How do gold and oil react to the COVID-19 pandemic: A review

Min Bai¹ and Ly Ho²

Abstract
This paper reviews COVID-19 pandemic-related literature to examine its impacts on oil and gold prices during and since the initial outbreak. The literature reviewed covers varying markets, hypotheses, methodologies, robustness checks, and findings. Crude oil is important to everyday life for individuals, businesses, investors, and markets globally. The forces exerted by demand and supply and shocks can greatly increase volatility in oil commodity prices, which has been the case during the COVID-19 pandemic outbreak. Oil has also in the past been used as a risk diversifier in portfolio optimization strategies. Gold has long been seen as a safe-haven asset that investors flee to during economic and financial market uncertainty and turbulence. How did the COVID-19 health crisis affect these two commodities during its initial outbreak and consequent persistence since then? How did government lockdown and restriction measures, monetary and fiscal stimulus packages, and pandemic-related news impact these commodity markets and their movements? Is there a contagion volatility effect between different markets and if so, who have been net transmitters and recipients of these flow-on effects? This literature review offers some insight into the answers to these questions while also highlighting the importance of further study since COVID-19 and its strains are not finished with the world yet.

Keywords
COVID-19, safe-haven assets, gold, oil, literature review

Introduction
On 30 January 2020, the World Health Organization (WHO) declared the outbreak of the novel coronavirus (2019-nCoV) as a Public Health Emergency of International Concern (PHEIC) with a total of 7818 confirmed cases globally. Due to the rapid spread and seriousness of the virus coupled with non-action, on 11 March 2020 the WHO characterized COVID-19 as a pandemic.

¹School of Accounting, Finance and Economics, Waikato Management Division, University of Waikato, New Zealand
²University of Economics, The University of Danang, Vietnam

Corresponding author:
Ly Ho, University of Economics, The University of Danang, Vietnam.
Email: lyhth@due.edu.vn
What followed was a worldwide pandemic like the world has never seen with confirmed cases of 246,594,191 and 4,998,784 deaths as of 1st November 2021. Then the world recognized the severe threat of the virus posed to all countries, governments scrambled to implement policies, lockdown, and quarantine measures to limit the spread of the virus and its impacts on economies and financial markets. These restrictions only permitted essential industry businesses to operate with travel, tourism, services, and industrial sectors coming to a standstill. COVID-19 has impacted the physical and psychological health of individuals worldwide, but almost two years after the outbreak, the impact on economic and financial markets is unprecedented, far exceeding that of the 2007/08 global financial crisis. In April 2020, managing director of the International Monetary Fund, Kristalina Georgieva, stated the coronavirus pandemic caused an economic crisis “like no other” with a never-before-seen phenomenon of the world economy coming to a standstill. Business closures severely impacted the labor market with 22.1 million U.S. job losses from January to April 2020, with the highest unemployment rate of 14.8% since 1948. As of July 2020, the employment rate aggregate was 5.4 million jobs lower than the pre-recession numbers1.

In the face of the pandemic, panic, fear, and uncertainty reached an all-time high, creating volatility in the oil-, Dow Jones index and several major stock exchanges globally. The Dow Jones dropped by 7.79% with 2104 points on 9 March 2020, followed by another 2352 points drop of 9.99% on 12 March 2020, and another 3000 (12.9%) points on 16 March 2020. On 12 March 2020, the FTSE 100, the UK’s main index, experienced their second largest one day crash in history with a decrease of 24.80% and similar impacts in the G7 countries” indices. More recently on 20 July 2021, due to the resurgence of COVID-19 cases and fear of the Delta strain across the globe, the S&P 500 fell by 1.6%, the Dow Jones 2.1%, Stoxx Europe 600 2.3%, the FTSE 100 2.3% and crude oil prices fell by 7%. Investors” flight to safety became evident as the U.S. 10-year Treasury Notes fell to lowest levels since February 2021.

During the turbulence and uncertainty, investors minimize their risk by fleeing to gold and oil as safe havens to preserve the value of their investments against adverse fluctuations. However, commodity prices rising amid volatility caused by financial crises is unavoidable, even for gold. Since stock markets exposure can effectively be hedged with oil,2 during economic shocks with the decreasing of share market prices, investors are likely to flee to safe-haven assets. By including the right weights of gold and oil into their portfolios, investors can achieve superior hedging prospects. However, in April 2020, West Texas Intermediate (WTI) crude oil prices plummeted to negative values, a first in history, when it fell from $18 to a staggering -$38 a barrel. Simultaneously, the price of gold significantly increases during this time to the highest point ever. Figure 1 present the fluctuation of oil and gold prices and Figure 2 illustrates the ratio between gold and oil prices2 from year 1950. Such ratio reaches the peak in April 2020. While geopolitical disputes between Russia, Saudi Arabia and OPEC were mostly responsible for the oil price crash, the role played by COVID-19 in reducing global demand due to lockdowns, limited travel and economic standstill cannot be denied. An immediate question arouses here, what is the real impact of COVID-19 on energy market, especially the safe assets – Oil and Gold? Specifically, this study aims to critically review how investors react in the face of the uncertainty, fear and volatility caused by the pandemic, consequent government policies for lockdown, stimulus packages, as well as media news and opinion.

Previous studies document that gold and oil are strategic commodities usually included in portfolios (i.e.,3,4). Oil is commonly known as an extremely volatile commodity and its” fluctuations represent significant insight when forecasting financial asset- and commodity prices.5 Based on their obvious different strengths and weaknesses, investors alternate or combine gold and oil to effectively diversify their portfolios.6 However, since the 2006 food crisis, both commodities
have experienced heightened volatility and instability, which makes investment decision-making more complex. The pandemic outbreak and related media news of its spread and confirmed deaths made investors progressively risk-averse. Thereby, investors are more likely to try safe-haven commodities such as gold. Furthermore, Narayan shows that media news has predictive power related to predicting crude oil future market dynamics specifically during economic turbulence. Without the time, skill, and experience to do their own research into crude oil futures, investors purchase oil futures discussed in news, known as the price pressure hypothesis. Takeda and Wakao show that news attracts investor attention which tends to generate abnormal returns. Bange finds a reliance primarily on news feedback strategies to evaluate the future expectations of stock.

To answer the above questions and by following the framework of Freeman III and Calcott, we review COVID-19 related studies in and around the pandemic outbreak to see how gold and oil markets have been affected through individual investor decision-making and government policies on lockdown and stimulus packages to soften the blow to the world’s economies. This literature summarizes empirical findings across different research articles focused on the gold and oil commodity markets during the outbreak and persistence of the COVID-19 pandemic. Answering these significant questions is also important to identify areas for future research to better prepare the governments, economies, and world markets for what remains an evolving global pandemic. More importantly, the novel coronavirus is forging ahead with renewed strength and shows no signs

**Figure 1.** Movements of gold and oil prices. Figure 1 Movements of gold (blue line) and oil (orange line). This figure shows how the price movement of Gold and Oil from 1946, compares the month-end LBMA fix gold price with the monthly closing price for West Texas Intermediate (WTI) crude oil, especially before and after the COVID-19 pandemic announcement. Source: http://www.macrotrends.net/1334/gold-prices-vs-oil-prices-historical-correlation.
The latter fact makes it imperative to understand how the pandemic has affected the world’s economies and financial markets to date that helps navigate the months and years to come in which the world will still be dealing with coronavirus.

The review will be presented as follows. Section 2 surmises extant studies. Section 3 provides empirical analyses. Section 4 provides implications and an agenda of future research. Section 5 concludes.

**Empirical impacts of COVID-19 on oil and gold**

*The relationship between oil and gold*

The relation between crude oil and gold markets and crude oil and gold prices has been theoretically constructed and argued for long time based on their global impacts on the macroeconomic fundamentals of many countries (i.e.,15-17 As a major source of energy worldwide, crude oil significantly affects many global macroeconomic aspects such as economic growth, inflation, and stock market fundamentals all over the world.18,19 On the other hand, gold has also increased its financial features and become an important market in the world especially after Bretton Woods20,21). Therefore, gold can act as a great hedge tool against oil price risk. Previous studies show that inflation can explain the relationship between gold and oil. As a key input for good and services, when oil prices increase leading to an increase in production costs, general price levels also increase.22,23
inflation. Therefore, it can serve as a hedge or safe asset. Many empirical studies also indicate that the crude oil and gold prices are positively correlated and have the mechanism of risk co-movement. Zhang et al.\textsuperscript{24} and Ewing and Malik\textsuperscript{25} show that the change of gold prices influences the volatility of crude oil prices and result in a casual association between of them. Moreover, a violent surge of crude oil price will increase the gold demand and promote the raise of the price of gold. Reboredo\textsuperscript{26} find that gold serves as a safe haven against crude oil price fluctuations during the financial crisis period. Narayan et al.\textsuperscript{27} provide the evidence that investors hold gold as a protection asset during inflation period and that oil is a tool to forecast gold prices. Pal et al.\textsuperscript{28} use the multifractal detrended cross-correlation method to examine the cross-correlations between gold, oil, and foreign exchange rates. They find evidence of multifractal cross-correlation between these markets.\textsuperscript{17} uses a novel multivariate Generalized Autoregressive Score (GAS) model to analyse and forecast volatilities and correlations between Brent, WTI and gold prices. Bedoui et al.\textsuperscript{16} indicate that gold and oil positively influence each other, possibly because both prices move in the same way with macroeconomics variables such as inflation and interest rates.

On the other hand, there is another strain of literature suggesting the insignificant relation between oil and gold. For instance, through three volatility models from the generalized autoregressive conditional heteroskedasticity (GARCH) family, Hammoudah and Yuan\textsuperscript{29} study the impact of oil prices and interest rate shocks on gold returns and the volatility of gold returns. For daily data and using an exponential general autoregressive conditional heteroskedasticity (EGARCH) model, they find that oil price shocks had an insignificant effect on gold returns. Exploiting Turkey market, Soytas et al.\textsuperscript{5} investigate the relationship between oil prices and gold, silver and other macroeconomic variables using a vector autoregressive model to examine the short-run and long-run relationships between metal prices and the oil price. They report that the world oil price had no predictive power over precious metal prices in the Turkish economy. Employing impulse response functions and forecast error variance decompositions, Sari et al.\textsuperscript{30} analyse the impact of oil price shocks on precious metal returns and the U.S. dollar/euro exchange rate. They show that precious metal markets responded positively and significantly to oil prices, but only in the short-run, with the effect dissipating over the long run.\textsuperscript{15} suggest that although gold price has stronger effect on the crude oil prices, the reversed effect does not exist.

In sum, there is a wide discussion about the relation between oil and gold prices that show different results. Since oil and gold have irreplaceable roles to the global economy and are commonly two strategic commodities, the impact of this relationship via the health crisis, COVID-19 pandemic, provide a new guidance for risk managers, producers traders and investors prior making investment decisions on oil, gold.

**Impacts of COVID-19 on oil and gold**

Never in history has there been a single event which has caused so much death, destruction and turmoil as the novel Coronavirus, and the devastation is continuing with no end in sight yet. Economies rebounded and strengthened once lockdown measures lifted until the next wave of the pandemic hit, and financial markets have seen extraordinary highs and lows never before witnessed in history. The importance of markets operating efficiently is commonly known amongst economic and financial market participants. It would be valuable to see whether the gold and oil commodity markets behaved efficiently and whether investors speculative flight to safety with these commodities may have inadvertently caused bubbles in the financial markets since the pandemic outbreak.
Commodity exchanges are essential for all economies by establishing a central marketplace where commercial producers, consumers, and manufacturers can trade. The exchanges provide price stability and commodity futures allow mitigation of risk caused by fluctuations in commodity prices. Without a central exchange where commodities can be traded at stable prices, many economies would struggle to grow, and diversification of risk would not be achievable. Gold is viewed as a safe-haven commodity to hedge against price fluctuations in the market and investors diversify their portfolios by increasing the weights of gold held during economic instability. A safe-haven asset is negatively related to other assets in a portfolio during market unrest and volatility. On the other hand, oil plays a vital role in manufacturing, transport, travel, energy production and everyday life. Major shocks to oil prices inflate the cost of production and ultimately the prices of goods and services. Understanding the forces COVID-19 has exercised on these commodity markets is essential to reduce and alleviate similar adverse shocks and impacts while the pandemic persists and in the future.

Since the outbreak of COVID-19 in late 2019 and throughout its continuation, studies have been and are being conducted on its impacts on economic factors, specifically, the relationship between COVID-19 and commodity market prices including precious metals and oil. Many researchers regard oil as a determining factor of gold prices. In periods of high financial markets uncertainties like the one brought about by the COVID-19 pandemic, investors are more concerned with cutting investment losses that makes risk aversion rises. The risk aversion motivates investors to look for alternatives to oil in their portfolio choices in the form of safe investment in gold. This view is based on the submission that gold market retains its low variability in the face of high uncertainty in the mainstream financial markets during pandemics.

Morema and Bonga-Bonga use Cappiello et al. asymmetric dynamic conditional correlation model (ADCC) to illustrate correlations, conditional volatility, hedge ratios- and optimal weights of gold-stock and oil-stock pairs to evaluate the effects of oil and gold price fluctuations on the South African equity market. They look at volatility spillovers caused by an inferred link between commodity- and stock markets and highlight the importance of combining stocks and gold to hedge against stock market risk during times of financial crises. On top of that, Gharib et al. examine the bubble contagion effect caused by the outbreak of COVID-19. Particularly, the study assesses the economic impact of the pandemic on gold and oil markets by analyzing causal relationships between gold and crude oil spot prices. The authors argue the oil price crash of April 2020 was a consequence of the breakdown of talks between OPEC and Russia and the decreased demand from the economic standstill caused by the COVID-19 pandemic. Furthermore, the panic caused by the pandemic and the oil price crash resulted in an increase in risk averse of investors that takes a flight to safe-haven assets such as gold. As gold and oil are the two most commonly trade commodities globally and guide economic variables, their price fluctuations have serious inference for global economies and financial markets.

Mensi et al. examine the COVID-19 impacts on the multifractality of oil and gold prices revealed by upward and downward trends. They indicate that both gold and oil markets are inefficient during the pandemic period, implying that outbreak has negative impacts of market efficiency for commodities. Particularly, before the pandemic, the study show that the gold (oil) market was more inefficient during downward (upward) trends. During the COVID-19 outbreak period, nonetheless, they reveal that the results have changed, that is gold (oil) is more inefficient during upward (downward) trends. Ultimately, this study helps to forecast future pricing behaviours in the markets. The investors and consumers of oil and gold cannot make decisions based on traditional models such as geometric Brownian motion. As this situation is likely to be exploited by speculators, these markets need to be regulated more frequency during the outbreak compared to normal
time. Investors and traders are also recommended to pay special attention to the switching behaviour of oil and gold of these commodities as well as the monitor from the regulators of these markets during the pandemic.

Previous literature shows that as gold is a safe asset that is chosen to provide cover for investors in the global crude oil market due to its low variability, its ability to preserve wealth during inflation and safeguard investment during financial crises/uncertainties.\textsuperscript{46-53} Selmi et al.\textsuperscript{56} suggest that gold is a worthy hedging asset when facing severe oil price movements. Ji et al.\textsuperscript{33} find strong hedging role for gold during COVID-19 pandemic when other potential asset classes are less effective. In this vein, the choice of gold is further underscored from the perspective of Conlon and McGee,\textsuperscript{57} Corbet et al. (2020), and Conlon et al.\textsuperscript{43} showing that other potential hedging assets link digital money and oil lose their hedging powers during the COVID-19 pandemic. Using the VARMA-CCC-GARCH model\textsuperscript{58} and\textsuperscript{59} Salisu et al.\textsuperscript{36} investigate the role of gold as a hedge or safe-haven against crude oil price risk during the health pandemic period. They document that inflationary pressures lead to the increase of oil prices and cause investors to look for safe-haven assets to guard against inflation risk. During times of uncertainty, such as COVID-19, the hedging effectiveness of gold against risks associated with crude oil are further validated. Interestingly, other precious metals such as palladium, platinum and silver also exhibit similar features as gold, albeit with lower magnitudes. The study implies that investors should diversify asset portfolio to improve the risk-adjusted return performance, especially during the outbreak scenario.

Shaikh\textsuperscript{60} uses daily closing prices of the implied volatility index of each commodity to examine the exceptional overreaction in investor sentiment in crude oil, gold, gold mining, silver, and energy markets. The author believes the fear of the COVID-19 disease outbreak news (DONs-COVID-19) has had a lethal impact within the commodity markets, the worst in history by exceeding common stock volatility for the first time. The study seeks to assess investor sentiment and commodity market trading. During times of economic and financial uncertainty and fluctuating prices, commodity investors turn to futures and options of those commodities. Investors favor options in the place of other hedge instruments based on the former giving them options in uncertain times. Investors who are fearful and uncertain of the commodity market hedge their portfolios by purchasing put options to mitigate their risk during market turbulence where real assets may lose value. The author extends on previous work by employing an implied options volatility index (OVX) based on the Chicago Board Options Exchange. The study assesses how investors commodity market sentiment and overreaction and disease outbreak news (DONs) amidst the COVID-19 pandemic affect the gold, silver, crude oil, energy, and gold mining sectors.

Utilizing the Diebold and Yilmaz\textsuperscript{61} spillover index and wavelet coherence to determine lead-lag interaction and directional spillover between the variables pre- and amidst COVID-19 periods, Hung and Vo\textsuperscript{62} investigate the relatedness between time-frequency and spillover effects between crude oil prices, gold and S&P500, the most diversified and dynamically traded stock indices and the two most traded commodities globally. The study evaluates co-movements between the S&P500, gold market and crude oil price caused by the COVID-19 pandemic before and since its outbreak, which is the main contribution to existing literature. In the pre-COVID period, the study documents that the gold market is a net transmitter of shocks while WTI and S&P500 cycles are net recipients. During the pandemic outbreak, however, the gold market becomes a net recipient of return spillovers during specific times while S&P500 and crude oil are net transmitters of return spillovers, reaching a high level of 32% during the outbreak. In addition, during the pre-crisis period, the relationship between S&P500 and WTI demonstrates high levels of consistency, but there is a weak relationship between gold markets and S&P500. Amidst the
COVID-19 outbreak, the contagion impact reveals a presence of positive and powerful relationships between S&P500 and crude oil, whereas gold displays a key protective role as safe-haven throughout severe price turbulence in crude oil and stock markets. This evidence illustrates a more visible return transmission in the pandemic period compared to the pre-COVID period. The information spillovers between S&P500, gold, and crude oil markets show an increase and considerable dependencies during different time frames.

During crisis, the quantity of non-hedging futures traded increase and lead to profitability which makes it important to analyze the proof and measurement of their impacts. Sifat et al. contribute to this gap in existing literature by examining ten futures instruments across the agriculture, precious metals, and energy markets. The authors examine speculation in agricultural, energy and precious metals futures amidst the COVID-19 pandemic period. The authors assess the varying and sizeable impacts for ten key market instruments caused by investors’ speculative intent when trading in the futures market.

Islamic markets are not negligible from the pandemic, Yarovaya et al. document the COVID-19 impacts on the spillovers between conventional and Islamic financial markets by examining the impacts of common risk-related determinants on spillovers, particularly safe-haven assets, during the pandemic period. Additional analysis is conducted by comparing whether Bitcoin, oil, gold, EPU-and risk measures VIX indexes impact relationships between these markets amidst the pandemic outbreak. They note that when compared to their conventional counterparts, the Islamic markets exhibited unique safe-haven qualities compared to conventional markets.

Then, Mensi et al. examine the asymmetric volatility transmission between the futures markets of four precious metals (silver, platinum, palladium, and gold) and crude oil futures to assess whether oil can be effectively used as a hedge or safe haven against those four precious metals. The research period includes the 1997–1998 Asian crisis, 2000 dot-com bubble crash, pre-2008-2009 global financial crisis (GFC), GFC period, and European sovereign debt crisis (ESDC), ensuing recovery period, recent oil price crash, and COVID-19 pandemic. Although palladium, platinum and silver are metals used in industrial sectors, they are also a store of value, like gold, and effective as hedge asset and diversifier under stable economic conditions, and a safe-haven asset during economic and political uncertainty. Fluctuations in crude oil prices impacts prices of precious metals which enhances turbulence in commodity markets as rising uncertainty causes a flight to safety through investments in safe-haven assets. In a recent study, Elgammal et al. examine the strong volatility and return interconnectedness amongst energy, gold, and global equity markets before and during the COVID-19 crisis. The uncertainty brought on by the combined impact of the pandemic has made investors doubt the effectiveness of protective assets such as gold as a hedge against losses. The authors state that the unusual and severe impact of the ongoing pandemic reinforces a need for safe-haven assets for investors and therefore, further research and insight into market effects are essential.

With the ongoing pandemic, more researchers look at the effect and try to find more robustness results and evidence on the world’s economy. Through applying the Phillips and Shi bootstrap method, Gharib et al. empirically reveal bubbles in the gold and oil markets during March and April 2020. Yilmazkuday and Maijama’a et al. already provide evidence of COVID-19 having detrimental effects on the global economy, and particularly on the demand for oil due to border closures.

Mensi et al. also provide evidence of dynamic asymmetric conditional variances amongst returns for precious-metals- and Brent oil futures. All precious metal-oil pairs exhibit negative conditional correlations apart from platinum-oil which in some past crises showed positive relationships, but these correlations decrease substantially during the COVID-19 health crisis. During
the pandemic, the most affordable hedge is short gold and long Brent oil, while the most expensive hedge is platinum-Brent oil. Improved risk reduction is achieved by a diversified portfolio containing precious metals- and Brent oil futures. Where gold proved to be a have greater hedging effectiveness during past economic shocks, during COVID-19, platinum delivers superior hedging effectiveness. By looking at 16 markets, Liao et al. find that COVID-19 has the most significant return and volatility spillovers risk transmitted from the oil market while the usually steady gold market becomes a recipient of risk spillover amongst the different public health events.

In sum, the global financial and commodity markets have been empirically shown to be negatively impacted by COVID-19 pandemic. The crude oil market has witnessed some of its highest uncertainties partly due to the pandemic and political manoeuvres among oil producers during the period. Recent studies show that facing the scenario of crashing in the global oil price that increasing the risk aversion in the global financial market, investors search for a safe asset. Among others, gold has low variability and can preserve wealth during inflation and safeguard investment during crises. Therefore, gold has strong hedging role during COVID-19 pandemic when other potential asset classes are less effective.

The association among oil prices, gold, exchange rate, and cryptocurrencies: impacts of COVID-19

Since gold and oil are mostly traded in U.S. dollar terms, their prices are associated with the U.S. dollar exchange rate, therefore, they are directly affected by the fluctuations of the U.S. dollar against other major currencies. The exchange rate market has recently faced rigid disruptions, whereas gold and crude oil are usually used as safe havens or hedging tools against inflation and rising money market risks (Mensi et al., 2021). Previous studies highlight the association between gold prices and exchange rates that indicate the hedging and safe-haven properties of gold against currency. When exchange rates fluctuate (i.e., the depreciation of the U.S. dollar) and the diversification of major currencies (i.e., the Japanese yen and the euro) increases, the investment demand for gold associated with the world’s major currencies is gradually increasing. Toraman et al. show a strong and negative link between gold prices and the U.S. exchange rate. Simon and Hauser indicate that the euro crisis has a negative impact on gold prices and reach an all-time high in September 2011 in Switzerland. Srinivasan employ that exchange rate and gold price are associated in the long-run. Nair et al. also suggest that in India, the exchange value of the U.S. dollar is a key factor explaining the volatilities in gold prices. Yaqoob and Iqbal find a long-run relationship between precious metals and exchange rates.

On the other hand, a large number of empirical studies use various data sets and econometric models to investigate the price dynamics in the crude oil and foreign exchange markets, such as cointegration tests, error correction models, Granger causality tests, and vector autoregressive (VAR) models. The empirical literature highlights strong bidirectional causality between oil prices and exchange rates. They mostly show that higher oil prices are associated to the appreciation of exchange rate in net oil exporting economies and the depreciation of exchange rate in net oil importing countries. Chen and Chen use panel data analysis for G7 countries and find that real oil prices may be the most important determinants of real exchange rate volatilities. Nikbakht suggest the long-run correlation between oil price and exchange rate for OECD countries. Brahmasrene et al. find that changes in oil price significantly affect exchange rate volatilities in U.S. in the medium run and the long run. Singhal et al. indicate that oil prices and exchange rate
are negatively associate in the long run and gold price does not affect the exchange rate in Mexico. Furthermore, several researchers apply the popularity of the spillover index method of \textsuperscript{61,90} (DY) to examine the spillover impacts between oil prices and exchange rates. For instant, Singh et al.\textsuperscript{91} find that the general link between crude oil and exchange rates is mainly affected by the oil market. Nonetheless, Malik and Umar\textsuperscript{92} suggest that oil price shocks have no impact on the changes of the exchange rate.

There is also a stream of research that examine the dynamic associations among the oil, gold and exchange rates, with a focus on U.S. dollar exchange rate. These studies mostly employ GARCH-based or copula-based models to investigate the link among these three markets, including the DCC-GARCH model,\textsuperscript{93} the nested copula-based GARCH models,\textsuperscript{16} DCC-GARCH t-copula model,\textsuperscript{94} VAR-BEKK-GARCH model,\textsuperscript{95} and wavelet-based vine-copula approach.\textsuperscript{96} Utilising a nested copula-based GARCH model, Bedoui et al.\textsuperscript{16} show that the dependence among oil, gold and U.S. dollar exchange rates is stronger in times of crisis. Applying the DY approach to address the return spillovers among crude oil, gold and five major currencies, Singh et al.\textsuperscript{97} indicate that the Canadian dollar against U.S. dollar and gold are sensitive to volatility in crude oil prices. However, these studies do not highlight the different frequency responses of risk spillovers. Mensi et al.\textsuperscript{65} investigate the role of frequency factors in spillovers between precious metals and seven major currency markets and demonstrate a strong relationship between gold and currency. They prove that regardless of the time horizon, the euro, Australian dollar and Canadian dollar are net contributors to risk.

As both bitcoin and gold are valued for their scarcity and both the assets are international in nature as hardly controlled by any sovereign government,\textsuperscript{98} previous studies also investigate hedging effectiveness of bitcoin and gold and investigate the association among gold, bitcoin, and oil. For instant, Ciaian et al.\textsuperscript{99} state bitcoin volatility is determined the oil price. Vassiliadis et al.\textsuperscript{100} illustrate a cross-correlation relationship between gold and oil prices and bitcoin, whilst Okorie and Lin\textsuperscript{101} show a substantial and unidirectional volatility spillover from bitcoin to the crude oil market. Examining the 2012–2015 time period, Kang et al.\textsuperscript{102} show that there was a high degree of co-movement across the 8–16 weeks frequency band between bitcoin and gold futures prices, especially when Europe was in a debt crisis. Pal and Mitra\textsuperscript{103} show that gold is found to provide a better hedge against bitcoin.

The COVID-19 outbreak results in uncertainty in financial and commodity markets lead to heightened volatility. Previous studies investigate the impacts of COVID-19 pandemic on connectedness among the financial assets. Specifically, Aslam et al.\textsuperscript{104} show that the COVID-19 pandemic reduces efficiency in exchange rate markets for the Euro, Australian dollar, and Japan Yen. Ding et al.\textsuperscript{105} highlight that the risk spillovers from the exchange rate market to the gold and oil asset markets are stronger than the risk spillovers in the opposite direction, and the risk spillovers of the exchange rate markets of advanced economies are much stronger than those in emerging economies. Moreover, the results for spillover networks show that the Euro, Australian dollar, and Canadian dollar are the main risk transmitters during the European debt crisis and the COVID-19 pandemic, and the gold and oil markets are the main receivers of risk spillovers with high short-term vulnerability. Omane-Adjepong and Alagidede\textsuperscript{106} demonstrate that there was strong volatility spread between exchange rates, gold, bitcoin, oil, and stocks. According to them, gold and U.S. dollar were receivers by pandemic while others were transmitters. Dutta et al.\textsuperscript{107} find a significant change in the correlations among crude oil, gold, and bitcoin. Ozturk and Cavdar\textsuperscript{108} further assess the COVID-19 contagion effect on gold, exchange rates, bitcoin, and international crude oil price volatilities. Apart from the exchange rate variable, information entering the market is effective at 5% significance level when looking at conditional variances of
all other variables examined. Gold highest prices” conditional variance is impacted by new information in the market, followed by bitcoin prices, exchange rate, and crude oil prices in that order. The entrance of asymmetric information into the market impacts the conditional variance of crude oil the least. The study finds that negative shocks impact prices more drastically than gold market positive shocks, and the reverse is true for the other variables tested.

Due to the speculative characteristics, bitcoin’s volatility has significantly increased during the COVID-19 outbreak. Corbet et al. indicate an essential and directional impact of the pandemic on the bitcoin market. Although Chen et al. mention that bitcoin failed to act as a safe-haven asset, some studies suggest vice versa. Specifically, Mnif et al. demonstrate that bitcoin became more efficient after the spread of the pandemic. Jalal et al. also imply that despite the high volatilities, bitcoin keep its safe-haven characteristics. Mzoughi et al. find that the significant impact of COVID-19 pandemic on bitcoin and oil prices are adversely. Towards the end of 2020, bitcoin prices reached the highest value. The probable reasons may be that it is found as a safe-haven and expected to be used soon as the increasing role of hygiene and digitalization due to the pandemic.

**The impact of media news on oil and gold during COVID-19 pandemic**

The role of COVID-19 related news and media coverage on gold and oil prices. Narayan demonstrate that news has predictive power that helps investors forecast crude oil future market dynamics during the pandemic. The psychological and mental repercussions caused by panic and fear over the pandemic has become more evident as the crisis continues and high levels of uncertainty influences investor sentiment. According to Ravenpack, news talk related to COVID-19 hysteria and panic reach their highest levels on 30 March 2020. The pandemic related news has also resulted in substantial volatilities in commodity markets that has caused debilitating impacts on the global economy. Apart from the oil price crash in April 2020, the demand for precious metals also declined in early 2020 due to economic slowdown brought on by lockdown measure across the world. On the other hand, investors panicked over rising commodity prices amidst the pandemic and despite the climbing number of COVID cases, gold prices started increasing dramatically. As the health crisis unfolded, concerned investors increasingly fled to safety by investing in gold. Similarly, Weng et al. study the role of news during the COVID-19 pandemic. With news and opinions being so readily available, fear and uncertainty have caused increased volatility in crude oil futures prices. The authors examine whether coronavirus opinions and news had any predictive value for the volatility in crude oil futures throughout the pandemic. Also, Liao et al. investigate the magnitude and scale properties of spillovers in the gold, oil and stock markets during unforeseen shocks caused by the health crises. Their study further expands on correlation evaluation, adds to the risk transmission mechanism and its development, and methodically illustrates market risk sources and their structural shifts. The authors observe short-term spillovers to play a key role in risk surges and low interest rates as a probable source of general volatility. Atri et al. further show a short-term positive effect of media news on oil prices. They document gold prices behave less reasonable to negative news and prices rise amid the unfolding pandemic. Gold prices respond positively to media coverage, deaths, and new infections and thus, gold responds differently than other commodities and financial assets during the crisis. Media coverage impacts the gold and oil market dynamics positively which implies an important function of the media mitigating fear and uncertainty to improve investor sentiment in the market. The
movements of the two commodities are connected positively in the way they respond to COVID related numbers and information.

The impacts of COVID-19 on oil and gold around the world

This section reviews studies that investigate the effects of COVID-19 on oil and gold in countries all over the world. Mensi et al.117 examine price-switching spillovers between gold futures and crude oil of two largest stock markets in the world, Chinese and U.S., before and during the COVID-19 pandemic. Since these two markets are open for foreign investors, they are especially vulnerable to external shocks. The study shows that gold and stock markets were net contributors (receivers) of spillovers in the low (high) volatility regime whereas oil was the major receiver (contributor) for spillovers in the low (high) volatility regime. More importantly, COVID-19 pandemic intensified spillovers from commodity markets to the U.S. and Chinese stock markets. Costa et al.118 investigate sectoral association in the U.S. using data from 2013 to the end of 2020. They show that general association has experienced a dramatic increase during the outbreak. Furthermore, Farid et al.119 use GARCH (MCS-GARCH) model to demonstrate extraordinary changes in the time-varying patterns and structure of volatility relationships among key commodities and equities in the U.S. economy pre- and during COVID-19 crisis. The authors argue that during events such as disaster and shocks, the economic turbulence causes contagion effects within asset classes which strengthen the value of safe-haven assets. The study examines whether the COVID-19 outbreak causes shifts in the spillover connectedness network among these assets and further explores which asset class proved to be a superior hedge or safe-haven in the face of the disastrous COVID-19 pandemic. The study uses relationship measures to assess risk-return spillovers amongst assets in times of economic declines.

Turn to the most rapidly developing economies in the world, India, Ahmed et al.120 explore the impact of COVID-19 on the Indian commodity and stock markets amidst different lockdown stages. The study also compares the COVID-19 impacts on these Indian markets during the first and second waves of the pandemic and includes a relative analysis of certain countries in South Asia and examines the COVID-19 impact on Indian stock and commodity markets including a comparison of stock market volatility in India, Bangladesh, and Pakistan. Among these countries, a negative association is observed.

In Turkey, Depren et al.121 examine the impacts of monetary policy measures on gold prices by using 11 indicators. Compared to other machine learning algorithms they considered, the authors find the Random Forest algorithm to be the most accurate prediction model. The researchers hypothesize that the COVID-19 pandemic, global and national indicators, and monetary policy measures can impact the gold prices in Turkey.

Recently, motivated by mixed results found in studies concerning the safe-haven properties of gold during the COVID-19 pandemic, Akhtaruzzaman et al.122 apply the Dynamic Conditional Correlation-Generalized Autoregressive Conditional Heteroskedasticity (DCC-GARCH) model to address this lack of agreement on the topic. They examine the function of gold as safe-haven asset or hedge during different COVID-19 pandemic phases, particularly when monetary- and fiscal stimulus packages were rolled out by governments to support the deteriorating economy. With narrow time-frames between these phases and the dynamic evolvement of the pandemic, the authors argue more robust results will be achieved by using data with higher than daily frequency. They contribute to existing literature by: acquiring a volume of observations on COVID-19 pandemic influence by utilizing intra-day data to produce realistic and factual results; examining the safe-haven properties of gold during unique stages of the pandemic, specifically when monetary- and fiscal stimulus packages were employed by governments and central banks to support the decreasing economy; incorporating...
a wide range of conventional assets, diverse categories of equity indices of China, Japan, Eurozone and U.S., to study the safe-haven characteristics of gold.

Shaikh finds OVX, the oil volatility index, to be the key measure to proxy the oil price turbulence. With an increase in price, the OVX proves to also be higher and achieve maximum levels of 325%, a signal of market participant overreaction relating to commodity prices. EPU and EMU slopes indicate factors of uncertainty pertaining to the equity market and macroeconomy, and in the case of both, the estimates are positive with only equity market uncertainty causing to a steep increase in the OVX level. Oil market volatility directly influences USO and USTBILL yields with statistically significant negative correlations, which indicates that a negative yield causes an increase in volatility. In China and the USA, gold markets remained more volatile from February to March 2020, with a 40% decline in bullion demand.

**Empirical analyses**

To better show the picture of the effect of COVID-19 on gold and oil, we collect Standard and Poor’s gold and oil prices period from 11th March 2018 to 10th March 2022 from Datastream. To compare the gold and oil performance before and after the WHO pandemic announcement, we use the T-test to estimate the differences before and after the announcement. The results of gold and oil performance are reported in Table 1 and Table 2, respectively.

**Table 1.** T-test of differences for S&P gold Index before and after the WHO pandemic announcement on 11th march 2020.

| S&P GSCI Gold Total Return | Mean    | Variance | Observations | Degree of Freedom | t statistics |
|-----------------------------|---------|----------|--------------|-------------------|--------------|
| 2 years before the WHO announcement | 1355.27 | 15219.7  | 522          | 521               | -64.545      |
| 2 years after the WHO announcement | 1811.94 | 7666.28  | 522          |                   |              |
| 1 year before the WHO announcement | 1815.65 | 12259.3  | 262          | 261               | 60.360       |
| 1 year after the WHO announcement | 1446.97 | 11623.0  | 262          |                   |              |
| 6 months before the WHO announcement | 1773.70 | 17571.4  | 130          | 129               | 28.611       |
| 6 months after the WHO announcement | 1525.04 | 3222.11  | 130          |                   |              |
| 3 months before the WHO announcement | 1673.12 | 4990.04  | 66           | 65                | 20.062       |
| 3 months after the WHO announcement | 1562.31 | 3161.9   | 66           |                   |              |
| 1 months before the WHO announcement | 1590.50 | 4035.46  | 22           | 21                | -3.581       |
| 1 months after the WHO announcement | 1620.10 | 1364.50  | 22           |                   |              |
| 10 days before the WHO announcement | 1537.42 | 2666.51  | 10           | 9                 | -6.474       |
| 10 days after the WHO announcement | 1639.64 | 759.07   | 10           |                   |              |

We test differences of gold prices for short, media and long-term event windows, (−10, 10), (−22, 22), (−66 66), (−130, 130), (−262, 262), (−522,522).

Notes, observations are based on trading days.
As shown in Table 1 and Table 2, both gold and oil prices are significantly different for subsamples of before and after the pandemic announcement of WHO on 11th March 2020 even when we consider alternative time periods including 2 years, 1 years, 6 months, 3 months, 1 months, and even 10 days. This indicates that the announcement of WHO of the pandemic has significant impacts on gold and oil performance.

We next present the trendline evaluation of gold and oil for the period from 11th March 2018 to 10th March 2022. From the Figure 3 it is evidence that the gold and oil prices move in a similar manner. Interestingly, the prices of oil decreases from January 2020 and even get negative value after the pandemic announcement of WHO before increasing again to the peak in May 2022. The correlation between gold and oil can again be confirmed in the following analysis.

We further employ some correlation analyses to describe the degree to which the performance of gold is linearly related to oil performance. The results are presented in Table 3.

The result of panel A shows the positive relation between gold and oil prices. More interestingly, we investigate the correlation of the oi and gold prices among main markets around the world. Panel B and C of Table 2 present that the prices of gold and oil of most markets around the world are positively associated with the degrees of correlation are high.

The relationship can further be analyzed with the help of gold to oil ratio. The ratio indicates how many barrels of crude oil are needed to buy an ounce of gold. A rising ratio means more barrels of

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**Table 2.** T-test of differences for crude oil-WTI before and after the WHO pandemic announcement on 11th March 2020.

| Crude Oil-WTI                  | Mean  | Variance  | Observations | Degree of Freedom | t statistics |
|--------------------------------|-------|-----------|--------------|-------------------|--------------|
| 2 years before the WHO announcement | 60.004 | 54.300    | 522          | 521               | 2.208        |
| 2 years after the WHO announcement       | 57.469 | 438.508   | 522          |                   |              |
| 1 year before the WHO announcement      | 40.328 | 157.005   | 262          | 261               | -16.759      |
| 1 year after the WHO announcement        | 56.796 | 21.666    | 262          |                   |              |
| 6 months before the WHO announcement   | 32.659 | 126.506   | 130          | 129               | -20.473      |
| 6 months after the WHO announcement     | 55.247 | 24.914    | 130          |                   |              |
| 3 months before the WHO announcement   | 24.790 | 120.66    | 66           | 65                | -15.720      |
| 3 months after the WHO announcement     | 54.591 | 44.319    | 66           |                   |              |
| 1 months before the WHO announcement    | 23.529 | 19.685    | 22           | 21                | -14.241      |
| 1 months after the WHO announcement      | 47.900 | 34.180    | 22           |                   |              |
| 10 days before the WHO announcement     | 24.601 | 24.212    | 10           | 9                 | -12.856      |
| 10 days after the WHO announcement       | 43.396 | 35.981    | 10           |                   |              |

We test differences of oil prices for short, media and long-term event windows, (−10, 10), (−22, 22), (−66, 66), (−130, 130), (−262, 262), (−522, 522).

Notes, observations are based on trading days.
oil are needed to buy an ounce of gold. When the ratio falls, it implies that oil is becoming relatively more expensive to gold. Figure 4 shows that from March 2020 oil becomes more expensive than gold. This ratio decreases in April 2020 before increasing again to the peak in May 2020 and declines after that.

We also investigate the relation between oil, gold, and bitcoin represented in Figure 5 and Figure 6. Specifically, Figure 5 and Figure 6 shows the trendline evaluation of gold and bitcoin and oil and bitcoin, respectively, for the period between 11th March 2018 to 10th March 2022. Generally, it is evidence that gold, oil, and bitcoin move in a similar trend. Interestingly, the price of such cryptocurrency fluctuates a lot from December 2020 and reach the peak on Dec 2021 before decreasing until now.

To further empirically investigate the relation between oil, gold and Bitcoin, we employ the DCC-GARCH model suggested by Engle that is used widely in literature to examining the time-varying correlation among the financial markets. Specifically, following Dutta et al., we estimate the following regression to examine the dynamics of the conditional correlations for the pairs oil-gold and oil-Bitcoin:

$$\hat{\rho}_{xyt} = \alpha_0 + \beta_1 COVID_t + \mu_t$$  \hspace{1cm} (1)

where $\rho_{xyt}$ indicates the conditional correlation between asset $x$ (WTI or Brent) and asset $Y$ (gold or Bitcoin) at time $t$, which is obtained from the bivariate DCC-GARCH process. $COVID_t$ is a dummy variable that takes a value of one during the coronavirus period (January 2020 to June 2022) and zero, otherwise.

Table 4 presents the estimates of Eq. (1). Specifically, panels A and B show the association between oil including WTI and Brent markets and gold whereas panels C and D explore the link between oil including WTI and Brent markets and Bitcoin. The coefficients $\beta_1$ in both panel A and B are negative and statistically significant indicate that during the COVID-19 pandemic
Table 3. Correlation analyses.

Panel A. Correlation analysis between oil and gold prices

|                  | Crude Oil-WTI Price | Gold Price |
|------------------|---------------------|------------|
| Crude Oil-WTI Price | 0.110602            | 1          |
| Gold Price       | 0.110602            | 1          |

Panel B. Correlation analysis among major gold markets around the world

| Price Index in USD | BIC   | EAFE  | EUROPE | G7    | GLOBAL | MENA | OIC | ASIA | LATIN | NORTH |
|--------------------|-------|-------|--------|-------|--------|------|-----|------|-------|-------|
| BIC                | 1     |       |        |       |        |      |     |      |       |       |
| EAFE               | 0.5045| 1     |        |       |        |      |     |      |       |       |
| EUROPE             | 0.4979| 0.9984| 1      |       |        |      |     |      |       |       |
| G7                 | 0.6528| 0.9219| 0.9194| 1     |        |      |     |      |       |       |
| GLOBAL             | 0.6912| 0.9387| 0.9349| 0.9917| 1      |      |     |      |       |       |
| MENA               | 0.6952| 0.0705| 0.0675| 0.2539| 0.2942| 1    |     |      |       |       |
| OIC                | 0.4080| 0.9296| 0.922 | 0.812 | 0.8328| -0.0431| 1  |      |       |       |
| ASIA PACIFIC       | 0.8030| 0.7919| 0.7689| 0.8432| 0.8794| 0.3756| 0.7419| 1    |       |       |
| LATIN              | 0.6346| 0.8174| 0.8227| 0.7321| 0.7659| 0.2246| 0.7823| 0.6474| 1     |       |
| NORTH AMERICA      | 0.7051| 0.8370| 0.8326| 0.9830| 0.9668| 0.3435| 0.7153| 0.8410| 0.6574| 1     |

Panel C. Correlation analysis among major oil markets around the world

| Price Index in USD | AFRICA ASIA PACIFIC + RUSSIA | ASIA EAFE | EUROPE G7 | GLOBAL GLOBAL | NORTH NAFTA |
|--------------------|--------------------------------|-----------|-----------|---------------|-------------|
| Crude Oil-WTI Price | 1                              |           |           |               |             |
| Gold Price         | 0.110602                       |           |           |               |             |

(continued)
### Table 3. Continued.

Panel A. Correlation analysis between oil and gold prices

| Region          | Crude Oil-WTI Price | Gold Price |
|-----------------|---------------------|------------|
| EUROPE          | 0.4979              | 0.9984     | 1          |
| G7              | 0.6528              | 0.9219     | 0.9194     | 1          |
| GLOBAL          | 0.6912              | 0.9387     | 0.9349     | 0.9917     | 1          |
| MENA            | 0.6952              | 0.0705     | 0.0675     | 0.2539     | 0.2942     | 1          |
| OIC             | 0.4080              | 0.9296     | 0.9222     | 0.812      | 0.8328     | −0.0431    | 1          |
| ASIA PACIFIC    | 0.8030              | 0.7919     | 0.7689     | 0.8432     | 0.8794     | 0.3756     | 0.7419     | 1          |
| LATIN           | 0.6346              | 0.8174     | 0.8227     | 0.7321     | 0.7659     | 0.2246     | 0.7823     | 0.6474     | 1          |
| NORTH AMERICA   | 0.7051              | 0.8370     | 0.8326     | 0.9830     | 0.9668     | 0.3435     | 0.7153     | 0.8410     | 0.6574     | 1          |

BIC countries are - Brazil, Russia, India, China, and South Africa.
EAFE countries are - Australia, Austria, Belgium, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland and the UK.
MENA countries are - Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates and Yemen.
NAFTA = North American Free Trade Agreement.
EAFE countries are - Australia, Austria, Belgium, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland and the UK.
period, the return rates of both WTI and Brent oil markets are negatively associated with gold return rates. It implies that gold is a safe heaven asset for the US oil market that is consistent with previous studies \(^\text{31-33}\). More interestingly, panels C and D show that the coefficients \(\beta_1\) are also negative and
Figure 6. Movements of oil and bitcoin prices from March 2018 to July 2022. This figure shows the movements of oil and bitcoin prices right before and after the WHO COVID-19 Pandemic announcement.

Table 4. The empirical linkage among oil, gold, and bitcoin.

|                  | Estimate | Standard Error | t-statistic | p-value |
|------------------|----------|----------------|-------------|---------|
| Panel A: WTI-Gold| 0.4144   | 0.1039         | 3.99        | 0.001***|
| \( \beta_1 \)    | -0.5023  | 0.1354         | -3.71       | 0.002***|
| F-statistic      | 13.75*** |                |             |         |
| Panel B: Brent-Gold| \( \alpha_0 \) | 0.2305 | 0.1291        | 1.79     | 0.094*  |
| \( \beta_1 \)    | -0.3115  | 0.1683         | -1.85       | 0.084*  |
| F-statistic      | 3.42*    |                |             |         |
| Panel C: WTI-Bitcoin| \( \alpha_0 \) | 0.2543 | 0.1211        | 2.1      | 0.056*  |
| \( \beta_1 \)    | -0.3767  | 0.1659         | -2.27       | 0.041** |
| F-statistic      | 5.16**   |                |             |         |
| Panel D: Brent-Bitcoin| \( \alpha_0 \) | 0.2750 | 0.1166        | 2.36     | 0.061*  |
| \( \beta_1 \)    | -0.3577  | 0.1716         | -2.08       | 0.038***|
| F-statistic      | 4.35*    |                |             |         |

This table reports the estimates of Eq. (1)

\[ \rho_{xyt} = \alpha_0 + \beta_1 \text{COVID}_t + \mu_t \]

***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively.
It indicates that Bitcoin can also act as a good hedging tool for oil during the pandemic period. This finding is in line with Jalal et al. and Mnif et al.

**Implications and an agenda of future research**

Studies show the COVID-19 outbreak aftermath intensified the volatility and shock transmissions between markets, with commodity and world financial markets carrying the burden of the health crisis. What implications are for the next phase?

The pandemic creates opportunities for speculation in the gold and crude oil markets causing a rise in market bubbles in different phases of the virus breakout. During the initial outbreak period, oil prices plummeted and hit an all-time low negative price in April 2020 based on the reduced demand while countries entered lockdown combined with failed negotiations between OPEC and Russia. At the time of the last literature reviewed being published, the countries of the world are still in varying states of lockdown with economies partially halted or slowly opening to trade. Oil commodities are essential for operations in the industrial sectors globally and investors include it in their portfolios for diversification and hedging of risk.

During times of financial and economic turbulence, investors engage in a flight to safety by moving their holdings to safe-haven assets such as gold and other precious metals while crude oil becomes very volatile in its movements. The stock and gold markets are negatively correlated which explains the safe-haven role of gold. The flight to safety behavior manifests in the form of exploitable speculation and inefficiencies in commodity markets as seen with gold and oil prices which swapped roles during pandemic phases. The increase in purchase of gold futures resulted in an increase in gold prices during the virus outbreak. A consequent mispricing of commodities during these times can cause investors to underestimate their exposure to risk and amplify the financial crisis underway.

The review implies that since the estimated risk in investing gold is very low, while its return is high compared to other investment opportunities such as oil and stock price, it is better off to calibrate gold in asset portfolio so as to maximize the expected utilities of risk-averse investors especially during the crisis such as COVID-19 pandemic. Moreover, the ability of gold to hedge or serve as a safe haven suggests investors rolling towards gold in order to lessen the growing concern about energy security and climate change related issues associated with oil. The review also imply that policymakers should reduce the adverse impacts of oil price volatility, which could be done by promoting the consumption of clean energy in place of fossil fuels.

Although being a new participant of the venue, Bitcoin has showed that it is also a good hedge and safe haven against extreme oil price volatility since it is not backed by a government entity, and its price is not affected by stock market movements. During financial distress, investors are likely to change their portfolios from money making and risky assets to safer schemes. If risky assets decline, investors become nervous and fear that leads them to seek out the safe haven assets such as Bitcoin and gold. If risky assets are rolling, they will significantly decrease the need for Bitcoin and gold. Nevertheless, investors should be careful when choosing bitcoin as safe haven assets for several reasons. First, compared to traditional assets, i.e., gold, bitcoin is lack of liquidity. Second, bitcoin is associated to multiple risk relative to gold. It is not easy to track Bitcoin, while gold is tracked via a worldwide tracking system that preserves its value as an investment. Scandals and frauds are also extensive in the Bitcoin ecosystem. Moreover, unlike gold, bitcoin suffers from information asymmetry, since its system is relatively complicated and may not be easily comprehended by all investors. In sum, whereas bitcoin has limited supply and enhanced popularity that definitely promote its value, gold is conventionally
most common use. Thus, whatever the investors’ goals are, both Bitcoin and gold can co-exist as refugee assets. It is also important to look at them as complements that diversify each other’s portfolios.

Media coverage of the pandemic in terms of confirmed cases, deaths and COVID-19 related news increased uncertainty, fear, and panic which resulted in amplification of volatilities due to rising inefficiencies in commodity markets. Careful real-time monitoring and regulation is necessary to prevent these inefficiencies and market bubbles from intensifying the volatility and fallout from these types of health crises. Media reporting positive news such as recovery rates and successes can go a long way in alleviating the panic, uncertainty, and fear amidst an evolving health crisis. News has a predictive power over financial markets and careful monitoring and policy measures are required to mitigate these impacts.

Islamic Sukuk bonds and stock illustrate safe-haven benefits against conventional bond markets. In addition, some other options may exist for safe-haven opportunities such as in the agriculture and renewable energies sectors. Fiscal and monetary policy stimulus packages reduced contagion risk positively affected the gold and oil commodity prices as investor confidence recovered. Portfolio optimization and successful hedging can be accomplished by adding crude oil to a precious metals’ portfolio with a higher weight of precious metals than oil. Financial markets should take joint control in preventing systemic risk outbreaks by studying risk transmissions and systemic correlations between assets and markets. The gold and crude oil relationship varies across different volatility regimes and according to market trends in the pandemic and include a strong predictive power over future stock prices. The characteristics of safe-haven assets changes over time and regular timely assessments are required. Careful monitoring and mitigation will prevent boom-bust cycles in the pandemic aftermath.

Possible future research would include examining the pandemic aftereffects during and after vaccine rollout stages and interestingly, during vaccine mandates being made by governments worldwide. As the COVID-19 pandemic is still underway and evolving with new strains emerging globally so further studies could assess the impact of the pandemic on gold and crude oil markets after three years. Studying the pandemic effects on these markets in the face of emerging evidence of waning vaccine efficacy which necessitate ongoing booster shots would provide valuable insights. Future applications of machine learning such as the Random Forest and others would contribute significantly to existing and emerging studies. These commodities, especially crude oil forms a part of daily living on individual and sector levels and no economy can function successfully without it which makes it essential to understand the interactions between these commodity assets and other markets during such an event as the COVID-19 pandemic outbreak.

Conclusion

The global economies and financial markets were not prepared and have not anticipated the devastating repercussions of the COVID-19 pandemic which is still forging ahead with new strains hitting the world in recurring waves. The literature reviewed in the writing documented some expected and unexpected pandemic impacts across varying financial asset classes and different markets in the world. COVID-19 has not done with the world yet and will be around for some time and the question remains on what that would look like going forward and the new impacts it may have on global financial markets and economies.

Understanding how the pandemic and related government interventions impact investor behavior, stock markets and commodity prices is essential for policy makers, portfolio managers and investors. Spillover effects have been determined between oil, gold, and stock markets.
Understanding the transmission of shocks and volatility between them will be helpful to cope with COVID as well as any future similar global challenges that may occur. If policy makers and reserve banks are aware of how the markets co-moved and spilled over, they can implement measures to carefully observe, control and prevent contagion effects of the magnitude seen during the outbreak. Investors, portfolio managers and hedgers can improve trading strategies and curb their tendencies to overreact in the presence of volatility and uncertainty. To maintain financial stability, financial markets and governments can work together to identify and warn of financial risk before it reaches the point of systematic correlation and prevent a systemic risk from occurring during extreme exogenous shocks such as COVID.

Reflecting on the past two years since the outbreak of COVID-19 will enable governments, individual investors, portfolio managers, hedgers, and financial markets to make improved decisions in their sphere of influence going forward. The knowledge and experience gained since the outbreak started will be valuable to decrease volatility, panic, overreaction, and uncertainty in markets and economies to create greater financial and economic stability in commodity markets across the world.

Studying how the persistent pandemic continues to affect gold and crude oil commodity markets will remain a consistent valuable and important research area for the immediate future. In addition, countries are still locking down and rolling out severe restriction policies such as vaccine mandates and how these measures impact the stock and commodity markets in these relative countries is a significant area of research to continue with including those in emerging economies. A new player in the financial asset field is Bitcoin and further research on the safe-haven properties it may offer investors can be valuable and impactful during these uncertain and turbulent times.

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ORCID iD
Min Bai https://orcid.org/0000-0003-1249-7344

Notes
1. Falk et al (2021)[51] Congressional Research Service.
2. Gold/oil ratio shows the ratio of the gold price for per ounce over the oil price for per barrel and it was determined how many barrels of oil you can get with per ounce of gold.
3. Both Freeman III (1996)[53] and Calcott [28] are review articles published in Resource and Energy Economics.

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