)	Price Weighed methodology.
4	S&P GSCI	The index includes 24 liquid commodity futures and provides diversification with low correlations to other asset classes.	1991 (S&P took ownership in 2007)	WTI Crude Oil Heating Oil RBOB Gasoline UK Brent Crude Oil Gasoil ICE Natural Gas	The S&P GSCI consists of 24 commodities, which are weighted by 5-year averages of their annual production volumes. Value-weighted

					methodology.
5	S&P GSCI- energy	Sub-index of S&P GSCI Index	2013 (as per investing.com)	WTI Crude Oil Heating Oil RBOB Gasoline UK Brent Crude Oil Gasoil ICE Natural Gas	Value-weighted methodology.

Source : Authors' compilation from individual *Handbooks of Indices.*

Energy commodities significantly impact our daily lives as they are related to electricity and heat. It is indispensable for human lives and makes an excellent investment for those willing to invest in commodities. Oil and natural gas are the primary energy commodities influencing the global economy's fuel prices. Crude oil is the undisputed champion in the energy market. The current research contributes to the literature in several approaches. We take a look at the impact of conflict on six commodity indices of widespread uses—Brent crude oil (benchmark used for more comprehensive light oil in Europe, Africa, and the Middle East), WTI crude oil (West Texas Intermediate—the benchmark used for more comprehensive light oil in the US), and natural gas (top producers being the USA, Russia, Iran). Crude oil is refined into various products, such as gasoline, diesel, jet fuel, and heating oil. RBOB Gasoline, Reformulated Gasoline Blend stock for Oxygenate Blending, is a motor gasoline blending component intended for blending with oxygenates to produce finished reformulated gasoline. Heating oil is any petroleum product or other oil used for heating. It is a fuel oil that most commonly refers to low-viscosity grades of fuel oil used for furnaces or boilers for home heating and other buildings. Gas oil is a fuel that is cheaper than regular diesel due to the rebated fuel used for heating, rail transport, and the agricultural sector.

World Energy Commodity Index — Instrument Design

WECI : Data and Methodology

An index is an economic barometer; it maps the changes based on similar assets' overall performance. Commodity indices play a central role in passive commodity investing. However, a closer look at commodity indices reveals considerable differences in construction and weighting. For stock market indices, on the other side, weighting is generally based on the market capitalization of an asset, according to the capital market theory. In contrast to this sound theoretical and practicable basis for stocks, there needs to be more commodity indexation. Therefore, in line with the classical capital market theory, we present a novel approach to determining a simple war energy commodity index.

There are considerable differences in the selection of commodities and their weightings observed. The authors have proposed constructing the War Energy Commodity Index (WECI), a composite index of six major energy commodities using future contract prices from June 1990 to July 2024. Authors have collected monthly futures prices of Crude-WTI, Crude-Brent, natural gas, RBOB Gasoline, heating oil, and gasoil data from June 1990 to July 2024 (410 observations) from open sources readily available through www.investing.com. The WECI is constructed using an equal risk contribution methodology (ERC) weighted approach based on the futures prices of six energy commodities. An equal risk contribution index offers a higher level of diversification because each constituent has an equal contribution to the overall risk of the index. This methodology differs from the equal weight or naïve weightage or the equal weight methodology, which gives equal weights to all commodities in the index. The ERC method is also different from the price-weighted index construction methodology. A price-weighted index may be more skewed in favor of assets that have higher prices, as the constituents are weighted based on their prices. The volume-weighted average pricing (VWAP) index introduces basis risk. It encourages manipulation because of the additional randomness in volume weight and the more significant price impact the prominent trader enjoys.

The Brent benchmark is used for more comprehensive light oil in Europe, Africa, and the Middle East. West Texas Intermediate is the US benchmark for more comprehensive light oil. Natural gas's top producers are the USA, Russia, and Iran. WECI excludes coal, as the study focuses on internationally most used forms of energy sources.

Equal Risk Contribution Methodology for Index Creation

Maillard et al. (2009) presented the equally weighted risk contribution strategy or ERC. In this method, every portfolio component contributes the same quantity to the overall risk ensuing. The maximum hard preference is choosing the proper chance measure to assess the risk contributions. Many authors have used the standard deviation, together with Maillard et al. (2009), Linzmeier (2011), and Stefanovits (2010), defining the standard deviation and the square of the standard deviation, i.e., the variance, as a measure of risk while calculating the weights of the different components in a portfolio. Ahn and Six (2019) compared the commodity indices constructed by Standard & Poor's equal weight (EW) and equal risk contribution (ERC) index with the GSCI & Bloomberg Commodity Index (BCOM) from August 1970 to August 2017, covering 565 monthly returns. They add to this new generation of commodity index creation by constructing a Global Minimum Variance commodity index (GMV). They found that ERC weighting performs second-best in terms of volatility after the GMV method. The original commodity market indices—GSCI & BCOM—perform poorly in volatility, with lesser Sharpe ratios and higher correlations with the equity markets.

A new mean-free strategy can provide equal risk contribution (ERC) through a risk parity approach. The risk contributions of all assets will be such that the portfolio will be fully diversified from a risk perspective (Maillard et al., 2009). The strategy allocates the weights based on the assets' volatilities and correlations, ensuring that each asset contributes equally to the overall portfolio risk. It provides a systematic way to balance risk across assets and can help manage downside risk and improve portfolio stability.

Let the risk of portfolio x be measured by $R(x)$ and the risk contribution of asset i be represented as $C_i(x)$. Then, as per the definition, it is held that $\sum_{i=1}^{N} Ci(x) = R(x)$. If the variance of its return measures the portfolio's risk, then $R(x) = x^T Qx$ and $Ci(x) = xi(Qx)i$, where $(Qx)i = \sum_{j=1}^{N} Qijxj$. Similarly, if we use the standard deviation of the return as the risk, it will yield.

$$R(x) = \sqrt{(x^T Qx)} \text{ and } Ci(x.) = (xi(Qx)i)/(\sqrt{(x^T Qx)}) \text{ ....Eq. (1)}$$

An ERC portfolio x^{ERC} satisfies the following:

$$Ci(x^{ERC}) = (R(x^{ERC})/N) \textit{ for } i = 1,2,\ldots N \text{..............................Eq. (2)}$$

Since $xi(Qx)i = (xi(Qx)i/N)$ if and only if

$$\frac{xi(Qx)i}{\sqrt{(xTQx)}} = \frac{\sqrt{(xTQx)}}{N} \text{ ....Eq. (3)}$$

In an ERC portfolio, one considers only the variance risk measure, recognizing that all results will be applied equally to the standard deviation (Mausser & Romanko, 2014). In our WECI-ERC index construction, the six commodities are first assigned random weights with the sum constraint kept to 1, with non-negativity constraints.

The variance of the monthly returns of the index is calculated using the random weights. The random weights are multiplied with the variance-covariance matrix of the individual asset returns. After that, these multiplied weights are divided by the total variance. Lastly, the deviation of the multiplied weights divided by the total variance is calculated from an equal weight of 1/6. The sum of the deviations is minimized using the MS Excel Solver function with the GRG non-linear method. The answer resulting from the solver function is equal risk contribution weights for all six assets. This procedure is repeated 20 times for every 20 months.

Since the number of observations was 410, close to 400, the index weight was rebalanced for every 21st month. This activity resulted in fresh weight generation 20 times. After the weights were generated, they were multiplied by the respective commodity prices. This procedure was done for the entire data set, resulting in a simulated ERC-based index.

Keeping the base month as June 1990, i.e., assigning a value of 100 to June 1990, the rest of the index was calculated by the given formula:

$$ERCWECI = \sum \frac{Index\ Value\ in\ Month\ i}{Index\ Value\ on\ Base\ Month} * 100 \quad \text{Eq. (4)}$$

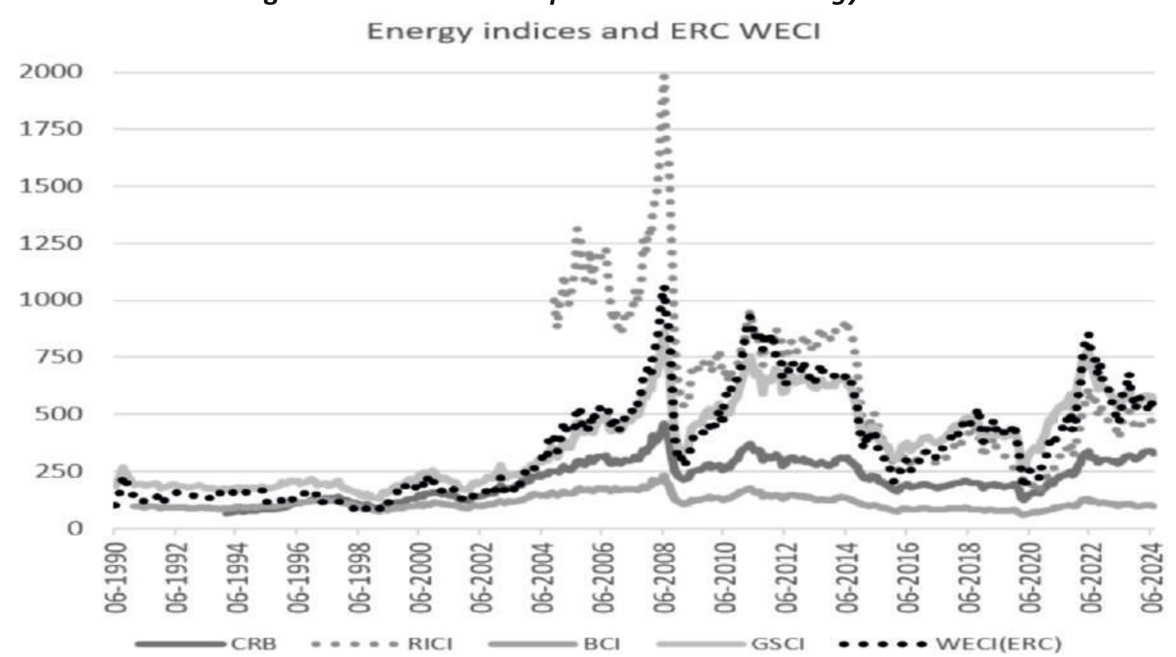
where i varies from July 1990 to July 2024 (We lose June 1990 value, as we convert the prices in lognormal returns or first differences).

Model

ERC-WECI

WECI shows high volatility in November 2003 and May 2008, May 2011 to May 2015, and May 2020 to May 2023 (Figure 1). In these war periods, the figures indicate that when wars erupt, prices become volatile, but as wars

Figure 1. ***ERC WECI Juxtaposed with Other Energy Indices***



finish, the index is resilient and comes to the same level (in line with McKibbin and Stoeckel (2003)) as war premiums.

Why Adopt WECI?

The GSCI energy index was created after 1990. Hence, it cannot be used for mapping the First Gulf War. We see a high standard deviation in the GSCI index compared to WECI (Table 2). Moreover, the GSCI index has 54% energy commodities; the rest are non-energy commodities. The GSCI index is based on the volumes of future contracts. It will roll over the future contacts to next month. Future contracts can be affected by contango and backwardation, which regular commodity prices are not. Hence, the volume-weighted methodology of the GSCI Index needs to be revised. Our index WECI is found to be independent of volumes, is composed of six energy commodities, and has a higher mean, lesser kurtosis, and lesser skewness as compared to the GSCI (Table 2); hence, in this paper, we use the WECI to capture the impact of the three wars—Gulf war, Iraq war and Russo-Ukraine war.

Model Testing and Forecast

The index created was subjected to VAR (Vector Auto Regression) with dummy variables for three wars. As per the Lag Criterion procedure, SQ (Schwarz criterion) and HQ (Hannan-Quinn criterion) say that two lags should be used, but AIC (Akaike info criterion) says that three lags should be used. Table 3 (using Least Square Multiple

Table 2. ***Descriptive Statistics of S&P GSCI and ERC WECI***

	GSCI	ERC WECI
Annualized Mean	67.56%	103.87%
Annualized St. Dev.	99.09%	162.58%
Skewness	–0.76	–0.65
Kurtosis	3.62	3.55

Table 3. ***Multiple Regression Dependent Variable–ERC–WECI Index***

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
Intercept	8.442024	3.681195	2.293283	0.0223
Lag of 1-month WECI	1.196602	0.048674	24.58413	0.0000
Lag of 2-month WECI	–0.227228	0.048214	–4.712896	0.0000
Dummy Variable of Gulf War	–4.753656	14.73203	–0.322675	0.7471
Dummy Variable of Iraq War	11.23741	4.907979	2.289620	0.0226
Dummy Variable of Russia-Ukraine War	9.228900	8.094617	1.140128	0.2549
R-squared	0.971842	Mean dependent var	366.3096	
Adjusted *R*-Squared	0.971492	SD dependent var	227.1574	
SE of Regression	38.35412	Akaike info criterion	10.14620	
Sum Squared Resid	591357.5	Schwarz criterion	10.20519	
Log-Likelihood	–2063.824	Hannan-Quinn criterion	10.16954	
F-Statistic	2774.915	Durbin-Watson stat	2.045515	
Prob. (*F*-Statistic)	0.000000			

Table 4. ***Wald Test***

Equation: Untitled			
Test Statistic	**Value**	***df***	**Probability**
F-statistic	47.37404	(5,402)	0.0000
Chi-square	236.8702	5	0.0000

Null Hypothesis:

C(1) = *C*(2) = *C*(3) = *C*(4) = *C*(5) = *C*(6)

Where, *C*(1) = coefficient of intercept, *C*(2) = coefficient of lag of 1-month WECI, *C*(3) = coefficient of lag of 2-month WECI, *C*(4) = coefficient of Gulf War, *C*(5) = coefficient of Iraq War and *C*(6) = coefficient of the Russia - Ukraine war.

Table 5. ***Null Hypothesis Summary Table***

Normalized Restriction (= 0)	Value	Std. Error
C(1) – *C*(6)	–0.786876	8.457168
C(2) – *C*(6)	–8.032298	8.098782
C(3) – *C*(6)	–9.456128	8.094770
C(4) – *C*(6)	–13.98256	16.68728
C(5) – *C*(6)	2.008505	8.020264

Note. Restrictions are linear in coefficients.

Regression) shows that lag 1 is statistically significant at the 1% level. Lag 2 is statistically significant at the 1% level. It can be concluded that immediate past months and two months back data affect the present variables. Lagged second-month prices neutralize the present prices with a negative effect. Observing the dummies for wars, only the dummies for the Iraq war are statistically significant at 5%. The Gulf War and the Russia-Ukraine War do not affect this broad index. Short-term wars have no impact on the index. Only long, continuous wars have an impact on this index. The model has no autocorrelation as Durbin Watson is close to 2. Breusch-Godfrey Serial Correlation LM Test also accepts the null hypothesis that the model has no autocorrelation. However, as the index shows high fluctuation, a few outliers result in data not being normally distributed. Jarque Bera rejected the null hypothesis that data is normally distributed, which is the limitation of this index. Data is not normally distributed because of certain outliers due to dummies.

The Wald test results (Tables 4 & 5) suggest accepting the alternate hypothesis as the coefficients differ. This hypothesis can hence be used in model building and making future forecasts. Figure 2 shows residuals fall within the range of 5%, meaning data is suitable for analysis.

Forecast for the Next 12 Months

Using the model

Index = *f*(lag1, lag 2, and lag 3, D1, D2, and D3) and assuming that war may continue for another 12 months, WECI is expected to be as follows:

WECI = 8.44 + 1.196*1-month WECI lag value – 0.227*2- month WECI lag value – 4.754*gulf war + 11.237*Iraq war + 9.229*Russia-Ukraine war

Figure 2. *CUSUM Test*

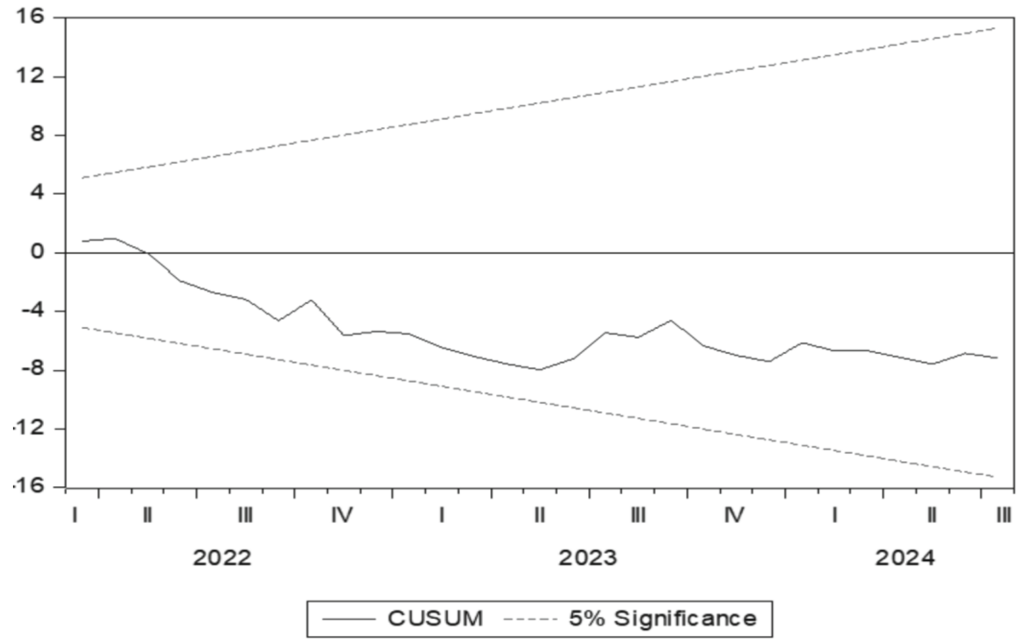


Table 6. *Forecast for the Next 12 Months*

Aug-24	538.9053
Sep-24	539.8813
Oct-24	541.2203
Nov-24	542.599
Dec-24	543.9449
Jan-25	545.2427
Feb-25	546.4906
Mar-25	547.6896
Apr-25	548.8415
May-25	549.9481
Jun-25	551.0112
Jul-25	552.0324
Aug-25	553.0135

It is a dynamic model and not a static model. The forecasted WECI values for the forthcoming 1 year are predicted and tabulated in Table 6. The forecast is made on the assumption that the ongoing war between Russia and Ukraine will continue at least till August 2025.

Conclusion

The study compares the performance of world energy commodities created by an equal risk contribution index methodology. The created index is studied with wartime response, offering insights for market participants. The composite index comprises six energy securities—Brent crude oil, WTI crude oil, natural gas, heating oil, gasoil, and RBOB gasoline. This index guides optimal trading through regression modeling. It is observed that when wars erupt, prices are volatile, but as the war subsides, the index falls to its original levels. Only medium-term wars have a statistically significant impact on indices. The findings align with the study of McKibbin and Stoeckel (2003), which found that a short oil price shock and a quick upward thrust in uncertainty from a short war are either small or modest; they compound and get absorbed in the equilibrium prices.

Minor wars or major continuous wars lose their impact. Volatility is high when wars start, but volatility subsides as soon as wars finish. As the immediate volatility is high during the war, the kurtosis of the data is high, leaving many outliers and non-normality in data. This index can be used with future dummies for war to forecast the prices. By incorporating dynamic rebalancing and considering the associated costs and constraints, future studies can provide valuable insights into the effectiveness of active portfolio management and the potential for further enhancing the accuracy of energy prices.

Implications

This study offers multiple implications for industry practitioners, investors, economic agents, and scholars. Industry practitioners will benefit from being able to predict energy commodities prices. Economic agents and index providers are encouraged to consider an index based on ERC because our study encourages them to invest in commodity indices based on equitable risk participation. Investors may assess the volatility concerning investments in energy commodities and improve their decision-making. Researchers propose broadening this investigation by including dynamic rebalancing and considering the related expenses and limitations. Subsequent studies have the potential to yield valuable findings regarding the efficacy of active portfolio management and the possibility of further refining the precision of energy prices.

Limitations of the Study and Scope for Further Research

This study has some limitations, including its reliance on only six commodities to construct the energy commodity index; incorporating additional commodities might offer additional insights. A future study may explore other dimensions using additional commodities and related variables. Furthermore, the WECI in this study is developed utilizing an equal risk contribution (ERC) weighted technique grounded in the futures prices of six energy commodities. The authors have not assessed alternative methods in this context, which may also include volumes of the assets in index construction. Future studies may utilize alternative methods and examine their impact on volatility. Scholars may consider applying the WECI approach outlined in this study to expand the investigations by integrating dynamic rebalancing and considering the limitations in their future research endeavors. Future studies may produce significant insights into the effectiveness of active portfolio management and the opportunities for improving the precision of this approach beyond energy commodities.

Authors' Contribution

Dr. Nupur Gupta conceived the idea and developed qualitative and quantitative designs for the empirical study. Dr. Nupur Gupta extracted research papers of high repute, filtered them based on keywords, and generated concepts and codes relevant to the study design. Dr. Jagdish Kumar Sachdeva verified the analytical methods, supervised the study and conducted the econometric investigations using R studio. Dr. Nupur Gupta constructed the War Energy Commodity Index using MS Excel with solver add-ins after carefully reviewing the index construction methodology, which Dr. Akshay Kumar Mishra validated. Dr. Nupur Gupta wrote the manuscript's first draft and conducted the visualization of the charts in consultation with both authors. Dr. Akshay Kumar Mishra finalized the final draft of the research paper.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

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