



# Oil price volatility and oil-related events: An Internet concern study perspective



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## HIGHLIGHTS

- The impact of four types of oil-related events on oil price volatility is analysed.
- Internet concern is introduced to identify the magnitude of the market response.
- The cumulative abnormal returns of oil prices induced by events present significant.
- Oil price presents different effects in response to various oil-related events shocks.
- The role of information in influencing oil price volatility has been verified.

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## ABSTRACT

Oil-related events have increased the uncertainty and complexity of the worldwide oil market. This paper investigates the effects of four types of oil-related events on world oil prices, using an event study methodology and an AR-GARCH model. The Internet information concerning these events, which is derived from search query volumes in Google, is introduced in an analytical framework to identify the magnitude and significance of the market response to oil-related events. The results indicate that world oil prices responding to different oil-related events display obvious differentiation. The cumulative abnormal returns, which reflect the influence of the global financial crisis, tend to drop first and then reverse and rise, while the cumulative abnormal returns induced by other oil-related events present a stronger persistent effect. The impact of the global financial crisis on oil price returns is significantly negative, while the impact of the Libyan war and hurricanes is significantly positive. However, the reactions of oil price returns to different OPEC production announcements are inconsistent.

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## 1. Introduction

Crude oil is the most traded commodity in the world and its price volatility has great influences on macroeconomic activities, which has been widely analysed in the previous literatures [1,12,32]. Since 2004, the frequency and extent of the volatility in international oil prices have been augmented [14,20]. Due to the commodity boom started around 2004, international oil price rose steadily until 2008. Especially, the crude oil price doubled from June 2007 to June 2008 and reached a record near \$147 per barrel in July 2008. Subsequently, the crude oil prices had fluctuated in a wild roller-coaster ride and collapsed below \$33 within the next few months, dropping 70% from its peak, which indicates that oil prices are more volatile. After the 2008 financial crisis, the oil market pricing mechanism had been disrupted by uncertain

external macroeconomic situations. During this period, most of the huge oil price changes were caused by oil-related events that can be viewed as shocks to the oil industry. According to the previous researches, the oil price trend in the long term is finally determined by oil supply and demand, while events and speculation activities can amplify the oil price volatility and increase instability of oil market. The influence of events on oil prices is implemented by affecting oil supply and demand conditions and market participants' psychological expectation. Consequently, the degree of the volatility in oil prices has exceeded the extent to which it can be explained by fundamental factors. Oil prices have become more sensitive to the occurrence of oil-related events, such as wars, the release of OPEC production quota decisions, oil stock fluctuations and extreme weather [2,7,18,35]. Moreover, oil market analysts tend to incorporate information about these emergency events into their judgments and predictions of oil price changes. For example, Hamilton [15] argues that three events that occurred from 1973 to 2007 (the Iranian revolution in 1978, Iraq's

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invasion of Iran in 1980 and Iraq's invasion of Kuwait in 1990) resulted in the disruption of the flow of oil from key global producers. This indicates that many oil price shocks initially induced by largely exogenous oil-related events can increase the short-term price volatility by influencing the balance between oil supply and demand. Therefore, further research into the effects of various oil-related events is vital to understanding how the oil market reacts to extraordinary uncertainty. This research can provide complementary explanations for unexpected oil price changes that cannot be attributed to fundamental factors.

The literature on the effects that oil-related events have on oil prices has focused on two primary issues: production announcements of OPEC conferences and wars. Some studies have focused on the influence that production decisions published by the OPEC conferences have on oil price changes [e.g. 7,8,11,13,19]. Kaufmann et al. [24] indicates that OPEC has considerable power over prices, via decisions about OPEC quotas, production and operable capacity. Wirl and Kujundzic [33] compare the changes in crude oil prices before and after the OPEC announcements, and conclude that OPEC's impacts have weakened. Lin and Tamvakis [26] use event study methodology to examine the effects of OPEC announcements on major crudes, and several other heavy and light grade types of oil, and find differentiation in the magnitude and significance of the market responses to OPEC's quota decisions. Schmidbauer and Rosch [31] investigate the impact of different OPEC announcements on the expectation and the volatility of daily oil price changes.

Some studies have verified that wars are another main origin of shock, seriously impacting oil price volatility, which induced the three oil crises. Zhang et al. [35] employ the EMD-based event analysis approach to investigate the effects of the Persian Gulf War and the Iraq War on oil price volatility. Fan and Xu [9] investigate the drivers of oil price changes and use dummy variables to describe the effects of the 9/11 attacks and the Iraq War, indicating that these two episodic events became the main driving factors for oil price changes from 2000 to 2004. Moreover, some researchers have added other related events to their research on the oil market. Actually, many studies have been focused on the impacts of oil price shocks on macroeconomic variables and other markets [e.g. 20,27,34], while economic recession can also exert its specific influence on the oil market by changing the oil supply–demand balance. Hammoudeh and Li [16] find that the Asian crisis has weakened the long-term relationship between oil spot and futures prices. Coleman [6] uses dummy variables to examine the effects of major events on oil prices, including the Asian crisis, the Kuwait invasion and the PDVSA strike. That study finds that major events cause significant perturbations in oil prices. Blair and Rezek [2] use an error correction model to investigate the effects of Hurricane Katrina on price pass-through for gulf coast gasoline. Hanabusa [17] examines how certain disasters, such as the terrorist attacks, Iraq War and Hurricane Katrina, have affected the stock prices of the Japanese petroleum industry. There is also some literature focused on the impacts of the Gulf of Mexico hurricanes on oil production [e.g. 21–23].

According to the study findings presented above, the research on the effects of oil-related events on oil price volatility is limited and centralised. The main reasons that the influence of oil-related events on oil price volatility is investigated are twofold. First, oil market has entered an era of higher crude oil volatility. Oil-related events have played an important role in inducing market price uncertainty and have been brought forth to explain extreme movements in oil prices. These events usually occur suddenly and lasts a very short time, which lead to a particular channel to induce volatility. However, empirical findings on whether crude oil price movements are significantly triggered by oil-related events are still not enough. Second, the events selected in this paper are closely related to the oil market which had been verified in previous liter-

atures. Our empirical results have further proven that oil price returns and volatility have significant responses to oil-related events. Therefore, it is important to measure the effects of events on oil prices. In addition, the effects of the events are usually measured using dummy variables in the analysis models, in which information loss is inevitable. Hence, that approach becomes a bottleneck used to describe the events intrinsically, including their magnitude and the influence of the top-down changes. In fact, market-related events exert their effects via changing the behaviours of the market participants. So, to some extent, the evolution and dynamic influence of certain events can be better depicted by tracking and recording human behaviour on a larger scale.

Nowadays, many human activities leave a digital fingerprint, like credit card transactions, Web activities and e-commerce, and growing electronic traces makes it possible to extract market-related behaviour visually, which has bred a new data-oriented research field called the Mathematical Methods of Computer Science [29]. In the financial field, it has been proven that there are some useful indicators of the sentiments on Twitter that can contribute to predicting stock prices [3]. Bordino et al. [4] reveal the existence of a positive correlation between today's stock-related Web search traffic and the trading volume of the same stocks in subsequent days. Mao et al. [29] perform a comparison of the predictive relationships between different mood indicators and the Dow Jones Industrial Average index, trading volumes and market volatility. Furthermore, Rao and Srivastava [30] study the forecasting models using large scale micro-blog discussions and search behaviour data. Their results show that human behaviour traces on the Web can provide good insights, enabling a better understanding of the market's movements in oil, gold, forex and stock. Obviously, financial market analyses on the basis of online sentiment tracking have drawn a lot of attention in recent years, and this research has extended from stock markets to commodity markets. However, the research that measures oil-related events using Internet concerns is scarce.

The query volumes on a Web search engine are excellent indicators of public concern, which could be quantitative measures of oil-related events. Therefore, this paper investigates the information transmission between oil price changes and Internet concerns for three different types of oil-related events, in which the data is derived from search query volumes in Google, using event study methodology and an AR-GARCH model. In this way, this paper offers a new perspective for analysing the influence of event shocks on oil price volatility. This approach has a competitive advantage in that it measures the magnitude effect of events with the time series of Internet concern, instead of considering the events as dummy variables whose values are restricted to 0 or 1.

The next section provides details about the data and the selected oil-related events. Section 3 introduces the methodology used in this study. The empirical results are presented in Section 4, and finally, the conclusions are given in Section 5.

## 2. Data and oil-related events

This paper investigates the effects of different oil-related events on oil prices. According to the classification previously proposed [15,25], the origins of oil price shocks are divided into three groups: supply-side shock, aggregate demand shock and precautionary demand shock<sup>1</sup>. This paper discusses four main oil-related

<sup>1</sup> The origins of oil price shocks are classified by identifying the different path and mode that variables can influence oil supply and demand. According to Kilian [25], oil supply-side shocks are shocks to the current physical availability of crude oil; aggregate demand shocks are shocks to the current demand driven by fluctuations in the global business cycle; and precautionary demand shocks arise from the uncertainty about shortfalls in the expected supply relative to the expected demand.

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