



Research article

Oil and stock markets volatility during pandemic times: a review of G7 countries

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Abstract: This review aims to produce insight into the volatilities trio (COVID-19 crisis, stock markets, and crude oil volatility). The understanding of risk trends in stock markets of G7 economies and crude oil as a hedge are two vital concerns for investors, researchers, and portfolio managers around the globe. During the pandemic times, globally among others oil and stock markets are severely getting affected. Considering the main purpose and role of G7 countries to resolve global issues focusing on economic concerns, this review is planned. The published work in journals of repute was selected on the term mechanism (COVID-19 and stock markets or COVID-19 and oil prices) was conducted which resulted in 29 articles in total. It was found in the resulting articles that there exists plunged volatility in stock markets and crude oil due to COVID-19. Crude oil has mixed results as a hedge due to price fluctuation. It was found that prices of crude oil declined due to lockdowns which consequently decreased the demand, however, still demand caused lower oil price. Likewise, the COVID-19 triggered to increase in the volatility of all G7 stock markets. This review is the first of its kind combining theoretical information about the impact of COVID-19 on crude oil and stock markets around G7 countries. Moreover, current research opens potential avenues for future research and this review can be helpful for similar efforts at a later stage.

Keywords: COVID-19; stock market volatility; crude oil volatility; G7 countries

JEL Codes: I1, G01, G120, H12, P51

1. Introduction

Catastrophic events always have sudden and unpredictable behavior. The novel COVID-19 appeared in Wuhan city of China in late 2019 and astonishingly blown-out around the world. This pandemic is also referred to as a catastrophe by researchers (Krzyżanowski & Sosa, 2020). Similar catastrophic events and their impacts on stock markets and other important economic activities were also seen in history e.g. terrorist attacks (Aslam et al., 2014; Aslam & Kang, 2015; Aslam et al., 2020; Aslam et al., 2018), earthquakes (Ferreira & Karali, 2015; Hendricks et al., 2020) and other such natural disasters (Worthington, 2008). Along with the spread of the virus, the fear of the virus termed as a social stigma was noticed among people (Aslam et al., 2020). Multiple studies predicted the outbreak (Aslam et al., 2021; Awan & Aslam, 2020) using different tools and techniques and gave policy recommendations that can be helpful (Aslam et al., 2020). Both positive and negative impacts of the pandemic are studied extensively in literature e.g. in the banking industry (Demirguc-Kunt et al., 2020; Haq & Awan, 2020), in climate change and environmental concerns (Manzanedo & Manning, 2020; Sipra et al., 2020; Zambrano-Monserrate et al., 2020). It damaged almost every economy and particularly stocks markets (Şenol & Zeren, 2020) and crude oil prices. Crude oil is considered to be the main hedging asset after gold and attracted financial investors and researchers (Xu et al., 2020). Stock markets are influenced by the diverse nature of events either social, economic, political, or cultural. Similarly, COVID-19 being a global pandemic forced stock markets to decline globally (Şenol & Zeren, 2020). The governments around the world are initiating supportive policies for investors, industries, and the general public to refrain economies from economic turmoil. The policies like travel bans, lockdowns, and incentive packages reduce the COVID-19 effect consequently and improvement in the stock market returns in G-7 countries was noticed (Narayan et al., 2020). Although limited studies emphasized the current subject predominantly researchers have captured COVID-19 and the consequences spillover toward stock markets and oil prices. The worldwide consumption of oil has shrunk up to 3.9 million barrels per day due to lockdown (Amir, 2020). The magnitude of undesirable consequences of COVID-19 on economic and financial activities is yet to be witnessed in the future. The outbreak of COVID-19 has stunned the financial systems and financial markets (Akhtaruzzaman et al., 2020) due to increased global financial integration.

The vital effect of COVID-19 in terms of volatility of stock markets and oil prices is a core focus of the current research. The selection and screening process of research articles is depicted in Figure 1.

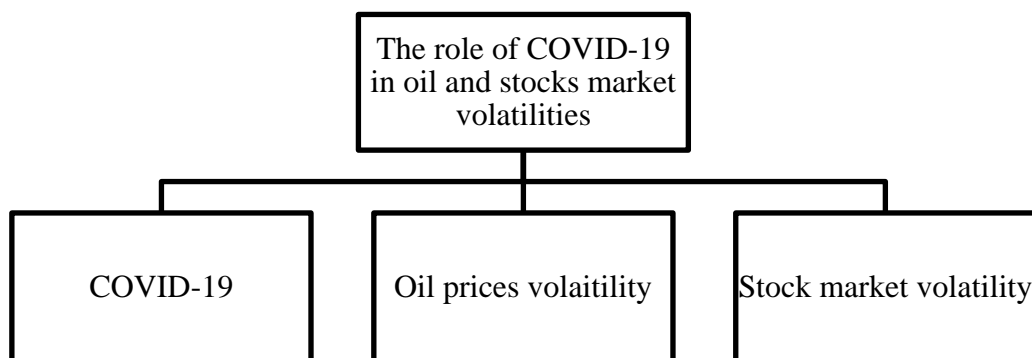


Figure 1. Screening process.

This study offers an explanation of the consequences of COVID-19 toward financial and commodity participants based on exclusively published research papers. In present times, several authors have frequently examined the adverse role of COVID-19, thus, it was required to have a comprehensive understanding of how COVID-19 influenced the stock markets' and the crude oil volatility in G7 countries. Investors around the world are more attracted toward assets that are potentially strong to hedge during the current turmoil period (Xu et al., 2020). Multiple researchers (Baker et al., 2020; Demirer et al., 2020; Devpura & Narayan, 2020; Kokudo & Sugiyama, 2020) demonstrated serious implications for policymakers and investors of G7 countries. The models and methodologies employed are diverse including wavelet coherence analysis (Sharif et al., 2020; Xu et al., 2020), Fourier cointegration series (Pata, 2020; Şenol & Zeren, 2020), multiple regressions (Devpura & Narayan, 2020; Narayan et al., 2020; Nonejad, 2020), mixed data sampling (GARCH-MIDAS model) (Fang et al., 2020), DCC-MGARCH model (Akhtaruzzaman et al., 2020), Pentavariate structural vector autoregression (SVAR) model (Mohammed & Barrales-Ruiz, 2020), heterogeneous autoregressive realized volatility model (Bouri et al., 2020), autoregressive-distributed lag (ARDL) approach (Albulescu, 2020), unit root test (Aldawsari & Alnagada, 2020; Sulemana, 2020; Wang & Enilov, 2020) etc. however results are equally important for decision-makers. The remainder of this study is organized as the next section sketches the methodology and article management process followed by critically scrutinizing the published research papers in the current strand. In the end, the conclusion & future research directions conclude this study.

2. Methods

The process defined at the initial stage as depicted in Figure 2. captures the current strand of literature related to oil and stock market volatility. A sample of G7 countries including Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States of America was focused concerning COVID-19 and volatility of oil markets and stock markets from published articles in the journals of repute only.

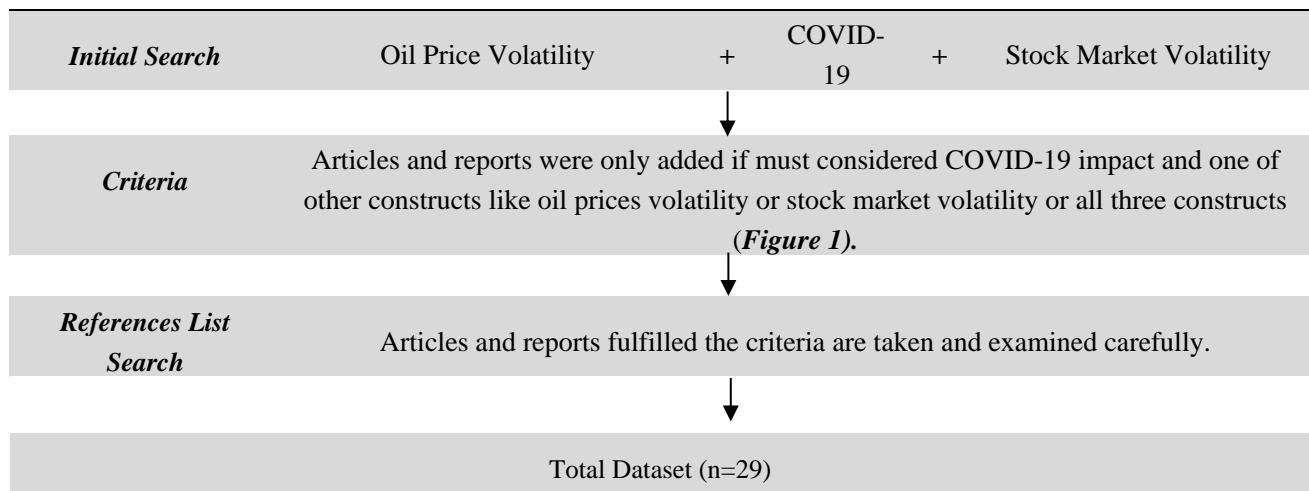


Figure 2. Management process.

The summary of articles used for this study is provided in Table 1. Based on the search criteria described earlier, all the articles are published in the year 2020 since the novel pandemic started and the effects are studied.

Table 1. Summary of articles.

<i>S. No.</i>	<i>Authors</i>	<i>Research Area & Broad Coverage</i>	<i>Methodology</i>
1	(Xu et al., 2020)	COVID-19 crude oil as a hedging against stock market price fluctuations	Wavelet Coherence Analysis
2	(Şenol & Zeren, 2020)	COVID-19 and stock markets volatility	Fourier KPSS unit root test and Fourier cointegration series
3	(Pata, 2020)	COVID-19 and stock markets disaster	Fourier-Shin cointegration test
4	(Aldawsari & Alnagada, 2020)	COVID-19 and G-7 Stock Markets volatility Spillover	Independent Samples test in SPSS Levene's Test
5	(Kokudo & Sugiyama, 2020)	Conference among foreign ministers about COVID-19 and WHO in G7 countries	Conference via video call
6	(Nonejad, 2020)	Crude oil volatility and stock predictability	1. Small sample correction test (Diebold & Mariano, 1995) 2. Predictive regression model (Welch & Goyal, 2008)
7	(Fang et al., 2020)	COVID-19 and stock market volatility predictions	GARCH-MIDAS Model
8	(Bouri et al., 2020)	Infection diseases and stock market & oil market volatilities	Heterogeneous Autoregressive Realized Volatility Model (HAR-RV)

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<i>S. No.</i>	<i>Authors</i>	<i>Research Area & Broad Coverage</i>	<i>Methodology</i>
9	(Mohammed & Barrales-Ruiz, 2020)	Pandemic and Oil Shocks	Pentivariate Structural Vector Autoregression (SVAR) model
10	(Albulescu, 2020)	COVID-19, volatility of oil price and VIX	1. Phillips-Perron unit root test 2. ARDL Model
11	(Akhtaruzzaman et al., 2020)	COVID-19 and Financial Contagion	DCC Multivariate-GARCH Model
12	(Narayan et al., 2020)	COVID-19 and equity market return's volatility	Multiple regression of Garsia (2013) 1. Semi-structured interviews, company documents, direct observation, and a reflective journal.
13	(Sulemana, 2020)	COVID-19 and Crude oil price fluctuations	2. Methodological triangulation and thematic data analysis techniques.
14	(Haydar & Reilimo, 2020)	OPEC Announcements and Stock Returns in LSE	1. CAPM 2. OLS Regression Model
15	(Sharif et al., 2020)	Oil price, stock market and COVID-19	Coherence wavelet method Wavelet-based Granger causality test
16	(Devpura & Narayan, 2020)	Oil Prices Volatility and Role of COVID-19	Multiple regression under Newey and West (1987) approach
17	(Wang & Enilov, 2020)	COVID-19 and Global Financial markets	Unit root tests LLC, IPS and PP-FISHER'S PANEL NON-CASUALITY TEST
18	(Izzeldin et al., 2020)	COVID-19, Stock market volatility and oil	Heterogeneous Autoregressive Model (ST-HAR)
19	(Albulescu, 2020)	The dependence of stock market volatility on the new COVID-19 case announcements.	Simple OLS regression Model
20	(Narayan et al., 2020)	Japanese currency and stock market during the COVID-19	GARCH model, VAR model
21	(Sharif et al., 2020)	COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus	Wavelet-based approach
22	(Salisu et al., 2020)	Hedging oil price risk with gold during COVID-19 pandemic	VARMA-GARCH model
23	(Adekoya & Oliyide, 2020)	COVID-19 and connectedness among commodity and financial markets	TVP-VAR and causality-in-quantiles techniques
24	(Lin & Chang, 2020)	Volatility Transmission from Equity, Bulk Shipping, and Commodity Markets to Oil ETF and Energy Fund	GARCH-MIDAS Model
25	(Demirer et al., 2020)	oil price shocks on realized volatility of oil	HAR-RV model

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<i>S. No.</i>	<i>Authors</i>	<i>Research Area & Broad Coverage</i>	<i>Methodology</i>
26	(Ali et al., 2020)	Exchange Rate, Gold Price, and Stock Market	Quantile Regression Approach ARMA-GARCH models:
27	(Adenomun & Emenogu, 2020)	Global Financial Crisis and COVID-19 Pandemic on Crude Oil Stock Returns	ARMA-sGARCH, ARMA-eGARCH, ARMA-TGARCH and ARMA- aPARCH with dummy variables
28	(Peng et al., 2020)	Crude Oil Price Fluctuation	state-space model

3. The COVID-19 outbreak and crude oil and stock markets volatility

3.1. The hedging ability of crude oil

A tremendous decrease in the prices of petroleum from 60USD to 28.03USD per barrel was noticed during these pandemic times. No such price setback was noticed since the Gulf War 1991 (Weerasinghe, 2020). The hedging ability of crude oil against the financial securities was examined using wavelet coherence analysis. The time-varying correlation among crude oil and equity markets variations in developed economies i.e. China, Hong Kong, Japan, and the USA was found (Xu et al., 2020). The outcomes confirmed the hedging aptness of crude oil which is conditionally dependent and mixed against underlying financial securities. Interestingly, it was found that crude oil is a strong hedge in the Chinese stock market, however, in other G7 countries, the hedging ability of crude oil has limped and weakened during the COVID-19 times. It further indicates a higher correlation among USA and Japan stock markets volatility with the volatility of crude oil, hence, a clear picture is portrayed that confirms the volatility of crude oil has increased in the stock market of USA and Japan. The positive impact of the EMVID index and its influence on the oil market was confirmed and high significant statistical results confirming the positive impact of the EMVID index and the positive influence on oil market volatility were reported (Bouri et al., 2020). The preparedness of individual G7 countries and their response toward COVID-19 was also accessed by comparing three COVID-19 response measures and two general health preparedness indicators before the WHO declared the COVID-19 pandemic (Krantz & Rao, 2020; Salisu et al., 2020). As result, the USA outperformed in preparedness and readiness due to two vital factors i.e. strong health system and a strong economic system. These two factors strengthened the US economy against COVID-19, but later when the spread increased it damaged the economy and stock markets severely. The oil market disruption during the pandemic was studied using the SVAR model (Mohammed & Barrales-Ruiz, 2020), and was found that the fluctuations in stock markets volatility and overall conditions directly influenced the investors' decision making in financial markets (Awan & Maqsood, 2021). Thus, transformed decisions making in stock markets due to COVID-19 played a significant part to increase oil volatility and price movements (Salisu et al., 2020). Noticeably, the findings affirm investors in stocks markets of G7 countries to be prepared and keep an eye on the global health situation too (Şenol & Zeren, 2020).

3.2. *The volatility of stock indices*

During April 2020, through various methods including structural developments, structural changes in time series, Fourier KPSS unit root test, and Fourier series, the consequences of the novel pandemic on the global financial markets were studied (Şenol & Zeren, 2020). The results simplified that volatility of all considered indexes are highly correlated and move together with infected cases and total death. Interestingly, the announcement of WHO as a global pandemic caused a decline of -25% in the G7 index. Besides, results demonstrated increased economic and financial volatility in the said study, the adverse effects of a pandemic on stock markets among G7 economies was also reported (Pata, 2020). The researcher employed Fourier shine cointegration and FKPSS test for stationarity by using a dataset of four months (January–April 2020), quite similar to (Şenol & Zeren, 2020), due to unavailability of data at that time. The outcomes of the research showed a negative impact of COVID-19 on all G7 countries. Among all, the FTSE MIB was most negatively affected, while Nikkei 500 had a weak negative effect among all seven countries by that time. Similar results were reported by earlier research (Şenol & Zeren, 2020) as well. Furthermore, it is important to mention here that the FKPSS test proved that all the time series are non-stationary thus negative shock will stay in the long-run. Another research on G7 (Kokudo & Sugiyama, 2020) narrated the video conferencing of foreign ministers during the early lockdown period. The goal of the meeting to acknowledge the significant support by WHO to enhance global cooperation. This conference did not consider the effect of COVID-19 on the stock or oil market but the valuable insight about G7 nations. Nonejad (2020) investigated the predictability of equity returns and the volatility of crude oil by employing regression analysis proposed by (Welch & Goyal, 2008) and the test of small correlation presented by (Diebold & Mariano, 1995) to model the association.

In a similar context, to predict the long-term risk of stock markets during the COVID-19 episode, the combination of two econometric models GARCH and MIDAS was employed (Fang et al., 2020). The GARCH model captured the short and long-term volatility components however the MIDAS model solved the mixed data sampling issues. Moreover, the beta weighting scheme was introduced as the independent variable for lower frequency data. Results confirmed the countercyclical patterns of volatility in the USA stock market. Interestingly, the authors argued GARCH-MIDAS model is the best suitable model to capture the long-term volatility.

The hourly oil price volatility and the role of COVID-19 were examined in few studies (Akhtaruzzaman et al., 2020; Demirer et al., 2020; Devpura & Narayan, 2020; Lin & Chang, 2020). Various methods including multiple regression under Newey and West (1987) approach, GARCH-MIDAS Model, HAR-RV model were used. It was found that after controlling for conventional predictors of oil price volatility, COVID-19 cases and deaths led to an increase in daily oil price volatility by between 8% and 22%. The responses of global stock prices during the COVID-19 outbreak were inspected (Akhtaruzzaman et al., 2020; Aldawsari & Alnagada, 2020) and a clear indication of COVID-19 involvement in financial contagion between Chinese and G7 firms was noted (Akhtaruzzaman et al., 2020). Policymakers should consider these findings as a caution to protect themselves from cross-market risk transmission. It is obvious that after China, Japan is considered a net transmitter of financial contagion and spillovers (Akhtaruzzaman et al., 2020).

An enhanced event study methodology to examine the relationship between the G7 stock markets and their responses to rapid exposure of the pandemic was noted through independent samples. Daily data was used to analyze the spillover and volatility concluding that each stock market is experiencing

distress and uncertainty due to the COVID-19 pandemic. These results are sourced from the substantial statistical differences between the global stock prices in the absence of the COVID-19 pandemic and the presence of the viral outbreak.

3.3. *Qualitative perspective*

It was explored in a qualitative study (Sulemana, 2020) related to strategies of oil production leaders that they have to embrace the growth of artificial intelligence and the internet of things to improve the efficiency of business operations and maintain profitability. used to maintain profitability when crude oil prices fluctuate. The data collection methods included semi-structured interviews, company documents, direct observation, and a reflective journal. They executed methodological triangulation and thematic data analysis techniques. The strategic oil production leaders used to maintain profitability when crude oil prices fluctuate. A comprehensive connectedness and association among several well-reputed indexes i.e. geopolitical risk index and economic policy uncertainty were found (Sharif et al., 2020). The infected cases of coronavirus, shocks in oil prices volatility, and the stocks market of the USA along with EPU and geopolitical risk were considered and correlation and dynamic association with coherence wavelet approach was used. Besides, the authors choose the Granger causality approach to model the impact of COVID-19, oil price volatility shocks, and the rest of other indicators of economic and financial risk. The outcomes of this study describe the impact of COVID-19 on US EPU and geopolitical risk is unprecedented and EPU is strongly affected by the pandemic in comparison to geopolitical risk. During the novel epidemic, unpredicted price discounts and price strategies implemented by Saudi Arabia dropped down the oil market in the USA.

4. Discussion

The detailed review of relevant literature in this study unveils that the ability to hedge stock market risk is mixed. It is due to the fluctuating prices of crude oil. Besides, the volatility of crude oil and stock markets of G-7 has increased due to COVID-19, due to the lockdowns, demand shrunk. Globally these fluctuations were seen and a decrease in value stock was reported. The earlier literature (Bakas & Triantafyllou, 2019; Joëts et al., 2017; Prokopczuk et al., 2019; Van Robays, 2016) shows significant linkages between this macroeconomic uncertainty and the oil price volatility. The conventional approach states that rising economic uncertainty results in increased oil price volatility, however, during pandemic times, the uncertainty of the macroeconomic outcomes declines. Many of the obvious reasons include disruptions in the economic activities and the uncertainty about macroeconomic fluctuations decline in usual times (Bachmann & Bayer, 2013; Basu & Bundick, 2017; Bonciani & Van Roye, 2016; Caldara et al., 2016; Popp & Zhang, 2016). Similarly, the real options approach to the theory of investment in uncertain times reported firms delaying their investment decisions. In other words, they use their real option to wait for the highly uncertain times, as the nature of investment decisions is irreversible (Brennan & Schwartz, 1985; Henry, 1974; Triantis & Hodder, 1990). During this uncertain time of COVID-19, almost every country's stock market is strongly hit by COVID-19, and fluctuations are observed. There is a decrease in the value stock in every country due to the outbreak of the virus. As the uncertainty surrounding pandemic rises, the macroeconomic

uncertainty reduces, hence, explaining the negative effect of the COVID-19 pandemic on crude oil price volatility.

5. Conclusions

The outbreak has damaged economies and caused crises around the world. This review aims to critically analyze the current published research related to the volatility of stock market markets and crude oil in G7 countries due to the outbreak of COVID-19. The ability to hedge stock market risk is mixed due to the fluctuation in crude oil prices. Besides, the volatility of crude oil and stock markets of G-7 has increased due to COVID-19. A plunged volatility in crude oil is due to shrunk demand for oil due to COVID-19 lockdown and industries particularly transportation around the world were closed. In gist, almost every country's stock market is strongly hit by COVID-19, and fluctuations are observed. There is a decrease in the value stock in every country due to the outbreak of the virus. The governments around the world should implement policies for the purpose to defeat unfavorable consequences of COVID-19 in form of fluctuations in crude oil and stock market volatility. They should make some laws and strategies which can ensure price stability in the price levels and to deal with the competition. Moreover, strict policies should be imposed to stop spreading fake news related to COVID-19 as investor's perception regarding risk changes due to it.

6. Avenues for future research

A conceptual framework of COVID-19 contagion and other "black swan" events was proposed (Aldawsari & Alnagada, 2020) with a claim that public attention and media are channels of contagion that should no longer be ignored. Similar words were used by other researchers (Aslam et al., 2020; Awan & Aslam, 2020; Sipra et al., 2020) and it was confirmed that the virus itself is not that dangerous but the fear of the virus is making it more dangerous. Considering the future avenues, firstly, it is important to investigate whether the COVID-19 is fast contagion in financial markets or to respect it as simultaneities. Secondly, researchers should study the possibilities of financial or economic crisis due to a sudden shift in the demand, and lastly, it is of utmost importance to consider how COVID-19 will transform the investors' behavior toward stock markets volatility and volatility perception. The directions for future research are highlighted in Table 2.

Table 2. Future research avenues.

S. No.	Authors	Future Avenue
1	(Pata, 2020)	COVID-19 and emerging financial markets. Short and long-run effects of the COVID-19 pandemic on the
3	(Sharif et al., 2020)	US output, financial stability, monetary policy and other macroeconomic factors.
4	(Sulemana, 2020)	Embrace the growth of artificial intelligence and the Internet of Things to improve the efficiency of business operations in sub-Saharan African countries.
2	(Bouri et al., 2020)	COVID-19 energy and non-energy commodities. COVID-19 pandemic is fast contagion or simultaneities. Potentiality of COVID-19 for financial and economic crises.
5	(Yarovaya et al., 2020)	COVID-19 and attitudes toward equity risk and changes in risk mindset. Possibilities of stock market contagion, bubble or crisis.

The virus trashed important sectors like consumer goods & services, the healthcare sector, oil & gas, and many others. Financial markets in the UK and the USA took the largest hits, yet with high response heterogeneity across business sectors. This may be a reflection of the indecisiveness and ambiguity of the political response to the pandemic crisis. The COVID-19 infected cases shift a negative long-run impact on the crude oil prices while excluding the effect of economic policy uncertainty and financial market. However, the indirect consequence of financial market volatility toward crude oil is considered significant and COVID-19 still negatively influences the crude oil volatility thus cannot be ignored.

Conflicts of interest

All authors declare no conflicts of interest in this paper.

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