Hedging against risks associated with travel and tourism stocks during COVID-19 pandemic: The role of gold

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Abstract
The global lockdowns including movement restrictions during COVID-19 pandemic impacted the hospitality business negatively and by extension the trading of related stocks such as travel & tourism stocks. Owing to the long standing hedging potential of gold, we examine whether this potential can be extended to the travel & tourism stocks in order to hedge against the associated risks caused by the current pandemic. Using daily data from January 2016 to July 2020 and constructing optimal portfolio strategies, we find that gold serves as a very strong hedge and safe haven for travel & tourism stocks, most especially in the pandemic period. This conclusion validates the inclusion of gold in the diversified portfolio of travel & tourism stocks in order to improve the risk-adjusted return performance for investors in the sector particularly during COVID-19 pandemic.

KEYWORDS
gold, hedging, travel & tourism stocks, volatility spillovers

1 | INTRODUCTION

The proliferation of papers examining the relationship between stock and precious metals, especially gold, is a testimony to the keen interest among researchers in understanding the hedging relationship between the two financial assets. Gold is particularly considered an important asset and effective diversifier by investors, academics and policymakers owing to some intrinsic characteristics it possesses (Conover, Jensen, Johnson, & Mercer, 2010; Henriksen, 2018; Wen & Cheng, 2018). It is seen as a financial/liquid asset which can easily be converted into cash and as a store of value as it helps hedge against inflation (see Arnold & Auer, 2015; Aye, Chang, & Gupta, 2016 for a review of the literature). Gold also possesses other values like acting as financial arbitrage, diversification benefit and hedging potential against dollar-priced stocks and commodities as gold is also priced in dollars (see Baur & Lucey, 2010; Corbet, Larkin, & Lucey, 2020; Dee, Li, & Zheng, 2013, among others) as well as its safe haven property during tranquil and turbulent times (see Arfaoui & Rejeb, 2017; Baur & Lucey, 2010; Baur & McDermott, 2010; Capie, Mills, & Wood, 2005; Corbet et al., 2020; Gencer & Musoglu, 2014; Gokmenoglu & Fazlollahi, 2015; Lu, Wang, & Lai, 2014; Reboredo & Ugando, 2014; Reboredo & Ugolini, 2016; Sadorsky, 2014; Salisu, Ndako, & Oloko, 2019). However, some thoughts have expressed caution, stating that investor behaviour can limit the hedging property of gold particularly when investment in the precious metal is done for speculative reasons (see Baur & Glover, 2012).

Theoretically, analysing the relationship between among financial assets stems from the modern portfolio theory pioneered by Markowitz (1952, 1959) where the mean–variance (return–risk) framework is used to analyse portfolio choice and diversification decisions (see also, Adewuyi, Awodumi, & Abodunde, 2019). The justification for this is the importance of risk minimization and the belief that asset volatilities or market instabilities
due to economic conditions such as business cycles and technological changes vary across assets over time. Capital asset pricing model (CAPM) is an improvement on the modern portfolio theory, it specifies a linear relationship between the expected rate of return on an asset and the risk on the asset. This theory is further expanded to accommodate risks in the international market which culminated in the development of international capital asset pricing model (ICAPM). This framework allows investors to move their investment from local assets like stock to international assets like gold during market turmoil (Arfaoui & Rejeb, 2017).

The analysis of the relationship between gold and stock returns is not new (see for example, Basher & Sadorsky, 2016; Baur & Lucey, 2010; Baur & McDermott, 2010; Beckmann, Berger, & Czudaj, 2015; Chkili, 2016; Gürgün & Ünalmuş, 2014; Raza, Jawad, Shahzad, Kumar Tiwari, & Shahbaz, 2016; Shahzad, Raza, Balciar, Ali, & Shahbaz, 2017) and most of the findings are in favour of the use of gold as a hedge or safe haven for stocks albeit with varying outcomes across countries and financial assets. For instance, Baur and Lucey (2010) find that gold serves as both hedge and safe haven for stocks in the United States and the United Kingdom but not for Germany. Baur and McDermott (2010) also report evidence of hedging and safe haven potential for Europe and United States but not for Australia, Canada, Japan and the BRIC countries. Meanwhile, only few studies have shown that gold is neither a hedge nor a safe haven. For instance, Charlot and Marimoutou (2014) establish that oil rather than gold or bond, hedges stock best in the emerging markets. Similar claim is reported in Basher and Sadorsky (2016), however Shahzad, Bouri, Roubaud, and Kristoufek (2020) find superior outcomes for gold when comparing the hedging and safe haven potential of bitcoin and gold for stocks of G7 countries.

From the foregoing, arguments in favour of the use of gold as a hedge or safe haven for stocks seem stronger than those against it. Given the current pandemic and the need for investors to diversify their investment, this study seeks to examine whether investors in travel & tourism stocks can also draw from the potential of gold as a viable investment opportunity during crises particularly those associated with pandemics including COVID-19 pandemic. Our interest in travel & tourism stocks finds its root in a number of reasons. One, in recent times, the tourism industry has witnessed a prominent increase all over the world. For example, the tourism receipts in 2018 reached 1,451 billion U.S. dollars vis-à-vis 2 billion U.S. dollars in 1950, and international tourist arrivals increased to 1,401 million in 2018 vis-à-vis 25 million in 1950 (UNWTO, 2020; Salisu & Akanni, 2020). Two, the outbreak of coronavirus which has triggered an economic crisis has seen the travel & tourism sector become its most affected victim with about 70% loss in revenue (Salisu & Vo, 2020; Statista, 2020). The aftermath of such fear is always a severe demand shock for services such as tourism, hospitality, mass transportation and logistics (Page, Yeoman, Munro, Connell, & Walker, 2006). It tends to reduce the competitiveness of affected countries and by extension may cause huge declines in tourist receipts (Kuo, Chen, Tseng, Ju, & Huang, 2008).

In terms of methodology, we employ a bivariate generalized autoregressive conditional heteroscedastic (GARCH) based on the preliminary tests as well as its ability to capture time-variation in the analysis of hedging relationship between gold and travel & tourism stocks. In addition, the considered methodology tends to offer superior hedging effectiveness performance relative to other competing models as Vector Autoregressive model and its variants (see Lee, Chiou, Wu, & Chen, 2005; Lypny & Powalla, 1998; Yang & Lai, 2009). Finally, the use of this approach to compute optimal weight ratios and optimal hedging ratios is well documented in the empirical literature (see Arouri, Jouini, & Nguyen, 2011; Arouri & Nguyen, 2010; Salisu et al., 2020; Salisu & Mobolaji, 2013; Salisu & Oloko, 2015a, 2015b).

Following this background, we offer some preliminary analyses in Section 2 to determine the appropriate model for analyses; in Section 3, we evaluate the relative hedging effectiveness of gold for travel & tourism stocks to minimize the risks due to the pandemic while Section 4 concludes the paper.

2 DATA AND PRE-TESTS

In line with the study objectives, we utilize data covering the two main variables of interest namely gold and travel & tourism stock prices. Although the gold price is measured using the London Bullion Market Association (LBMA) gold fixing price in U.S. Dollars per troy ounce, the travel & tourism stock price index is measured as the Dow Jones (DJ) travel & tourism indices. The DJ travel & tourism index measures the stock performance of U.S. companies in the travel & tourism sector. Daily data on gold price were collected from the US Federal Reserve Bank of St. Louis (fredstat) economic database while data on travel & tourism index were retrieved from the investing.com online database. Our data scope spans a period of January 2016 to July 2020. However, as noted in the introduction, we account for the pandemic effect by partitioning the data sample into two sub-samples: (a) before COVID-19, which covers the period before the
emergence of COVID-19 (2 January 2016 to 30 December 2019); and (b) during the COVID-19 pandemic period (2 January 2020 to 5 August 2020).

The descriptive statistics using the returns series of the two variables are summarized in Table 1. The statistics considered include mean, maximum, minimum, standard deviation, skewness and kurtosis (see Table 1). The mean of the summary statistics indicates positive average value for gold stock returns across the data samples, while the average travel & tourism stock return is only positive before the emergence of COVID-19 but negative during the pandemic period. The positive mean value of gold returns could be indicative of improved average performance during the COVID-19 pandemic, whereas the travel & tourism sector witnessed a general decline in its stock performance since the outbreak COVID-19.

Furthermore, the standard deviation, which is a measure of some level of volatility in time series, shows that travel & tourism stock is more volatile than gold across the three data samples considered although the volatility is higher for the two series during the COVID-19 pandemic than the period before it. In addition, while travel & tourism stock is negatively skewed, gold is positively skewed. Both series are also leptokurtic implying that they are heavy-tailed. The graph presented in Figure 1 depicts the co-movement between the two return series.

Next, we perform some pre-tests to determine the appropriate model for the computation of optimal weight and optimal hedging rations. These tests include serial correlation and conditional heteroscedasticity tests. The serial correlation test is carried out using the Ljung–Box Q-statistics and the ARCH-LM test is employed to evaluate the conditional heteroscedasticity. In addition, we conduct the asymmetry test using the Engle and Ng (1993) sign and bias [Engle–Ng hereafter] test as well as the constant conditional correlation (CCC) test using the Engle and Sheppard (2001) [Engle–Sheppard hereafter] test. The pre-tests are carried out across the three data samples and their results are summarized in Table 2.

The ARCH-LM tests indicate that the two return series exhibit conditional heteroscedasticity, across the three data samples and therefore, accounting for ARCH effects in the estimation process is desirable. Similarly, the Ljung–Box serial correlation tests show statistical significance, especially during the COVID-19 data sample. Thus, accounting for more dynamics in the empirical model is necessary to improve the goodness of fit. Furthermore, the results of the Engle–Ng test are not statistically significant for the full and covid samples. This implies that there is no evidence of significant asymmetric effects in gold and travel & tourism stock returns for both the full and covid samples. However, gold exhibits significant joint and negative asymmetric effects, while travel & tourism series shows evidence of positive asymmetric bias in the pre-covid sample. Finally, the non-significance of Engle–Sheppard test across the three data samples provide statistical evidence of constant conditional correlations between the two series. Consequently, we favour the VARMA-CCC-GARCH over than the other variants in the full and covid samples while the asymmetric variant is preferred for the pre-covid sample.

### 3 | THE MODEL AND EMPIRICAL ANALYSES

#### 3.1 | The model

This study employs the VARMA-CCC-GARCH model proposed by Ling and McAleer (2003), relying on the outcome of the formal pre-tests reported and discussed in Section 2. The VARMA-CCC-GARCH model has been one of the prominent instruments for modelling interdependencies among financial time series both with or without asymmetric shock effects (see Al-Maadid,
Caporale, Spagnolo, & Spagnolo, 2017; Salisu & Mobolaji, 2013; Salisu & Oloko, 2015a, 2015b). The model specifies conditional mean and conditional variance equations within a bivariate framework where both return, shock and volatility spillovers are evaluated. The mean equations for the two series are expressed as:

\[ r_{tsm}^t = \phi_{tsm} + \phi_{tsm} r_{tsm}^{t-1} + \theta_{tsm} r_{gld}^{t-1} + \epsilon_{tsm}^t, \] (1)  
\[ r_{gld}^t = \phi_{gld} + \phi_{gld} r_{gld}^{t-1} + \theta_{gld} r_{tsm}^{t-1} + \epsilon_{gld}^t, \] (2)

where \( r_t \) is for the return series; \( \phi \) denotes the constant terms; \( \phi \) is for the coefficients of lagged own-returns; \( \theta \) signifies the coefficients of lagged cross-returns and measures cross-return spillovers between the two markets; \( \epsilon_t \) is for the identically distributed errors while the superscripts gld and tsm respectively denote gold and travel & tourism. On the other hand, the conditional variance equation, which provides the computation of the volatility and shock spillover effects between the two asset classes, is specified in Equations (3) and (4) for gold and travel & tourism stock returns respectively:

![Figure 1](wileyonlinelibrary.com)

**Table 2** Conditional heteroscedasticity, autocorrelation and asymmetry tests

|                  | Full sample | Pre-covid sample | Covid sample |
|------------------|-------------|------------------|--------------|
|                  | Gold        | Tourism          | Gold         | Tourism       | Gold        | Tourism       |
| ARCH LM (5)      | 23.82***    | 31.02***         | 5.20***      | 0.53 (0.76)   | 4.39***     | 4.16***       |
| ARCH LM (10)     | 19.25***    | 20.77***         | 2.79***      | 0.66 (0.76)   | 3.00***     | 2.74***       |
| LB (5)           | 2.87 (0.58) | 6.82 (0.15)      | 1.71 (0.79)  | 2.61 (0.70)   | 1.64 (0.80) | 5.12 (0.28)   |
| LB (10)          | 12.23 (0.20)| 44.10***         | 7.68 (0.57)  | 8.91 (0.45)   | 15.34*      | 19.23**       |
| LB (5)           | 168.3***    | 261.4***         | 24.84***     | 2.78 (0.73)   | 29.45***    | 35.68***      |
| LB (10)          | 380.3***    | 434.0***         | 27.99***     | 6.89 (0.74)   | 63.48***    | 57.64***      |

**PANE 2b: Asymmetry test and CCC test**

|                  | Full sample | Pre-covid sample | Covid sample |
|------------------|-------------|------------------|--------------|
|                  | Gold        | Tourism          | Gold         | Tourism       | Gold        | Tourism       |
| Sign bias        | 1.061 (0.289)| 1.054 (0.292)    | 0.840 (0.401)| 1.270 (0.205)| 1.150 (0.252)| 1.318 (0.190)|
| Negative bias    | 1.295 (0.195)| 0.466 (0.641)    | 2.200** (0.028)| 0.340 (0.734)| 0.893 (0.373)| 0.606 (0.546)|
| Positive bias    | 0.244 (0.807)| 0.412 (0.681)    | 1.511 (0.131)| 2.304** (0.021)| 0.159 (0.874)| 1.144 (0.255)|
| Joint bias       | 2.279 (0.517)| 1.118 (0.773)    | 7.511* (0.057)| 5.547 (0.136)| 1.922 (0.589)| 2.091 (0.553)|
| ES test          | 0.0171 (0.992)| 0.007 (0.997)    | 0.120 (0.942)|

Note: The ARCH LM test refers to the Engle (1982) test for conditional heteroscedasticity while the LB and LB^2 imply the Ljung–Box tests for autocorrelations involving the standardized residuals in levels and squared standardized residuals respectively. The ES test is the Engle and Sheppard (2001) CCC ^2 test; the values in parentheses denote the computed probability values. *, **, and *** indicate statistical significance at 10%, 5% and 1% levels, respectively.
\[ h_t^{\text{gld}} = c^{\text{gld}} + \alpha_1^{\text{gld}} (e_{t-1}^{\text{gld}})^2 + \beta_1^{\text{gld}} (h_{t-1}^{\text{gld}}) + \beta_2^{\text{gld}} (h_{t-1}^{\text{tsm}}), \] (3)

\[ h_t^{\text{tsm}} = c^{\text{tsm}} + \alpha_1^{\text{tsm}} (e_{t-1}^{\text{tsm}})^2 + \alpha_2^{\text{tsm}} (e_{t-1}^{\text{gld}})^2 + \beta_1^{\text{tsm}} (h_{t-1}^{\text{tsm}}) + \beta_2^{\text{tsm}} (h_{t-1}^{\text{gld}}). \] (4)

The conditional variance equations show that conditional variance for each series is dependent on its immediate past values and innovations as well as past values and innovations from the other asset class. Thus, the shock and volatility spillover effects between the two return series are measured respectively as \( \alpha_2 \) and \( \beta_2 \) where the superscripts are used to identify the series in question. The conditional covariance is expressed as:

\[ h_t^{\text{GT}} = \rho^{\text{GT}} \times \sqrt{h_t^{\text{gld}}} \times \sqrt{h_t^{\text{tsm}}}, \] (5)

where \( \rho^{\text{GT}} \) is the conditional constant correlations between the two series where GT distinctly denotes Gold (G) and Travel & Tourism (T). The estimation procedure as well as the statistical and structural properties of the model which provide both the necessary and sufficient conditions are provided in Ling and McAleer (2003) (see also Salisu & Oloko, 2015a, 2015b). Relevant post-estimation diagnostics such as the Ljung–Box statistics and the McLeod–Li statistics are employed to test if the inherent dynamics in the series are adequately captured in the estimation process. The estimated model is robust when the null hypotheses of both the Ljung–Box and McLeod–Li statistics are not rejected. The estimated results are presented and discussed in the next section.

### Table 3

| Variables | Full sample | Before COVID-19 | During COVID-19 |
|-----------|-------------|-----------------|-----------------|
| Mean equation | | | |
| \( \varphi_1 \) | 0.0250* (0.0150) | 0.0440*** (0.0000) | 0.0379 (0.0858) |
| \( \varphi_2 \) | 0.0496 (0.0354) | 0.0026 (0.7343) | 0.2194*** (0.0000) |
| \( \varphi_3 \) | -0.0089 (0.0205) | -0.0146 (0.1994) | 0.0228 (0.1093) |
| \( \varphi_4 \) | 0.0236 (0.0310) | 0.0438*** (0.0000) | 0.0245 (0.5423) |
| \( \theta_1 \) | 0.0426*** (0.0125) | 0.0391*** (0.0000) | -0.0218** (0.0361) |
| \( \theta_2 \) | 0.1923*** (0.0621) | 0.2024*** (0.0000) | -0.2237*** (0.0003) |
| Variance equation | | | |
| \( c_1 \) | 0.1490*** (0.0000) | 0.1626*** (0.0000) | 0.0356*** (0.0000) |
| \( c_2 \) | -0.6966*** (0.0000) | 1.0044*** (0.0000) | 0.3140*** (0.0000) |
| \( \alpha_{11} \) | -0.0043 (0.2543) | -0.0394*** (0.0000) | 0.0333*** (0.0000) |
| \( \alpha_{12} \) | 0.1157*** (0.0000) | 0.0947*** (0.0000) | 0.1104*** (0.0000) |
| \( \alpha_{21} \) | 0.0183*** (0.0000) | 0.0309*** (0.0000) | 0.0209*** (0.0000) |
| \( \alpha_{22} \) | 1.3600*** (0.0000) | 1.5085*** (0.0000) | 0.6226*** (0.0000) |
| \( \beta_{11} \) | 0.6058*** (0.0000) | 0.4725*** (0.0000) | 1.0040*** (0.0000) |
| \( \beta_{12} \) | 0.2824*** (0.0000) | 0.3614*** (0.0000) | 0.8220*** (0.0000) |
| \( \beta_{21} \) | 0.0248*** (0.0000) | 0.0356*** (0.0000) | -0.0270*** (0.0000) |
| \( \gamma_1 \) | 2.6603*** (0.0000) | -0.7823*** (0.0000) | -0.1948*** (0.0000) |
| \( \gamma_2 \) | 0.0027 (0.8416) | 0.0080*** (0.0000) | 0.0080*** (0.0000) |
| \( \rho_{12} \) | -0.1170*** (0.0000) | -0.0659*** (0.0020) | -0.2141*** (0.0000) |
| Model diagnostics | | | |
| AIC | 6.315 | 5.835 | 8.770 |
| SBC | 6.390 | 5.929 | 9.104 |
| Hannan-Quinn | 6.343 | 5.871 | 8.771 |

Note: Parameters in mean and variance equations are as defined in the model given in Equations (1)–(4); the subscripts 1 and 2 respectively indicate gold and travel & tourism stock returns. The values in parentheses denote the computed probability values.

*Denote statistical significance at 10% level.
**Denote statistical significance at 5% level.
***Denote statistical significance at 1% level.
3.2 Discussion of results

The results of the bivariate VARMA-CCC-GARCH (without asymmetry) and VARMA-CCC-AGARCH (with asymmetry) models are summarized in Table 3. The results are portioned into full sample, pre-covid sample and covid sample as discussed in the data section. Beginning with the mean equation, we find evidence of statistically significant return spillovers between gold returns and travel & tourism stock returns across the three data samples. However, while the coefficients are positive in the full sample and pre-covid sample, it is negative for the covid sample. This is explained by the significant values of $\theta_1$ and $\theta_2$ for the two return series in all the data samples. The contrasting evidence between the covid sample and other data samples in terms of direction of return spillovers further validates the adverse effect of the pandemic on financial markets (see also Gil-Alana & Claudio-Quiroga, 2020; Narayan, 2020a, 2020b; Salisu & Akanni, 2020; Salisu & Sikiru, 2020; Sharma, 2020).

Besides, the magnitude of the effects of gold returns on the travel & tourism stock returns is higher than the reverse, which is the effect of the one lag travel & tourism stock returns on gold return. During the COVID-19 pandemic outbreak, a 1% increase gold returns in the immediately preceding period will lead to a decline in travel & tourism sector returns by about 0.22% while it is just about 0.02 vice versa. An implication of the finding is that the magnitude of economic risks associated with the ongoing global COVID-19 pandemic affects the travel & tourism sector, almost bringing it to a total halt as a result of economic lockdowns and movement restrictions, whereas on the other hand, a number of investors mitigate their investment risks by investing in commodity stocks such as gold. This finding is also consistent with empirical results from previous studies which establish that travel & tourism firms are severely exposed to event-related risks such as the 9/11 attacks in the United States and the global financial crisis of 2008 (see also Kim, Kim, & O’Neill, 2013; Lee & Jang, 2011; Li, Feng, Li, & Sun, 2020; Paraskevas & Quek, 2019; Park, Song, & Lee, 2017; Srydeh, Shahateet, Mohammad, & Sumadi, 2019).

Furthermore, the volatility spillover effects captured in the variance equation are summarized in the lower pane of Table 3. The results show that all the parameters including the ARCH terms ($\alpha_{11}$, $\alpha_{12}$, $\alpha_{21}$ and $\alpha_{22}$) and the GARCH terms ($\beta_{11}$, $\beta_{12}$, $\beta_{21}$ and $\beta_{22}$) are statistically significant especially for the covid sample. The own shock effect for the gold returns ($\alpha_{11}$) is negative and statistically significant before the pandemic while it is positive and significant during the pandemic. Essentially, while the gold returns have negatively responded to previous own shocks before the occurrence of COVID-19 pandemic, the response is positive during the pandemic period. On the other hand, for the travel & tourism stocks, the own shock response ($\alpha_{22}$) is positive and statistically significant across the three period sub-samples. The cross-market shock spillovers between gold and the travel & tourism stocks ($\alpha_{12}$, $\alpha_{21}$) show that the current conditional volatility for each of the markets significantly depends on immediate past shocks from the other market. In addition, the signs are similar and positive for both markets across the three period samples considered.

As expected, the own-volatility transmission for both markets ($\beta_{11}$, $\beta_{22}$) is positive and statistically significant. However, the results of the cross-volatility spillover effects ($\beta_{12}$, $\beta_{21}$) are mixed although they all are statistically significant. We find that the immediate past value of gold volatility impacts negatively on the current volatility of travel & tourism stocks before and during COVID-19 pandemic. This satisfies the requirement for validating the hedging and safe haven potential of gold where higher volatilities in the gold market tend to reduce the volatility in the travel & tourism sector both in tranquil (pre-covid) and crisis (covid) periods. Although, the sign of the cross-spillover from the travel & tourism sector is negative during the pandemic, it is however less effective in providing protection against risks during crisis. Similarly, unlike gold, the positive sign obtained for travel & tourism market in the pre-covid period further attests to the weak potential of this market in providing protection even in tranquil periods. Finally, the outcome of the return and volatility analyses offers a caution about the choice of data samples for hedging analysis. More importantly, the covid sample needs to be distinctly analysed or accounted for when modelling return and volatility transmission given the contrasting evidence between the pre-covid and covid periods.

In terms of asymmetric shock effect which is only established in the pre-test for the pre-covid estimation, the results show evidence of positive asymmetric shock effects for both markets but only statistically significant for the travel & tourism market given the $p$-value of $\gamma_2$. Where it is significant, it implies that negative shock may fuel higher volatilities than positive shock of the same magnitude. We further render some post-estimation diagnostics using the Ljung–Box statistic and McLeod–Li statistics as previously discussed. The diagnostic tests summarized in Table 4 confirm the adequacy of the dynamics in the model. The results of the Ljung–Box test indicate that the null hypothesis of no serial correlation cannot be rejected, similarly the adequacy of the ARCH and GARCH terms is supported by the McLeod–Li test which shows that there are no remaining ARCH and GARCH effects in model. In other words, allowing for lag
order of one both in the mean and variance equations is sufficient to capture the inherent dynamics in the model and increasing (reducing) the lag order may lead to model over (under) fitting.

3.3  Optimal portfolio and hedging effectiveness of gold against travel & tourism stocks

We extend the estimated results from the preceding section by evaluating the optimal portfolio weights and hedging effectiveness of gold for travel & tourism stocks. The statistically significant returns and volatility spillovers between the two markets indicate that investors’ assets in both markets are volatile and susceptible to risks. Besides, the outbreak of COVID-19 amplifies the vulnerability of global financial markets to risks. Hence, to mitigate such risks, investors engage in portfolio rebalancing and hedging through investment in futures contract and without jeopardising their expected returns. Therefore, we estimate the optimal portfolio weights (OPW) to evaluate the optimal proportion of gold and travel & tourism stocks that should be included in the investment portfolio of an average rational investor. We follow Kroner, Ng, Kroner, and Ng (1998) and Arouri, Lahiani, and Nguyen (2011) by constructing the optimal portfolio weight of holding the two assets using the conditional variance and covariances as earlier estimated (see also, Salisu & Mobolaji, 2013; Salisu & Oloko, 2015a). The OPW is defined as:

\[ \omega_{GT,t} = \frac{h_t^{gld} - h_t^{GT}}{h_t^{tsm} - 2h_t^{GT} + h_t^{gld}}, \]  

(6)

and,

\[ \omega_{GT,t} = \begin{cases} 
0, & \text{if } \omega_{GT,t} < 0 \\
\omega_{GT,t}, & \text{if } 0 < \omega_{GT,t} \leq 1 \\
1, & \text{if } \omega_{GT,t} > 1 
\end{cases} \]  

(7)

where \( \omega_{GT,t} \) denotes the weight of gold asset in a one-dollar gold/travel & tourism stock portfolio at time \( t \) and \( h_t^{GT} \) is the conditional covariance between the gold and travel & tourism stock returns at time \( t \). Consequently, the optimal weight of gold in the two asset classes considered can be evaluated as \( 1 - \omega_{GT,t} \). Furthermore, we construct the optimal hedge ratio (OHR) to evaluate the hedging effectiveness of gold against travel & tourism stocks. Following Kroner and Sultan (1993), the risk of an investment portfolio is minimized if a long position of one dollar in one asset (e.g., travel & tourism) can be hedged by a short position of \( \alpha_t \) dollars in another asset (e.g., gold). The formulation of the OHR between the two assets is defined as (see also Arouri, Jouini, & Nguyen, 2011; Salisu & Mobolaji, 2013; Salisu & Oloko, 2015a):

\[ \alpha_{GT,t} = \frac{h_t^{GT}}{h_t^{gld}}. \]  

(8)

The results of the optimal portfolio weights and OHRs, computed for the three data samples, are summarized in Table 5. We find that the optimal weight of gold assets in a one-dollar gold–tourism stock portfolio is about 27% before the outbreak of COVID-19 and 13% after the outbreak. On the other hand, for OHR, the negative values of the hedge ratios suggest that risks associated with tourism stocks can be hedged by taking a short position in gold assets (see Baur & Lucey, 2010). The OHR for the pandemic period shows that the hedging effectiveness of gold against travel & tourism stocks increased with the outbreak of COVID-19. For example, while the OHR value for the pre-covid sample is about −0.11, that of the pandemic is about 0.70. Previous empirical including Kumar (2014) and Shrydeh et al. (2019) find that stock-gold portfolio provides better diversification benefits than holding just stock portfolios. However, contrary to the results which suggest that the hedging effectiveness of gold against stocks tends to

| TABLE 4 Post estimation diagnostics |
|-----------------------------------|
| **Full sample**                  | **Before COVID-19** | **During COVID-19** |
| Gold                              | Tourism            | Gold                | Tourism            | Gold                | Tourism            |
| Ljung–Box Q (2)                   | 0.2315 (0.8097)    | 0.2386 (0.8875)    | 0.2903 (0.8649)    | 0.0169 (0.9916)    | 0.6573 (0.7199)    | 1.2044 (0.5476)    |
| Ljung–Box Q (5)                   | 0.7261 (0.9815)    | 1.1835 (0.9464)    | 1.1661 (0.9481)    | 1.5028 (0.9127)    | 2.7782 (0.7341)    | 2.2363 (0.8156)    |
| McLeod–Li (2)                     | 0.0164 (0.9918)    | 0.4534 (0.7971)    | 2.1370 (0.3435)    | 0.2556 (0.8800)    | 0.0029 (0.9988)    | 0.1315 (0.9364)    |
| McLeod–Li (5)                     | 0.2971 (0.9977)    | 1.1347 (0.9510)    | 4.8004 (0.4407)    | 0.7363 (0.9809)    | 0.3567 (0.9964)    | 1.3149 (0.9334)    |

Note: The Ljung–Box and McLeod tests provide the empirical statistics respectively for the serial correlation and remaining conditional heteroscedasticity of orders 2 and 5 for robustness purposes.
diminish in a crisis era (see Hood & Malik, 2013; Shrydeh et al., 2019), gold continues to retain its property of minimizing losses during the pandemic period.

### 3.4 Additional results

We also offer additional analyses by investigating the role of exchange rate and market volatilities on the portfolio choice and hedging effectiveness between gold and travel & tourism stocks. As pointed out in the introduction, the emergence of COVID-19 pandemic and the consequent responses by countries across the globe through border closures to visitors and tourists have severely impacted the travel & tourism industry (UNWTO, 2020). Hence, we account for the pandemic effect using the newspaper-based Equity Market Volatility Infectious Disease Tracker (EMV) retrieved from the Fredstat database (Baker et al., 2020).

In addition, gold is traded and used all over the world for investment purposes, jewellery making and as a medium of exchange. However, while an ounce of gold and hence its spot gold price is theoretically the same globally, the differing currency values and dealer premiums can have varying effect on gold. Therefore, we include as additional exogenous variable, exchange rate, using the exchange value of Euro to US dollar as a proxy. Empirical studies have also indicated that increases in unexpected market volatility may cause investors to raise their estimates of future expected volatility, and thus increase their current demand for hedging (Chang, Chou, & Nelling, 2000). We measure the market volatility using gold exchange traded funds (ETF) volatility of the Chicago Board Options Exchange (CBOE). The Gold ETF captures shares of trusts that hold portfolios of stocks designed to closely track the price performance and yield of gold indices. Thus, for robustness, we extend the baseline mean equations to include additional exogenous variables such as EMV, exchange rate and gold market volatility. The revised results after controlling for these variables are summarized in Table 6.

The estimated OPW and OHR results summarized in Table 6 indicate that an increase in the optimal weight of gold assets after accounting for the exogenous factors. Contrary to the initial 13% OPW estimated after the outbreak, by accounting for exchange rate, market volatility and infectious disease index, the optimal weight of gold in a gold/tourism portfolio increased to about 52%. In addition, the negative values of the hedge ratios are still established across the three samples thus confirming that risks associated with travel & tourism stocks can be hedged by taking a short position in gold assets even after controlling for the exogenous factors. Although the pandemic hedge ratios decline after including the control variables, this outcome aligns with the empirical findings of Shrydeh et al. (2019) which suggest that the hedging effectiveness of gold against US stocks tends to diminish in a crisis era. Summarily, our empirical results show the significance of accounting for relevant exogenous factors when evaluating the hedging effectiveness between gold and US travel & tourism stocks in order to avoid misleading outcomes.

### 4 Conclusion

This paper empirically evaluates the returns and volatility spillover transmission between gold asset and US travel & tourism stocks as well as the hedging effectiveness of the former against the latter. Given the peculiarities of the series, and in line with the study objective, we employed the VARMA-CCC-GARCH model and its asymmetric variant to evaluate the spillover analysis as well as own and cross-market shock and volatility spillover effects.

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**TABLE 5** Optimal portfolio weights and hedge ratios

|                      | Full sample | Before COVID-19 | During COVID-19 |
|----------------------|-------------|-----------------|-----------------|
| $\sigma_{GT,t}$      | 0.1597      | 0.2717          | 0.1297          |
| $\alpha_{sz,t}$      | -0.2991     | -0.1116         | -0.7009         |

*Note: The table reports average optimal weights and hedge ratios in a gold-travel & tourism asset portfolio.*

**TABLE 6** Optimal portfolio weights and hedge ratios – with control variables

|                      | Full sample | Before COVID-19 | During COVID-19 |
|----------------------|-------------|-----------------|-----------------|
| $\sigma_{GT,t}$      | 0.1465      | 0.2898          | 0.5223          |
| $\alpha_{sz,t}$      | -0.3281     | -0.1319         | -0.2063         |

*Note: The table reports average optimal weights and hedge ratios in a gold-travel & tourism asset portfolio using the variance and covariance estimates of the VARMA-CCC-GARCH models after accounting for exogenous factors including exchange rate and gold EMV volatilities.*
We further account for the relevance of the COVID-19 outbreak in the estimation by portioning the data samples into pre-covid, covid and full samples. The estimated results indicate significant bidirectional return spillovers between the gold asset returns and travel & tourism stock returns. The computed optimal weight and hedge ratios further confirm that the hedging effectiveness of gold against risks associated with travel & tourism stocks particularly more noticeable in the covid period. Essentially, a diversified asset portfolio that includes gold alongside travel & tourism stocks may improve the risk-adjusted return performance. Our finding is further strengthened after accounting for exchange rates and market-related volatilities.

ACKNOWLEDGEMENTS

We thank the Editor-in-Chief, Professor Mark P. Taylor and the anonymous referee for helpful comments. However, any remaining errors are solely ours.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. Some of the data are not publicly available due to privacy or ethical restrictions.

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ENDNOTES

1 For clarity purpose, an asset is considered as an effective hedge once it proves to be uncorrelated or negatively correlated to stock price movements on the average. Whereas a safe haven is that which is consistently uncorrelated or negatively correlated to stock price movements during times of market turmoil (see Baur & Lucey, 2010).

2 Several studies have established a strong link between financial markets and the current pandemic (see for example, Gil-Alana & Claudio-Quiroga, 2020; Narayan, 2020a, 2020b; Salisu & Akanni, 2020; Salisu & Sikiru, 2020; Sharma, 2020, among others).

3 This is similar to the approach used in a related study by Salisu, Vo, and Lawal (2020) where the hedging potential of gold against oil price risk during COVID-19 pandemic is examined.

4 The return series is computed as the first difference of the natural log of price/index data in question.

5 The term VARMA denotes vector autoregressive moving average; CCC is constant conditional correlations; and GARCH is generalized autoregressive conditional heteroscedasticity. The inclusion of ‘A’ in the GARCH term implies ‘Asymmetry’. In our study, the VARMA components measure shock and volatility spillovers between the two asset classes and are incorporated in the conditional variance equations since these information are crucial in the evaluation of hedging strategies and effectiveness.

Nonetheless, it is also possible to incorporate the VARMA terms in both the conditional mean and conditional variance equations particularly in a situation where the focus is on impact analysis rather than hedging (see Salisu & Oloko, 2015a, 2015b for a review of the literature).

6 The pre-covid estimation is carried out using the augmented version of the VARMA-GARCH model as proposed by McAleer, Hoti, and Chan (2009) by accounting for asymmetry where such matters.

7 In this case, the variance equations in (3) and (4) are augmented with the asymmetry parameter as follows:

\[
\begin{align*}
    h_{t}^{gld} &= \alpha_{t}^{gld} \left( \varepsilon_{t-1}^{gld} \right)^{2} + \gamma^{gld} \left( \varepsilon_{t-1}^{gld} \right)^{2} I_{t-1}^{gld} \\
    &+ \rho^{gld} \left( h_{t-1}^{gld} \right) + \rho^{gld} \left( h_{t-1}^{tsm} \right),
\end{align*}
\]

\[
\begin{align*}
    h_{t}^{tsm} &= \alpha_{t}^{tsm} \left( \varepsilon_{t-1}^{tsm} \right)^{2} + \gamma^{tsm} \left( \varepsilon_{t-1}^{tsm} \right)^{2} I_{t-1}^{tsm} \\
    &+ \rho^{tsm} \left( h_{t-1}^{tsm} \right) + \rho^{tsm} \left( h_{t-1}^{gld} \right),
\end{align*}
\]

where the asymmetry indicator \(- I_{t-1} = 1 \) if \( \varepsilon_{t-1} < 0 \) and zero otherwise.

8 UNWTO is an acronym for the United Nations World Tourism Organisation.

9 The EMV index documents and quantifies increase in economic uncertainty and it is constructed by Baker, Bloom, Davis, and Kost (2019). To construct the index, the authors identify three indicators: stock market volatility, newspaper-based economic uncertainty, and subjective uncertainty in business expectation surveys that provide real-time forward-looking uncertainty measures.

10 See https://goldprice.org/spot-gold.html

11 The estimated results of the extended bivariate VARMA-AGARCH model for both the mean and variance equations after accounting for interest and exchange rates are not presented but could be made available upon request.

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How to cite this article: Sikiru AA, Salisu AA. Hedging against risks associated with travel and tourism stocks during COVID-19 pandemic: The role of gold. *Int J Fin Econ*. 2021;1–11. https://doi.org/10.1002/ijfe.2513