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THE INFLUENCE OF COVID-19 ON GOLD PRICE VOLATILITY - A COMPARATIVE STUDY OF INDIA AND VIETNAM

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The covid-19 pandemic has had far-reaching consequences for the global economy, affecting many financial market components, including the gold market. This study compares India and Vietnam based on data on several covid-19 indicators such as daily new infections, cumulative totals, daily new deaths from covid-19, and total deaths due to covid-19, affecting gold price volatility. The study's findings are based on daily observational data from the first confirmed case of covid-19 until March 11-2022, demonstrating that the covid-19 indicators have the opposite effect on gold prices in India and Vietnam. The study examined the effect of covid-19 (used as a dummy variable representing the date of covid-19 cases and the date of covid-19 deaths) using the GARCH (1,1) model. The study found no evidence of the covid-19 dummy's effect on gold price volatility in India. Meanwhile, the study's findings show that the impact of covid-19 exacerbates the negative effect on gold price fluctuations in Vietnam over time, especially on days when there is information about covid-19 deaths.

Keywords: *Coronavirus, gold price, gold volatility, ARCH/GARCH models.*

JEL Classifications: *C52, G15.*

1. Introduction

The Covid-19 pandemic began in Wuhan (China) at the end of 2019, and has since spread throughout the world. At the time of this study, as of the beginning of March 2022, the total number of infections worldwide had surpassed 450 million, with more than 6 million deaths. Every day, the world sees hundreds of thousands of new cases and thousands of deaths, and it shows no signs of slowing down, even spreading rapidly in some countries after social distancing measures were relaxed.

The Covid-19 pandemic has had far-reaching consequences for all countries. The global economy has entered a deep recession, supply chains have stalled, and the Covid-19 pandemic has affected virtually every market. Travel bans and border closures, stay-at-home and work-from-home orders, and extensive business closures have all been widely implemented around the world to stem the spread of the virus, causing massive economic fallout. The Covid-19 pandemic not only has a negative impact on trade and tourism, but it also has an impact on

investment activities, disrupting investment psychology and influencing individual investor decisions. Fear of a virus has caused significant stress in financial markets in general, as well as the Gold market in particular, where prices are frequently volatile.

Investors are all concerned about the impact of the covid-19 pandemic on gold prices in the context of constantly increasing infections that show no signs of abating. Simultaneously, policymakers are interested in the impact of information on the number of new infections and deaths caused by covid-19 on the gold market. Because fluctuations in the gold market can cause significant disruptions in people's saving and investment psychology, as well as start financial market crises.

Many studies have found a statistically significant relationship between the increase in the number of new Covid-19 infections and the increase in the price of gold (Yousef and Shehadeh, 2020); the number of new infections, the number of deaths, and negative information from the Covid-19 pandemic all have a positive effect on the price of gold (Hanen Atri et al., 2021). As a result, on a global research scale, there is empirical evidence on the impact of covid-19 on the gold market. Exploring the impact of covid-19 on gold price and volatility on a country, on the other hand, will help verify relevant prior research results and form the basis for making recommendations for private investors, as well as provide policy implications for policymakers, particularly in developing countries.

India and Vietnam are both Asian countries where people have an ancient love for Gold. Buying and storing gold is a long-standing popular habit of every citizen. So in this study, we examine the impact of coronavirus on spot gold prices in India and Vietnam for the first time, looking at the correlation between cumulative infections, daily new cases, the total number of deaths, and the number of new deaths daily. We'd like to know if there's a link between these variables.

We assume that this correlation is due to an increase in economic uncertainty caused by the virus's spread. Furthermore, a possible national recession caused by the COVID-19 pandemic may mean that investors will continue to seek refuge in gold for some time. As a result, demand for gold may continue to rise, pushing up the price until a vaccine or other virus treatments emerge to help stabilize the national economy.

Following that, because the price of gold tends to influence itself over time, we continue to investigate the impact of covid-19, as a dummy variable, on the volatility of Gold investment income in Vietnam and India using ARCH and GARCH models.

We assume that bad news tends to increase the volatility of gold returns more than good news, so an increase in the number of coronavirus cases or deaths (a bad news indicator) would increase the volatility of gold returns.

2. Literature review

Several empirical studies have found a statistically significant relationship between information about covid-19 and global gold price movements.

Yousef and Shehadeh (2020) discovered a link between the increasing number of coronavirus infections worldwide and the rising price of gold. The authors discovered a significant positive effect of COVID-19 on the conditional variance equation using the GARCH and GJR-GARCH models, implying that coronavirus may indeed increase the volatility of gold profit. This is due to the fact that the virus's spread raises uncertainty about the future of economic and financial markets, increasing demand for gold and driving prices higher, a trend that could continue. continue until vaccines or other treatments start to improve the global economic outlook. The authors contend that volatility is a major concern for both investors and policymakers, who base their decisions on the overall stability of financial markets. Furthermore, volatility estimation is an important component in many models and has a wide range of applications in companies' market risk management practices. Finally, understanding gold market volatility is critical to any analysis of current and future expectations for coronavirus-related risks in global markets.

In another study, Hanen Atri et al (2021) examined the impact of covid-19 news, panic, and social

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media reports about covid-19 on crude oil prices and gold price. Using ARDL approach with research data for the period from January 23, 2020 to June 23, 2020, the authors found a statistically significant relationship between research variables, in Meanwhile, information on the number of deaths from covid-19 and panic has a negative impact on crude oil prices, while information on the number of new cases of covid-19, the number of deaths and information on the media Social media has a positive effect on Gold price movements. The authors believe that the sensitivity of crude oil price to covid-19 is different from the sensitivity of gold price to Covid-19, gold price fluctuates as a compensation for economic crisis, because gold is always the safe haven for investors in the context of risks, especially in the context of the covid-19 pandemic. Although they all assess the negative impact of covid-19 on the economy in general as well as on crude oil prices in particular, the authors believe that the impact of information about covid-19 on gold prices depends on whether is covid-19 a pandemic or just a seasonal epidemic.

Alfi Syahri et al. (2020) investigated the relationship between gold price, exchange rate, and CSPI during the COVID-19 pandemic by looking at the impact of gold price and exchange rate on CSPI and stock volatility. Also, by examining the dynamics of the correlations between the CSPI and gold, as well as the CSPI and the exchange rate. The data is gathered from secondary sources such as JCI daily data, gold price, and exchange rate during the COVID-19 pandemic period, which runs from January to June 2020. Furthermore, the data was analyzed using the GARCH method to investigate the impact of changes in gold and USD prices on the CSPI and stock volatility. As a result, the DCC-GARCH method is used to examine the dynamic correlation between the CSPI and gold, as well as the IHSG and the exchange rate. The findings indicate that changes in the price of gold have a significant impact on stock price volatility, as well as the presence of a positive dynamic correlation between the CSPI and gold and a negative dynamic correlation between the CSPI and the exchange rate. Individual investors will benefit from this study because it examines the relationship between the CSPI, gold, and exchange rates.

Zeravan Abdulmuhsen Asaad (2021) uses econometric methods to determine the interactions between crude oil prices, gold prices, exchange rates and stock prices represented by the ISX60 index of the previous Iraq stock exchange. and during the global pandemic COVID19. The analysis uses daily data categorized into full sample time periods prior to the COVID-19 pandemic and during covid-19 to measure the interaction between variables for each period. To that end, the study used analytical techniques to ensure the stability of the ARDL model and the granger causality test. The results of the correlation analysis showed different results between the variables based on the time division. Furthermore, the results study accepts the null hypothesis of non-existence of cointegration between the corresponding variables for the full sample before and during COVID19. The results of the study cannot make any determinations about the long-run relationship between the variables over the time period (during COVID19), while the results of the short-run causal model show that crude oil prices and exchange rates are not suitable for the Iraq stock exchange.

Khani et al (2021) develop a new model to properly estimate stock market values for the COVID-19 dataset using a long-term short-term memory (LSTM) network. The goal of their study was to establish a model that could predict the near future involving a set of features. The nature of the characteristics in each pandemic is completely different; therefore, the results of pandemic prediction by the special model cannot be applied to other pandemics. Therefore, recognizing and extracting the characteristics that contaminate the pandemic is key. In this study, the authors developed a framework that provides a better understanding of features and the feature selection process, based on preliminary analysis of features such as COVID-19 and other market codes to enhance the performance of forecasting models against market volatility. The authors based on market value data and daily time series data on

the COVID-19 pandemic (i.e. number of new cases). In this study, the authors have chosen Gold Price as the basis for their forecasting task. The price of gold can be replaced by any other market. The authors applied convolutional neural network (CNN) LSTM, vector sequence output LSTM, bidirectional LSTM, and encoder-decoder LSTM on the data set. The results of the LSTM vector sequence output achieved on the validation set respectfully for the previous 1 day, 2 days, and 30 days, performed better than predictions suggested in other prior studies.

Preliminary research, however, is divided on the impact of COVID-19 on gold prices and the volatility of gold investment returns. However, in the majority of studies on this topic, the variables used to measure covid-19 infections include the total cumulative number of covid-19 infections, the number of daily new covid-19 cases, the total number of COVID-19 case deaths, and the number of daily deaths from covid-19 infections. At the same time, the majority of the studies combined OLS regression with time series autoregression techniques. In this study, the results of prior study analysis are used to select variables in the research model and appropriate data analysis techniques.

3. Methodology and Data Collection

Regression Model

The total number of daily global new coronavirus cases and the cumulative number of cases were extracted from the daily situation reports released by the World Health Organization (WHO) beginning on March 11 of 2020 in India and July 31 of 2020 in Vietnam. Our sample thus covers the period from March 11 of 2020 to March 11 of 2022 and includes 514 observations in India and the period from July 31 of 2020 to March 11 of 2022 and includes 205 observations in Vietnam. In addition, the daily gold spot prices were collected from Thomson Reuters for the timeframe 2010-2022, which we divide into two periods of study. The first period, COVID-19 in India and Vietnam, is used in the regression analysis to assess the impact of COVID-19 on gold spot prices, while the second period, January 1 of 2010 to March 11 of 2022, is used in the GARCH model to analyze the impact of the virus on the volatility of gold returns.

Concerning the impact of coronavirus on gold spot prices, the dependent variable is the daily gold spot price in local currency, and the independent variables are (1) the total number of new cases; (2) the cumulative total number of daily cases; (3) the cumulative total number of daily new deaths and (4) the total number of deaths. The relevant equations can be written as follows:

Covid-19 indicators	India	Vietnam
Number of new cases	$GP\_IN = \beta_0 + \beta_1 * Log(NC\_IN)$	$GP\_VN = \beta_0 + \beta_1 * Log(NC\_VN)$
Total cases	$GP\_IN = \beta_0 + \beta_1 * Log(TC\_IN)$	$GP\_VN = \beta_0 + \beta_1 * Log(TC\_VN)$
Number of new death	$GP\_IN = \beta_0 + \beta_1 * Log(ND\_IN)$	$GP\_VN = \beta_0 + \beta_1 * Log(ND\_VN)$
Total death	$GP\_IN = \beta_0 + \beta_1 * Log(TD\_IN)$	$GP\_VN = \beta_0 + \beta_1 * Log(TD\_VN)$

Volatility Models (ARCH/GARCH Models)

Since Engle first introduced autoregressive conditional heteroscedasticity (ARCH) models in 1982, this method, as well as its even more relevant cousin, the GARCH model (Bollerslev, 1986), have become standard tools for assessing the volatility of financial variables. The model, according to Sadorsky (2006), is extremely useful for observing heteroskedastic behavior or volatility clustering in financial markets without the need for higher-order models.

Essentially, the model predicts variance in the current period by forming a weighted average of (i) a long-term average, (ii) forecasted variance in the previous period, and (iii) volatility information observed in the previous period. When a return is unexpectedly large in either a positive or negative direction for a given period, the trader will respond by increasing the variance estimate for the next period.

The model also accurately represents the volatility clustering that is frequently observed in financial returns data, where significant changes in returns

are followed by even more significant changes (Trück, 2020; Yousef, 2020).

The ARCH (i) model mean equation:

$Return\_inr_t = \beta_0 + \beta_1 * Return\_inr_{t-1} + \beta_2 * \epsilon_{t-1} + \beta_3 * Covid\_I + \beta_4 * D\_cv\_I + \epsilon_t$

$Return\_vnd_t = \beta_0 + \beta_1 * Return\_vnd_{t-1} + \beta_2 * \epsilon_{t-1} + \beta_3 * Covid\_V + \beta_4 * D\_cv\_V + \epsilon_t$

The ARCH (i) model variance equation:

$h_t = \beta_0 + \beta_1 * h^2_{t-1} + \beta_2 * h^2_{t-2}$

The GARCH (1,1) model mean equation:

$Return\_inr_t = \beta_0 + \beta_1 * Return\_inr_{t-1} + \beta_2 * \epsilon_{t-1} + \beta_3 * Covid\_I + \beta_4 * D\_cv\_I + \epsilon_t$

$Return\_vnd_t = \beta_0 + \beta_1 * Return\_vnd_{t-1} + \beta_2 * \epsilon_{t-1} + \beta_3 * Covid\_V + \beta_4 * D\_cv\_V + \epsilon_t$

The GARCH (1,1) model variance equation:

$h_t = \beta_0 + \beta_1 * h^2_{t-1} + \beta_2 * h_{t-1}$

Where COVID (Covid_I, Covid_V, D_cv_I and D_cv_V) is a dummy variable equal to one for the coronavirus period or covid-19's death (from 03/11/2020 to 03/11/2022 in India and from 07/31/2020 to 03/11/2022 in Vietnam) and zero otherwise, and where the GARCH models are studied from January 01, 2010 to March 11, 2020. In addition, we use daily gold returns calculated as the first differences between natural logarithmic daily gold closing prices.

4. Results of the Data Analysis

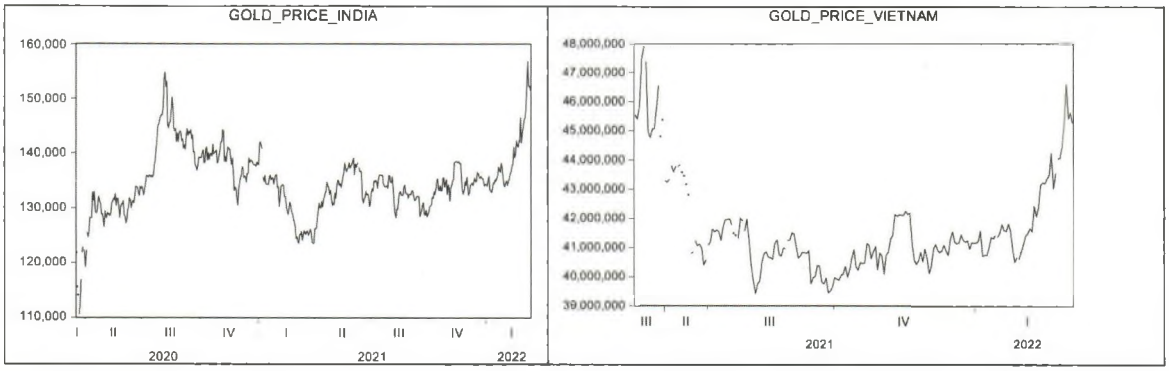
4.1. Covid-19 indicators and gold prices in Vietnam and India

On March 11, 2020, India had its first confirmed case of Covid-19, while Vietnam successfully implemented its zero-covid strategy until the end of July of the same year. By comparing the images below, we can see the image of gold price movements in India and Vietnam from the time the first case of covid-19 was detected until March 11, 2022. (Figure 1).

The image of gold price movements in India and Vietnam during the covid-19 period depicts the two countries' disparate gold market movements. Gold prices in India fluctuate up and down based on trends that show cycles in each Covid-19 wave. Meanwhile, in Vietnam, the gold price fell in the early stages of the pandemic, then stabilized with small fluctuations for a long time. When the number of infections increased in the fourth wave of the covid-19 epidemic, the gold price in Vietnam recovered strongly (possibly due to the easing of epidemic prevention regulations, and the vaccination rate in Vietnam has reached is very high and the death rate for covid-19 infections has dropped sharply). Figure 2 shows the evolution of important covid-19 indicators in Vietnam and India, including the number of new covid-19 infections, the total number of cumulative infections, the number of new deaths, and the total number of deaths from covid-19.

The descriptive statistics also show the difference in gold price volatility between India and Vietnam.

Although the observation time is different with 514 observations in India and 205 observations in Vietnam, the price of gold is expressed in different



Source: Authors

Figure 1: *Gold price movements in India and Vietnam during the covid-19 period*

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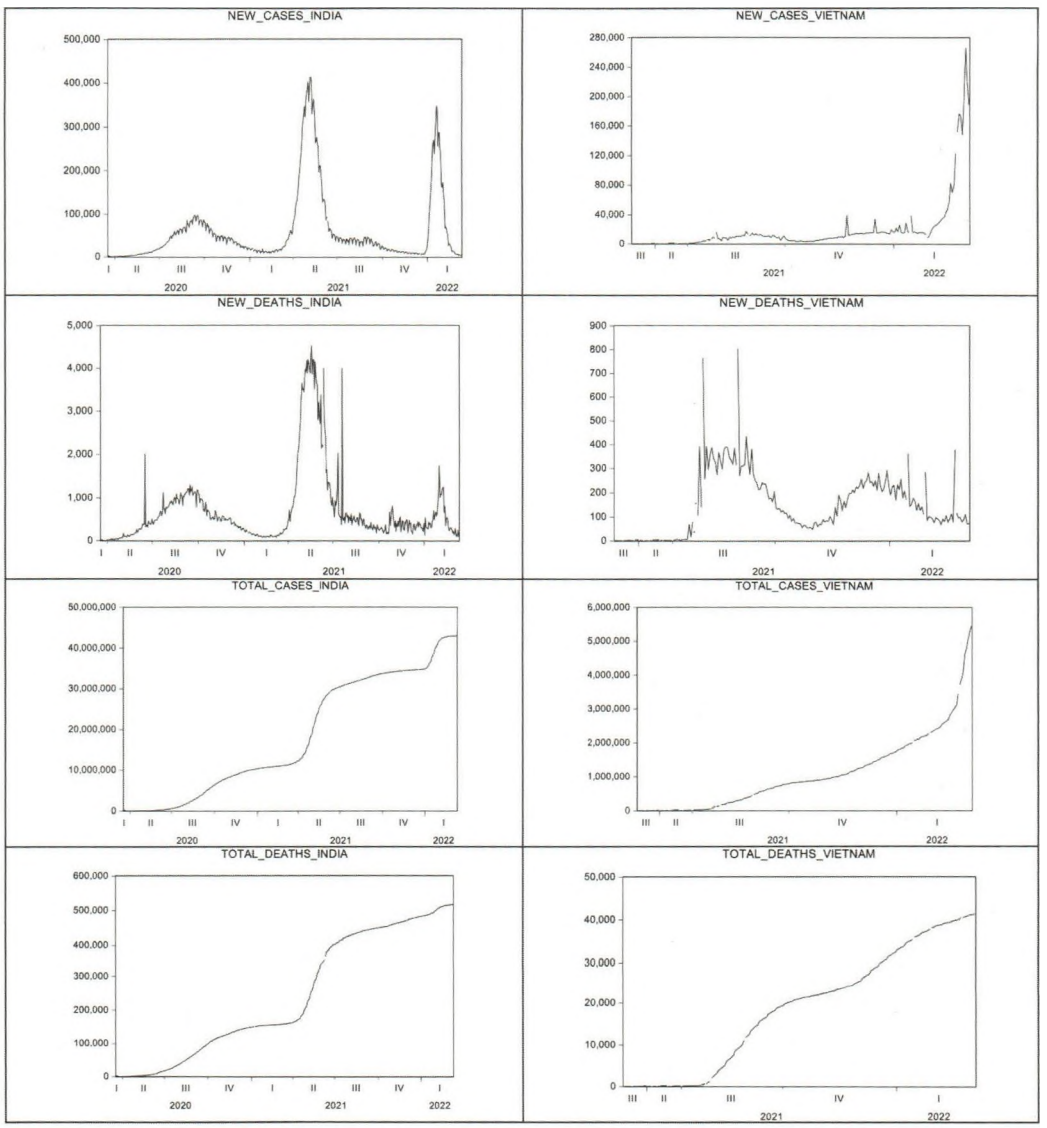

Source: Authors

Figure 2: *Covid-19 indicators in Vietnam and India*

local currency values (INR and VND), it is interesting that The coefficient of variation (CV of gold price) in both markets are the same (0.04), showing that the gold price movement in the two markets is quite similar. A kurtosis value greater than 3 but not much suggests that the daily gold price depends on leptokurtic characteristics, indicating a peak distribution. Furthermore, positive skewness and not too far from zero indicates that the distribution has a right long tail. It is clear that the distribution of the gold value chain in both countries is quite similar to the normal distribution and the experimental statistics of Jarque and Bera support this sign of normal distribution.

4.2. Correlation between covid-19 indicators and gold price

The results of the correlation analysis between the research variables, shown in Table 1, can help us

Table 1: *Summary statistics using observations in India and Vietnam*

	GP_IN	GP_VI
Mean	134745.9	41710421
Median	134387.1	41190058
Maximum	156815.7	47904132
Minimum	110550.3	39444037
Std. Dev.	6038.101	1669010.
Skewness	0.143866	1.523047
CV	0.04	0.04
Kurtosis	4.798405	4.962482
Obs	*514*	*205*
Jarque-Bera	71.04012	112.1523
Probability	0.000000	0.000000

see the relationship between covid-19 indicators and gold prices in India and Vietnam more clearly.

Table 2: *Correlation analysis results of research variables*

Correlation (Probability)	GP_IN	Correlation (Probability)	GP_VI
NC_IN	0.089023**	NC_VI	0.388234***
	0.0437		0.0000
ND_IN	0.189964***	ND_VI	-0.427832***
	0.0000		0.0000
TC_IN	0.107560	TC_VI	0.169121**
	0.0147		0.0153
TD_IN	0.103445	TD_VI	-0.121233*
	0.0190		0.0834

*Note: * Significance level of 0.1*
***Significance level of 0.05*
**** Significance level of 0.01*

Source: Authors

According to the findings of the research variable correlation analysis, the price of gold in India has a positive and statistically significant correlation with the number of new covid-19 infections and deaths per day. In Vietnam, the number of new infections and total number of covid-19 infections are positively correlated with gold price, whereas the number of daily deaths and cumulative total number of deaths are statistically significant negatively correlated with gold price.

We continue to examine the results of the regression model of the impact of the covid-19 indicators on the gold price in each country to further clarify the impact of covid-19 on the gold price, with a comparative approach to India and Vietnam.

4.3. Results for the Impact of the Coronavirus on Gold Prices

The regression results for the influence of covid-19 indicators on gold prices differ between observations in India and those in Vietnam.

In India, all covid-19 indicators have a statistically significant positive influence on gold prices, ranging from strong to weak. These indicators include the number of deaths per day, the number of new infections in a year, the cumulative total of deaths, and the cumulative total of infections.

In Vietnam, all indicators of covid-19 have a statistically significant negative effect on the gold price, in order of influence from strong to weak, the number of deaths per day, the total number of positive infections cumulative number of new infections per day and cumulative total deaths.

The findings of the study on 514 observations in India are quite similar to those of Yousef and Shehadeh (2020), Hanen Atri et al (2021), but differ from those of Zeravan Abdulmuhsen Asaad (2020).

Meanwhile, the findings of 205 observations in Vietnam differed from the studies mentioned in the research review. The mixed effect of covid-19 information on gold prices in Vietnam can be explained by the fact that Vietnam has been quite successful in controlling the covid-19 pandemic, and during the covid-19 epidemic, people pay more attention to developments related to health and life, so the gold price does not support a positive uptrend with covid-19 indicators.

4.4. Volatility Measures Using ARCH/GARCH Models

The price of gold, like many other assets traded in financial markets, tends to self-regulate over time. Many studies have found that gold price volatility and gold investment income follow the time-series lagged autoregression rule. To further clarify the research hypotheses, it is necessary to

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Table 3: *Summary statistics for the regression analysis.*

	GP_IN				GP_VN			
R^2	0.161269	0.142896	0.255106	0.156734	0.174365	0.245641	0.331944	0.253934
Adj R^2	0.159631	0.141222	0.253651	0.155087	0.170298	0.241925	0.328653	0.250259
Const (p-value)	118995.9 (0.0000)	120359.0 (0.0000)	120622.5 (0.0000)	122395.6 (0.0000)	44435011 (0.0000)	46143850 (0.0000)	43788280 (0.0000)	44392935 (0.0000)
Log(NC_IN) (p-value)	1552.027 (0.0000)							
Log(NC_VI) (p-value)					-319500.0 (0.0000)			
Log(TC_IN) (p-value)		919.1675 (0.0000)						
Log(TC_VI) (p-value)						-349251.9 (0.0000)		
Log(ND_IN) (p-value)			2374.436 (0.0000)					
Log(ND_VI) (p-value)							-503421.9 (0.0000)	
Log(TD_IN) (p-value)				1073.667 (0.0000)				
Log(TD_VI) (p-value)								-314936.3 (0.0000)

Source: Authors

continue analyzing the effects of covid-19 on gold price movements using the ARCH/GARCH model.

The ARCH(i) model is used in this study to determine whether the coronavirus is impacting the volatility of gold returns. In the ARCH model, the authors will perform tests to find the optimal delay(i), suitable for the data set. The GARCH model is used also in this study to determine whether the coronavirus is impacting the volatility of gold returns. Since several previous studies have noted this specification's appropriateness for studying time series, we analyze the estimation of the generalized model to the case where both p and q are set to 1. That means we will use the GARCH(1,1) model to analyze the effect of covid-19 on gold price movements in its own dominion over time series. In both the ARCH(i) and GARCH(1,1) models, we use dummy variables in this analysis to indicate whether the coronavirus is influencing gold returns or not, where 1 represents the coronavirus period, i.e., Jan-2020 to March-2022 in India and July-2020 to March-2022 in Vietnam and 0 indicates all other dates.

The observation of price movements and gold price fluctuations representing investment income in gold in India and Vietnam (Figure 3) also allows an initial assessment of the suitability of the ARCH/GARCH models in the study with the data set collected.

Although gold price movements in India and Vietnam differ during the covid-19 period, the movements on the two markets are quite similar from January 1st, 2010 to March 11th, 2022.

We can see that the trend of the Indian gold market and the trend of the Vietnamese gold market are in sync with the developments of the global gold market. At the same time, the volatility of gold investment income appears to dominate over time, in both bull and bear gold price waves.

Tables 4 show the results of testing the existence of ARCH when studying gold price volatility in India and gold price volatility in Vietnam.

Checking the existence of ARCH effects

H0 = There is NO existing ARCH effects up to the specified lag

H1 = There ARE ARCh effects up to the specified lag

If $p<0.05$, we reject the null hypothesis and confirm the existence of ARCH effects

The p_value<0.05, so there is Heteroskedasticity. For RESID^2(-1) component, P_value<0.05, so we reject the null hypothesis and confirm the existence of ARCH effects in India.

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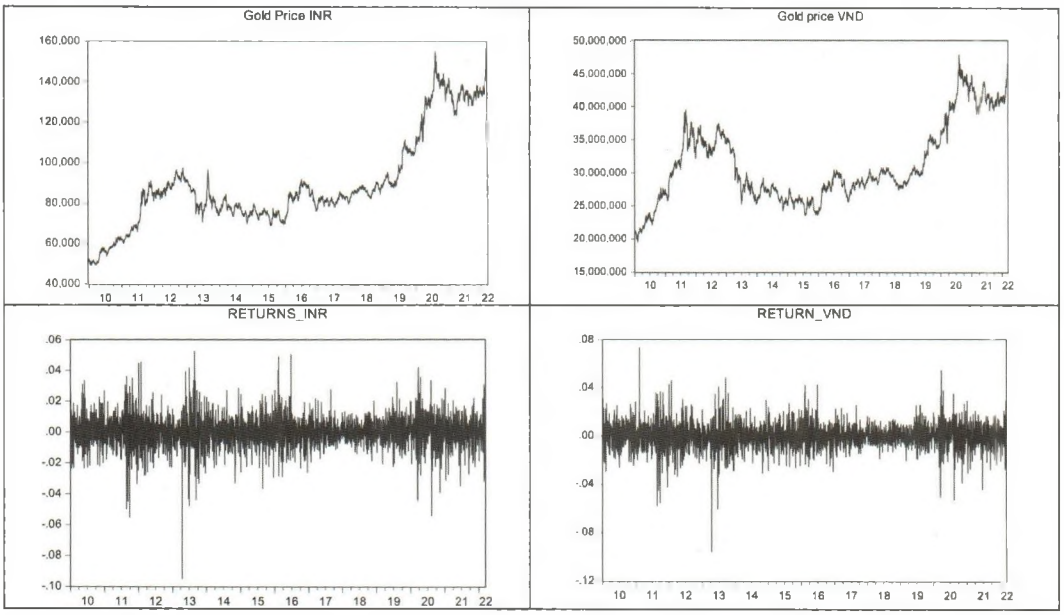

Source: Authors

Figure 3: *Gold price fluctuations in Vietnam and India from Jan-1-2010 to March-11-2022*

Tables 4: *Testing the existence of ARCH in India*

Heteroskedasticity Test: ARCH

F-statistic	43.74894	Prob. F(1,3176)	0.0000
Obs*R-squared	43.18167	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1/06/2010 3/11/2022
Included observations: 3178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.67E-05	5.16E-06	16.80827	0.0000
RESID^2(-1)	0.116566	0.017623	6.614298	0.0000

R-squared	0.135888	Mean dependent var	9.82E-05
Adjusted R-squared	0.132777	S.D. dependent var	0.000276
S.E. of regression	0.000274	Akaike info criterion	-13.56625
Sum squared resid	0.000238	Schwarz criterion	-13.56244
Log likelihood	21558.77	Hannan-Quinn criter.	-13.56488
F-statistic	43.74894	Durbin-Watson stat	2.014476
Prob(F-statistic)	0.000000		

Source: Authors

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The results of testing the existence of ARCH when studying gold price fluctuations in Vietnam are similar to the results of testing the existence of ARCH when studying gold price fluctuations in India. The results of the analysis are shown in Table 5.

model in our analysis. Examine the effect of covid-19 (a dummy variable that represents the date of infection and death) on gold price volatility in India.

Following that, the indicators Log likelihood, Akaike info criterion, Schwarz criterion, and

Table 5: *Testing the existence of ARCH in Vietnam*

Heteroskedasticity Test: ARCH

F-statistic	8.246069	Prob. F(1,3176)	0.0041
Obs*R-squared	8.229894	Prob. Chi-Square(1)	0.0041

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1/06/2010 3/11/2022
Included observations: 3178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.48E-05	5.54E-06	17.11730	0.0000
RESID^2(-1)	0.050888	0.017721	2.871597	0.0041

R-squared	0.259000	Mean dependent var	9.99E-05
Adjusted R-squared	0.227600	S.D. dependent var	0.000296
S.E. of regression	0.000296	Akaike info criterion	-13.41186
Sum squared resid	0.000278	Schwarz criterion	-13.40804
Log likelihood	21313.44	Hannan-Quinn criter.	-13.41049
F-statistic	8.246069	Durbin-Watson stat	2.008252
Prob(F-statistic)	0.004111		

Source: Authors

The p_value<0.05, so there is Heteroskedasticity. For RESID^2(-1) component, P_value<0.05, so we reject the null hypothesis and confirm the existence of ARCH effects in Vietnam.

Table 6 shows the results of testing the optimal lag for the ARCH model when studying gold price volatility in India. Because the optimal lag is 2, we employ the ARCH(2)

Table 6: *Optimal lag testing for the ARCH model in India*

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
|* |	|* |	1	0.117	0.117	43.234	
|* |	| |	2	0.075	0.062	61.028	
| |	| |	3	0.054	0.039	70.363	0.000
| |	| |	4	0.065	0.051	83.736	0.000
|* |	| |	5	0.077	0.060	102.58	0.000
|* |	| |	6	0.091	0.070	129.24	0.000
|* |	| |	7	0.081	0.054	150.41	0.000
| |	| |	8	0.064	0.034	163.31	0.000
| |	| |	9	0.054	0.026	172.74	0.000
| |	| |	10	0.054	0.026	182.13	0.000

Source: Authors

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Hannan-Quinn criterion are used to select the better research model among the two models ARCH(2) and GARCG (1,1).

Table 7: *Summary statistics for ARCH (2) and GARCG (1,1) in India*

Criteria	Model		Best Model
	ARCH(2)	GARCH(1,1)	
Log likelihood	10234.71	10356.97	GARCH(1,1)
Akaike	-6.433915	-6.510834	GARCH(1,1)
Schwarz	-6.418654	-6.495573	GARCH(1,1)
Hannan-Quinn	-6.428442	-6.505360	GARCH(1,1)

Source: Authors

So the GARCH(1,1) model is preffered over the ARCH(2) model.

Estimate the GARCH (1,1) model in India

The Heteroskedasticity test from the GARCH (1,1) model estimating show that the GARCH(1,1) model is enough to mitigate the heteroskesdasticity.

However, because both factors, including covid i and d cv i, are not statistically significant, we remove them and estimate the GARCH(1,1) once more.

Following that, the indicators Log likelihood, Akaike info criterion, Schwarz criterion, and Hannan-Quinn criterion are used to select the better research model among the two models ARCH(2) and GARCG (1,1).

Table 8: *GARCH(1,1) in India*

Dependent Variable: RETURN_INR
Method: ML - ARCH (Marquardt) - Normal distribution
Sample (adjusted): 1/05/2010 3/11/2022
Included observations: 3179 after adjustments
Convergence achieved after 64 iterations
MA Backcast: 1/04/2010
Presample variance: backcast (parameter = 0.7)
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000218	0.000145	1.495268	0.0135
AR(1)	0.617301	0.285856	2.159483	0.0308
MA(1)	-0.639811	0.277515	-2.305503	0.0211
Variance Equation				
C	1.90E-06	2.26E-07	8.374475	0.0000
RESID(-1)^2	0.063681	0.003947	16.13324	0.0000
GARCH(-1)	0.919495	0.004071	225.8513	0.0000

R-squared	0.232390	Mean dependent var	0.000337
Adjusted R-squared	0.223540	S.D. dependent var	0.009913
S.E. of regression	0.009916	Akaike info criterion	-6.511786
Sum squared resid	0.312278	Schwarz criterion	-6.500340
Log likelihood	10356.48	Hannan-Quinn criter.	-6.507681
Durbin-Watson stat	1.989073		

Inverted AR Roots	.62
Inverted MA Roots	.64

Source: Authors

Table 9: *Optimal lag testing for the ARCH model in Vietnam*

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
| |	| |	1	0.051	0.051	8.2399	
|* |	|* |	2	0.083	0.081	30.295	
| |	| |	3	0.044	0.036	36.320	0.000
| |	| |	4	0.061	0.051	48.250	0.000
| |	| |	5	0.046	0.035	54.931	0.000
| |	| |	6	0.071	0.058	70.852	0.000
| |	| |	7	0.072	0.058	87.465	0.000
| |	| |	8	0.061	0.042	99.364	0.000
| |	| |	9	0.030	0.009	102.18	0.000
| |	| |	10	0.041	0.021	107.53	0.000

Source: Authors

Table 10: *Summary statistics for ARCH (2) and GARCG (1,1) in Vietnam*

Criteria	Model		Best Model
	ARCH(2)	GARCH(1,1)	
Log likelihood	10187.16	10312.05	GARCH(1,1)
Akaike	-6.403998	-6.482881	GARCH(1,1)
Schwarz	-6.388737	-6.467620	GARCH(1,1)
Hannan-Quinn	-6.398525	-6.477408	GARCH(1,1)

Source: Authors

So in Vietnam, the GARCH (1,1) model is preffered over the ARCH (2) model.

Estimate the GARCH (1,1) model in Vietnam

The Heteroskedasticity test from the GARCH(1,1) model estimating show that the GARCH(1,1) model is enough to mitigate the heteroskesdasticity.

However, because the covid_v term is not statistically significant, we remove it and estimate the GARCH (1,1) once more.

So in India, we have the mean equation from GARCH (1,1) model:

$Return\_inr_t = 0.000218 + 0.617301*Return\_inr_{t-1} - 0.639811*\epsilon_{t-1} + \epsilon_t$

Variance equation:

$h_t = 1.90E\text{-}06 + 0.063681*h^2_{t-1} + 0.919495*h_{t-1}$

As we can see, the variance adds up to 0.97, very closer to 1, that mean the volatility of gold price in India is very persistence.

And in Vietnam, we have the mean equation:

$Return\_vnd_t = 0.000260 - 0.000506*d\_cv\_v - 0.794631*Return\_vnd_{t-1} + 0.817932*\epsilon_{t-1} + \epsilon_t$

On days when there are deaths due to covid-19, the mean equation is as follows:

$Return\_vnd_t = -0.000246 - 0.794631*Return\_vnd_{t-1} + 0.817932*\epsilon_{t-1} + \epsilon_t$

When there are no deaths due to covid-19, the mean equation is as follows:

$Return\_vnd_t = 0.000260 - 0.794631*Return\_vnd_{t-1} + 0.817932*\epsilon_{t-1} + \epsilon_t$

Thus, in addition to the time-delayed distribution autoregression, information about the number of deaths due to covid-19 in Vietnam tends to reduce gold price volatility compared to days when no deaths due to covid-19 occur.

Variance equation:

$h_t = 1.10E\text{-}06 + 0.048019*h^2_{t-1} + 0.943145*h_{t-1}$

As we can see, the variance adds up to 0.98, very closer to 1, that mean the volatility of gold price in Vietnam is very persistence.

5. Conclusion

Although the OLS regression results show that the covid-19 indicators have a positive influence on gold prices in India, the GARCG(1,1) model research results show that there is no statistically significant experiment showing the influence of covid-19 indicators on gold price volatility in India when observed over a longer time period.

Although the OLS regression results show a positive influence of the GARCH(1,1) model for gold price volatility in India, the regression results of the GARCH(1,1) model also show that gold investment income in India is positively influenced by investment income from the previous trading day, and gold price volatility in India is very persistent.

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Table 11: *GARCH (1,1) in Vietnam*

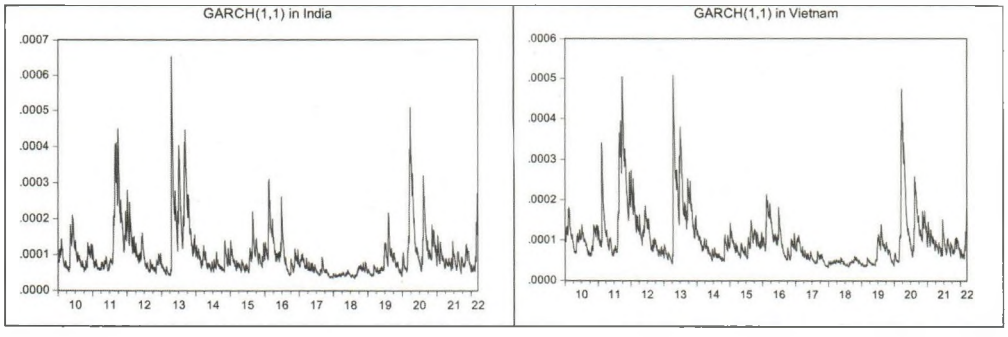
Dependent Variable: RETURN_VND
Method: ML - ARCH (Marquardt) - Normal distribution
Sample (adjusted): 1/05/2010 3/11/2022
Included observations: 3179 after adjustments
Convergence achieved after 59 iterations
MA Backcast: 1/04/2010
Presample variance: backcast (parameter = 0.7)
GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000260	0.000169	1.541380	0.0123
D_CV_V	-0.000506	0.000450	-1.123837	0.0000
AR(1)	-0.794631	0.103750	-7.659124	0.0000
MA(1)	0.817932	0.097497	8.389280	0.0000
Variance Equation				
C	1.10E-06	1.54E-07	7.127520	0.0000
RESID(-1)^2	0.048019	0.002979	16.11967	0.0000
GARCH(-1)	0.943145	0.002956	319.0653	0.0000

R-squared	0.342000	Mean dependent var	0.000246
Adjusted R-squared	0.287000	S.D. dependent var	0.010002
S.E. of regression	0.010009	Akaike info criterion	-6.483205
Sum squared resid	0.318048	Schwarz criterion	-6.469852
Log likelihood	10312.05	Hannan-Quinn criter.	-6.478416
Durbin-Watson stat	2.061744		

Inverted AR Roots	-.79
Inverted MA Roots	-.82

Source: Authors



Source: Authors

Figure 4: *GARCH (1,1) variance graph in India and Vietnam*

These findings may have implications for individual Indian investors interested in investing in gold, especially since the COVID-19 pandemic shows no signs of abating in the near future. Although COVID-19 has the potential to affect many markets, the study's implication is that gold investors in India should be concerned with gold price movements over time and time-series trends, rather than COVID-19-related indicator information, unless major shocks in the market occur as a result of COVID-19.

The results of OLS regression on the influence of covid-19 indicators in Vietnam show a polar opposite movement to the Indian market.

While the covid-19 indicators in India have a positive influence on the gold price, they have a negative influence on the daily gold price in Vietnam. Furthermore, according to the autoregressive effect, the GARCH(1,1) model in Vietnam demonstrates that there is a statistically significant relationship between the influence of covid-19 mortality information on gold price volatility.

Similarly to the findings of the Indian gold market research, the regression results of the GARCH(1,1) model also show that gold investment income in Vietnam is positively influenced by investment income from the previous trading day, and gold price volatility in Vietnam is very persistent.

As a result, private gold investors in Vietnam must pay close attention to daily gold price fluctuations over time. Private gold investors in Vietnam should also keep a close eye on volatile trends in the international gold market, as well as the lag in volatility transmission to the Vietnamese gold market.

At the same time, because there are still many complicated developments in the context of the Covid-19 pandemic, private gold investors in Vietnam should pay special attention to the days when there is sudden information about the number of deaths due to Covid-19. Because, according to the regression results of the GARCH model(1,1) in Vietnam, the negative impact of the previous trading day's gold price movement on the current day's gold price volatility will become more severe on those days.

The COVID-19 virus outbreak has jolted financial markets. To date, over 450 million people have been confirmed to have been infected, with most countries reporting more than 6 million deaths. The virus's continued spread and the measures that most governments have been forced to take to limit its spread have created widespread fears that global economic growth will plummet, and many investors are fleeing the stock market in favor of safe-haven assets such as gold. As the current situation increases global demand for gold, so will gold prices and the volatility of returns. This is due to gold's reputation as a "safe" asset during times of economic upheaval.

Research on the impact of covid-19 on gold price movements in Asian countries such as India and Vietnam must therefore be continued with longer-term observations, which may necessitate the addition of others independent variables to make the research model meaningful in order to better explain the volatility of gold prices in markets, particularly in developing economies such as Vietnam.◆

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Summary

Đại dịch covid-19 đã gây ra những hậu quả sâu rộng đối với nền kinh tế toàn cầu, ảnh hưởng đến nhiều bộ phận cấu thành thị trường tài chính, bao gồm cả thị trường vàng. Nghiên cứu này thực hiện dựa trên dữ liệu về một số chỉ báo covid-19 như số ca nhiễm mới hàng ngày, tổng số ca nhiễm tích lũy, số ca tử vong mới hàng ngày do covid-19 và tổng số ca tử vong do covid-19, ảnh hưởng đến sự biến động giá vàng trong sự so sánh giữa Ấn Độ và Việt Nam. Phát hiện của nghiên cứu dựa trên dữ liệu quan sát hàng ngày từ khi xuất hiện ca nhiễm covid-19 đầu tiên được xác nhận tại mỗi quốc gia cho đến ngày 11 tháng 3 năm 2022, chứng minh rằng các chỉ số covid-19 có tác động ngược chiều đến giá vàng ở Ấn Độ và Việt Nam. Nghiên cứu đã kiểm tra tác động của covid-19 (được sử dụng như một biến giả đại diện cho ngày mắc covid-19 và ngày có ca mắc covid-19 tử vong) bằng cách sử dụng mô hình GARCH(1,1). Nghiên cứu không tìm thấy bằng chứng về tác động của covid-19 tới sự biến động giá vàng ở Ấn Độ. Trong khi đó, phát hiện của nghiên cứu cho thấy tác động của covid-19 làm trầm trọng thêm tác động tiêu cực đến biến động giá vàng ở Việt Nam giai đoạn nghiên cứu, đặc biệt là vào những ngày có thông tin về ca tử vong do covid-19.

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