GOLD & STOCK RELATION: INVESTORS’ REACTION DURING COVID-19 OUTBREAK

SUBRATA ROY*

Abstract: The present study tries to examine the relationship between stock and gold during COVID-19 pandemic along with investors’ investment preference during COVID-19 lockdown by considering three macroeconomic variables (BSE, NSE & Gold) with their daily data over a period from 30 January 2019 to 31 July 2020 under VAR environment. The time series data are normally distributed and stationary after first difference with same order of integration without co-integrated equations with optimum lag length one. The long run equilibrium relationship is absent during COVID-19 outbreak but short run association is found when lagged gold price influences gold itself. Bi-directional Granger causality exists between BSE and NSE only. The investors prefer stock investment as compared to gold during COVID-19 lockdown. Finally, the VAR models are valid and stable based on various residuals tests.

Keywords: Co-integration, VAR, COVID-19, Gold, BSE, NSE

JEL Classification: C12, C15, C32

1. INTRODUCTION

It is true that water is life. Life without water is impossible. But in economic sense, it has almost no value. Oppositely, the yellow metal (gold) that has no need in livelihood as compared to water but its monetary value has already been touched the sky during this COVID-19 pandemic. So, a stable and healthy financial system depends on economic development of a country. If an economy has efficient and well functioning financial systems then the nation can flourish and may improve the standard of living of its countrymen. Presently, the activities of financial markets and their associations with the real sector have assumed significant importance (Tripathy,

* Associate Professor, Department of Commerce, School of Commerce & Management Sciences, Mahatma Gandhi Central University, Motihari, East Champaran, Bihar – 845401, E-mail: subrata1_roy@yahoo.com
According to Smith (2011), during the time of market crisis, stock market generally comes down but the gold’s at the same time price reacts oppositely. Currently, the investors are more tending to keep a portion of their investments in the form of gold with the expectation of higher prices and that can also hedge against inflationary situation. Sometimes, when an economy goes through political uncertainty, economic boom, emergency, war or when dollars weakens etc. then the investors have a tendency to buy gold as a store of value for economic safety and to protect their portfolios from uncertain economic shocks as a tool of diversification (Kiohos & Sariannidis, 2010). In India, due to its high domestic demand, the gold price is sharply increasing because of its high security, liquidity, risk diversification tool, a safe haven investment and an asset of last resort (Gaur & Bansal, 2010). According to the Webster’s dictionary “haven” means a harbor or a port; a place of safety or a destination that offers favorable opportunities and conditions (Baur & Lucey, 2006). In India, the capital market is not the first preference of investment till date because the investors believe that gold as a safe haven and an attractive investment tool for the Indian investors (Narang & Singh, 2012) and it depends on individual sentiment on gold holding and the habit of gold investment of Indians strongly ingrained in Indian social psyche because gold is held for years and passed hands of many generations without loss of its prime importance as a hedge against loss of wealth in time of market failure (Mishra & Mishra, 2010; Paul, 2012). The increasing demand of gold is not only due to the reasons of investment and uses only rather there are some other reasons which influence the demand for gold in Indian domestic market. The literature shows that the demand for gold may be having a causal association with the other investment options and stock market behavior. The market volatility creates panic to the investors and makes the investment decisions difficult and risky. So, deep uncertainty in stock market may have causal relation for movement in gold price and which might be influencing the demand for gold (Bhuyan & Dash, 2018). During this COVID-19 pandemic the world economy is in a turbulence situation. There is a deep uncertainty when the world economy will come out from this crisis period. The stock markets around the globe have lost investors’ faith due to COVID-19 pandemic shock. The global stock markets are under in volatile situations and very difficult to predict the movement of stock prices during this pandemic situation. Oppositely, it is found that the gold price is moving in upward direction sharply and touched a record high during this pandemic situation. The investors shift their investments from stock markets to gold because for safety, liquidity and it helps to hedge against this pandemic shock. Nationwide lockdown makes the economic activities more disruptive but on the other hand this
lockdown helps to control the spreading of this deadly corona virus into population. During this uncertain pandemic situation whether lockdown and investors preferences on gold influence the gold prices to move high? Some are arguing that gold prices are a good proxy for other macroeconomic variables. So it is a preferred indicator of global economic performances. The price of gold is viewed by some analysts as a leading indicator of inflation because gold is extensively held as a store of value. Many studies suggested that gold is one of the best investment instruments for diversification. Since gold is frequently traded, its price and relationship with stock market assumed significant importance from the investor, traders, policy makers, and academicians’ point of view. From the policy perspective, gold’s price rise has raised a concern as to whether a future crash in Gold prices would have financial stability implications. Therefore gold has become the main focus of research in the field of finance today (Tripathy, 2016).

Finally, the study is designed as follows: in section 2 literature survey is described. Section 3 deals with objective. Hypothesis is given in section 4. Section 5 describes data and study period. Section 6 provides methodology. Section 7 analyses the result. Conclusion and recommendation are given in section 8.

2. LITERATURE REVIEW

The relationship between socio-economic variables under the VAR environment is discussed very little. The economic impact due to COVID-19 pandemic is a recent phenomenon. The life and livelihood are now uncertain due to COVID-19. The human civilization is stood at risk for survival. The whole world is jointly working when we will get released from this deadly virus. Research in various fields is conducting around the globe for the way out. Few papers have already been published and considered for developing this research. The researchers around the globe are working on this issue critically and trying to establish the relationship between the socio-economic variables.

Truly, the concept of co-integration is first introduced by Granger (1981) and then extended further by Engle and Granger (1987); Eagle and Yoo (1987, 1991); Phillips and Ouliaris (1990); Stock and Watson (1988); Phillips (1991); Johansen and Juselious (1990); and Johansen (1988, 1991, 1994) and after that empirical studies have been conducted by the researchers around the globe. In 1986, Roll and Ross inspect the underlying association among the stock market and macroeconomic variables during the period from 1953 to 1983 and observe that stock market is significantly affected by the macroeconomic shocks (see Kim 2003).
It is evident from the above studies that the relationships between stock market performance and macroeconomic variables are well established. But the literature on socio-economic variables with pandemic effect is very scanty around the globe. In this situation, this study tries to investigate the long and short run equilibrium relationships among the socio-economic variables in Indian context under the VAR environment and along with the analysing of how a positive innovation or shock (impulse) can changes the behaviour of the socio-economic variables under the VAR framework and here is the identity of this study being considered.

In 2001, Smith Graham examines the relationship between gold price and stock price indices in the United States. Therefore, he considers daily prices over a period from 1991 to 2001 by considering four gold prices and six stock prices indices. He observes that the short-run correlation coefficient between gold return and stock return is very small and negative. But gold prices and stock prices are integrated at same order but they are not co-integrated. However, he observes that short-run uni-directional causality runs from US stock returns to gold returns. On the other hand, Baur & Lucey (2006) seek to examine two issues (a) whether gold may be used as a hedge against stocks and/or bonds and (b) whether gold is a safe haven for investors when market falls. Therefore, they consider time series data over ten years’ periods from 30th November 1995 to 30th November 2005. So, to examine the above two objectives they use various volatility forecasting measures like DCC, GARCH etc. They observe that gold can be used as a hedge against stocks and may be considered as a safe haven against stocks during trading days after an extreme stock market crash. In 2010, Kiohos and Sariannidis seek to examine the short effect of crude oil and financial markets on gold market by considering US market over a period from 1st January 1999 to 31st August 2009 using daily data and thus they apply GARCH type models. They opine that gold market acts as a mobilization factor of hedge against various portfolios and geopolitical risks. They also observe that US dollar exchange rate significantly influences gold markets’ volatility and observe presence of volatility persistence. Finally, they suggest that gold can be used as a safe haven during the time of high volatility in the market and this evidence is similar to the result of Baur and Lucey (2006). In the same light, Mishra et. al., (2010) examine the co-integration and causal relationship between the gold prices and stock market over a period from 1991 to 2009 by considering daily data by applying Johansen co-integration test along with Granger causality analysis. According to the Johansen co-integration test there are two co-integrated equations with same order. Finally, the Granger causality test discovers bi-directional short-run relationship between gold prices and BSE. Toraman et. al., (2011) seek to examine the probable
macro-economic factors that affect the gold prices in USA. To examine the above objective they consider many macro-economic factors like oil prices, USA exchange rate, inflation rate, real interest rate and gold price over a period from June, 1992 to March, 2010. Therefore, they apply MGARCH and CCC models. The study shows that ARCH effect exists on some variables but few variables follow non-stationarity. Finally, they observe that gold prices and exchange rate are negatively correlated but oil prices and gold prices are positively correlated. In 2012, Narang and Singh examine the causal relationship between gold prices and Bombay Stock Exchange by considering daily data over a period from 2002 to 2012 by applying Johansen co-integration test and Granger causality test. But their study shows that there is no co-integration relationship between the variables and also absence of causality association between gold and BSE at any direction. Similarly, in 2012, Omag examines the relationship between gold prices and some macro-economic variables over a period from January 2002 to December 2011 by considering daily data in Turkey. Thus, he applies multiple regression technique to examine the above objectives. He observes that there is a positive relationship between gold prices and exchange rate and also positive relationship is found between Istanbul stock exchange and exchange rate. Finally, he opines that gold may be used as a substitute for other securities. Likewise, in 2013, Baig et. al., tries to examine the causal relationship between gold prices and macro-economic variables over a period from 2000 to 2010 by applying co-integration and causality techniques by considering monthly data in Pakistan. They find absence of significant correlation between the macro-economic variables. They observe that the data are stationary after first difference and co-integrated at same order but there is no existence of co-integrated equation and thus long-run equilibrium relationship is absent. Moreover, they also exhibit absence of short-run Granger causality relationship. In 2013, Mukhuti et. al., investigates the association between Indian stock market and gold prices over a period from 2nd January 1991 to 10th August 2012 by considering daily time series data. Therefore, they use bi-variate and multivariate Johansen co-integration approach to study the above objective. First they observe that the data are stationary at 1st difference (see, Baig et. al., 2013) and integrated at same order. Then, they observe that there is absence of co-integrated relationship at any significance level (see, Baig et. al., 2013) based on bi-variate co-integration test but multivariate co-integration test signifies presence of long-run equilibrium relationship between stock markets and gold prices (see, Mishra et. al., 2010). In 2013, Sindhu tries to examine the impact of macro-economic variables on gold prices over a period from November 2006 to December 2011 by taking into consideration the daily prices in India. The
study applies simple correlation and regression analysis technique to examine the research questions. Finally, the study shows that gold prices and exchange rates are inversely related but energy prices positively influence gold prices. Moreover, inflation rates and gold prices are positively correlated but gold prices and repo rates are independent. Similarly, in 2013, Contuk et. al., examines the effect of fluctuations in gold prices on ISE100 index over a period from 2009 to 2012 by considering daily data in Turkey and thus they apply GARCH type models to investigate the effect. They observe that the time series data are suffered from ARCH effect and thus they apply GARCH models. Finally, they observe that gold and stock prices are influenced by their own shocks and shock by each other. On the other hand, Tripathi et. al., (2014) seeks to examine the causal association between gold prices and global macro-economic variables by considering nine years monthly time series data in India. To examine the above objectives they apply various statistical and econometrics measures like unit root test, Johansen co-integration test and Granger causality test. They observe that there are co-integrated equations that means long run equilibrium relationship exists among the co-integrated variables. They also observe that short-run causality runs from gold prices to exchange rate and energy prices. Again in 2015, Khan examines the impact of energy prices and gold prices on economic growth in Pakistan over a period from 1997 to 2014 by using monthly time series data. Thus, he applies OLS regression analysis to examine the above objective. He observes that Karachi stock exchange and GDP have negative correlation with gold prices. According to the regression analysis, it is found that economic growth has strong relationship with stock market and gold prices in Pakistan. In the same fashion, Gokmenogln et. al., (2015) investigates the impact of gold price, gold price volatility, energy price and energy price volatility on S&P 500 index by taking into account daily time series data over a period from January 2013 to 2014 by applying ARDL and error correction mechanism. Their study report that long run equilibrium relationship exists among the macro-economic variables. They also observe that short run bi-directional causality exists between oil price volatility and stock market. Similarly, in 2015, Akgulet et. al., tries to explore the non-linear relationship between gold prices and S&P 500 stock prices over a period from 1986 to 2013 by considering daily data. Thus, they apply Markov-Switching Bayesian VAR measures to examine the above research questions. They consider gold prices and stock market as the dependent variables and energy price as the independent variable. First they confirm the number of regime (3 regimes) by applying LR test statistic and then employed to estimate the MS-BVAR model. Finally, they observe that energy prices affect the gold prices and stock prices and the effects are varied
according to the regimes. According to impulse response function, the effect is diverse. In 2015, Tiwari and Gupta try to examine the causal association between gold prices and stock market return in India during a period from July 2005 to August 2014 with daily time series data. They apply unit root test and Granger causality test to examine their objectives. They observe that data are stationary after first difference and there is evidence of short run causal relationship between gold prices and stock market index in India (see. Narang 2012 & Baig 2013). A popular study by Tripathi in 2016, who examines co-integrated relationship between gold price and stock price in India by considering daily time series data over a period from July 1990 to April 2016. She applies various statistical tests to examine the above objective. She finds that the data are stationary after first difference with same order of co-integration. According to Johansen co-integration test gold price and stock price are related in the long run but there is no short run equilibrium relationship between them. She also observes that stock price can be used to forecast gold price. Similarly, in 2016, Raza et. al., investigates various asymmetric impact of gold price and energy price on stock markets by considering top ten emerging economies around the globe over a period from January 2008 to June 2015 of the daily time series data. They apply ARDL approach to study this relationship. They find that all the markets are positively correlated with gold and energy prices except China. The time series data are stationary after first difference and there is a presence of long run asymmetric equilibrium relationship among the macro-economic variables based on bound testing approach. They observe that energy prices negatively impact on all the stock markets. Finally, they argue that emerging markets are more prone to negative shocks. In 2017, Kaur and Kaur examine the effect of gold prices on Indian stock market by taking monthly time series data over a period from April 2007 to March 2016. They apply various statistical measures like J-B statistic, unit root test, correlation and regression and observe that gold price and BSE are positively correlated. Moreover, gold price can influence stock price significantly. In the same year (2017), Hlupo investigates the relationship between gold prices and stock market in Zimbabwe by considering daily data. Therefore, he uses various statistical and econometric tools like ADF test, multi-variate regression analysis and Granger causality test to examine the objectives. He finds that the daily time series data are stationary at first difference with positive correlation between gold prices and mining. He also observes that there is no Granger causality between the macro-economic variables which is also supported by the regression result. Similarly, in 2017, Seifoddini et. al., conducts a comparative study between gold prices and stock markets in the developed (US) and developing (Iran) markets over a period from
December 2013 to December 2016 by considering daily time series data on gold spot prices and stock prices. To examine the above objective they apply Threshold regime switching model. Finally, they observe that stock prices and gold prices don’t follow any specific regimes but this association may changes in short as well as long terms between the two economies. In 2017, Mittal examines whether the gold price is affected by macro-economic conditions. Therefore, he examines various macro-economic variables like gold supply, mine production, net central bank sales, interest rates, recycled gold, demand of gold, inflation, US dollar, economic strength, world instability, jewellery market and other investment alternatives to examine the above issues. Finally, he observes that all those macro-economic factors directly or indirectly influence gold prices. In the same year (2017), Shobha seeks to examine whether gold is a safer and attractive investment avenue to the investors in terms of its risk and return as compared to the stock and bond. The study uses daily data of gold, bond and Nifty 50 index over a period from 2012 to 2017 by applying volatility forecasting modelling. She observes that volatility of risk is lower than the stock and bond. The study also says about gold is a good investment avenue for the educated people as compared to others. Similarly, in 2017, Seshiah et. al., seek to examine the influence of energy prices, exchange rate, trade deficit and fiscal deficit on gold prices over a period from 1994-1995 to 2014-2015 with monthly observations in India. They apply various statistical and econometrical tools and techniques. They observe that the time series data are stationary after first difference with same order of integration. According to the Johansen co-integration test there are two co-integrated equations and the variables have long run relationships. They also observes bi-directional causality between trade and fiscal deficit as well as trade deficit and exchange rate similarly, uni-directional short run causality exists between gold and exchange rate; gold and fiscal deficit; trade deficit and gold; and also trade deficit and energy prices. In 2018, Balaji and Mahalingam seek to examine the impact of macro-economic variables on gold prices in India by considering secondary data. Thus, they use various statistical tools like correlation, regression and coefficient of variation to explore carious influences of the macro-economic variables. They observe that gold prices are more volatile as compared to other variables. They also find that gold price is strongly correlated with BSE, NSE, energy price, euro, Yen and foreign institutional investment. According to the regression result they point out that BSE, NSE and crude oil prices can influence the gold prices. Similarly, in 2018, Bhuyan and Dash examine the relationship between gold prices and National Stock Exchange (NSE) over a period from January 2001 to December 2017 by considering monthly time series data. Thus, they apply Johansen
co-integration and Granger’s causality tests. They observe that the time series data are stationary after first difference with co-integrated equations that means presence of long run equilibrium relationship between gold prices and NSE. But, there is absence of short run causal relationship between them. Once again in 2018, Ameer et. al., examines the relationship between gold prices and stock prices in Germany over a period from 2004 to 2016 by considering monthly data obtained from Bloomberg data base. They consider Frankfurt stock exchange and divide the entire time period in three parts (pre, post and during recession). Therefore, they use Johansen co-integration and Granger causality tests. They show that the correlation between gold prices and stock prices is positive and some time it is negative across the sub periods. According to the co-integrated test there is a long run equilibrium relationship among the variables. But Granger causality test indicates absence of short run causal relationship between the variables. Similarly, in 2018, Moreman and Bonga seek to examine the impact of gold and oil price shocks on South African stock market and its component indices over a period from 3 January 2006 to 31 December 2015 by considering daily data. To examine this issue, they use asymmetric dynamic conditional correlation (ADCC), generalised autoregressive conditional heteroskedasticity (GARCH) approaches. They also examine the magnitude of the optimal portfolio weight, hedge ratio and hedge effectiveness for portfolios. They observe that there is significant volatility spill over between the gold price and stock market and also energy price and stock market. In the same year in 2018, Mukhuti tries to examine the impact of volatility of domestic gold prices on stock prices in India over a period from 2008 to 2018. To examine this he applies various statistical and econometric tools and techniques like correlation, regression and Granger causality test. The study shows that BSE and NSE are positively correlated with the gold prices but there is no significant impact on gold prices as presented by the regression equation. Finally, Granger causality shows bi-directional relationship between gold prices and BSE’s return and also NSE’s return. Similarly, in 2018, Sharma et. al., seek to examine the determinants of gold prices over a period from 1991 to 2000 in India. Thus, they consider many macro-economic variables to examine this. Therefore, he applies simple and multiple regression techniques and also applies various statistical tests. They observe that the macro-economic variables have positive impact on gold prices. But, individual impact of inflation and interest rates on gold prices is negative and insignificant. In 2019, Sun tries to examine the relationship between the macro-economic variables in China over a period from 2008 to 2016 by taking into account the daily data collected from various secondary sources. Thus, he considers oil prices, gold prices, stock prices and foreign exchange
Subrata Roy

in China and applies correlation measure which is based on Vine Coupla technique. He observes that energy market captures the dominant position in other markets.

In the developed countries a lot of research works have shown the relationship between gold and the macro-economic variables. However, there is few research works are conducted in the developing countries like India. But, in pandemic situation, study on gold is scanty. The present study tries to address this research gap and add value to the existing literature. There is lot of evidences on financial disaster but global economic slowdown due to COVID-19 is totally new in financial literature. More specifically, the study focuses on to examine the equilibrium relationship between the stock prices and gold prices and also to examine the investors’ preferences on investment regarding gold and stock during COVID-19 in India

Objective of the study:

The study is designed to achieve the following objectives:

i. To examine the long-run equilibrium relationship

ii. To establish the short-run causal relationship and direction of causality

iii. To establish whether gold is more preferable by the investors as compared to stock during COVID-19 lockdown

Data & Study Period:

The study considers daily time series data over a period from 30th January 2019 to 31st July 2020. The daily closing value of BSE and NSE are obtained from their official websites. The daily gold prices of ten grams (22 carat) in Indian rupee is collected from multi commodity exchange and cross checked with prices provided by world gold council.

Hypothesis formulation:

The study is designed to examine the causal relationship between the gold prices and stock prices by using dummy variable under VAR environment during COVID-19 pandemic and thus the following hypotheses are formulated:

Hypothesis 1:

H0: The time series data are non-stationary
H1: The time series data are stationary

Hypothesis 2:

H0: There is no long run equilibrium association between the variables
H1: There is a long run equilibrium association between the variables
Hypothesis 3:
H0: There is no short run causal association between the variables
H1: There is a short run causal association between the variables

Hypothesis 4:
H0: Investors don’t like to prefer gold investment during COVID-19 lockdown
H1: Investors like to prefer stock investment during COVID-19 lockdown

3. METHODOLOGY

The study considers the closing prices of the time series data of the macroeconomic variables and then converted the data series into logarithm time series. When time series data is considered for empirical research then it is assumed that the time series data are normally distributed. The study uses Jarque-Bera (1981) test statistics to examine normality of the time series data based on sample skewness and kurtosis and thus, the following testable hypothesis is formulated as under:

H0: the distribution is normal
Ha: the distribution is not normal

The J-B test statistic can be defined as below:

\[ JB = (n-k)(\frac{s^2}{6} + \frac{(k-3)^2}{24}) \]  

(1)

Where, \( s \) and \( k \) measures sample skewness and kurtosis respectively, \( n \) represents number of observation. It is assumed that if the value of skewness and kurtosis is 0 and 3 respectively then the distribution follows normality and vice-versa. Here, the result of normality test of the time series data is presented in table 1. It is observed that the skewness and kurtosis of the time series data is less than 0 and 3 respectively that means data are normally distributed. Here, the probabilities values of the JB statistics are higher than 5% level in all cases indicating acceptance of the null hypotheses.

Table 1: Test of normality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Observation</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>JB</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>logBSE</td>
<td>125</td>
<td>-0.050278</td>
<td>2.109197</td>
<td>4.185631</td>
<td>0.123339</td>
</tr>
<tr>
<td>logNSE</td>
<td>125</td>
<td>-0.096592</td>
<td>2.110137</td>
<td>4.318628</td>
<td>0.115404</td>
</tr>
</tbody>
</table>
The non-stationarity is one of the significant problem when deals with time series data in modelling economic relationship. In case of non-stationary data, OLS regression procedures produce incorrect estimates of the parameters (spurious regression). So, non-stationarity must be tested and corrected for time series economic modelling. Here, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are applied to check non-stationarity. Therefore, the study considers the following random walk model

$$\Delta Y_t = \alpha + \beta \Delta Y_{t-1} + e_t$$  \hspace{1cm} (2)

Where, $Y_t$ is a series of observation at time $t$. It is evident that when $|\rho|=1$ then $Y_t$ faces unit root problem (non-stationary) and then the variances grow exponentially as $t$ increases (Dickey & Fuller 1979). After taking first difference, the series looks like $\Delta Y_t = Y_t - Y_{t-1} = e_t$ that becomes stationary (white noise) and then run regression $\Delta Y_t$ on $\Delta X_t$ instead of $Y_t$ on $X_t$. Dickey and Fuller extend the test procedure by inserting an extra lagged terms of the dependent variable in the right hand side of the regression in order to eliminate the autocorrelation problem. The optimum lag length may be determined by using various criterions (AIC, SBIC & HQIC). The ADF test may be written as under:

$$\Delta Y_t = \alpha + \delta Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + e_t$$  \hspace{1cm} (3)

Similarly, Phillips and Perron (1988) widen a generalization of the ADF test technique and consider the following equation:

$$\Delta Y_t = \alpha + \delta Y_{t-1} + e_t$$  \hspace{1cm} (4)

Here, the PP test makes a correction to the $t$ statistic of the coefficient $\delta$ from the AR(1) process to explain the serial correlation in $e_t$. So, PP test is the modification of the ADF test that takes into consideration the less restrictive nature of the error process.

The outcome of the unit root test is presented in table 2. It is observed that in level form the time series data are non-stationary or in other words have unit root problem based on both the test statistics. But the time series data become stationary after taking first differences because the probabilities values are less than 5% levels in all cases and thus, null hypotheses can be rejected here.
Gold & Stock Relation: Investors’ Reaction During Covid-19 Outbreak

Table 2: Unit root test

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF</th>
<th>Phillips-Perron</th>
<th>Order of Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>1st Difference</td>
<td>Level</td>
</tr>
<tr>
<td></td>
<td>-1.6451</td>
<td>0.4566</td>
<td>-12.8639*</td>
</tr>
<tr>
<td>logNSE</td>
<td>-1.6091</td>
<td>0.4749</td>
<td>-12.9000*</td>
</tr>
<tr>
<td>logGold</td>
<td>-0.0855</td>
<td>0.9480</td>
<td>-12.6836*</td>
</tr>
</tbody>
</table>

* Significant at 5 percent level.

Note: Author’s own calculation

Order of integration is one of the important criteria for co-integration analysis. According to the Ganger theorem if \( Y_t \) and \( X_t \) are I(d) then there exists a linear combination between them that is integrated of order “b”, where \( b < d \) that tells about that both \( Y_t \) and \( X_t \) are I(1) but the linear combination of them must be I(0) and thus, spurious regression can be eliminated. Here, the above series are stationary at their first differences and thus, the order of integration is I(1).

Then choosing of optimum lag length is another important criterion for co-integration and VAR modelling. It is assumed that the lag length will be optimum when the loss function will be minimized and thus, the study uses AIC, SBIC and HQIC criterions.

Table 3 highlights the result of choosing optimum lag length criterion. It is found that the optimum lag length based on SBIC and HQIC is one but AIC tells about four. The study uses, one lag because out of three criterions, two criterions indicate to choose one lag for co-integration and VAR modelling.

Table 3: Selection of optimum lag length

<table>
<thead>
<tr>
<th>Lag order</th>
<th>AIC</th>
<th>SBIC</th>
<th>HQIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-18.15645</td>
<td>-18.08562</td>
<td>-18.12769</td>
</tr>
<tr>
<td>1</td>
<td>-25.23725</td>
<td>-24.95395*</td>
<td>-2.12223*</td>
</tr>
<tr>
<td>2</td>
<td>-25.16149</td>
<td>-24.66572</td>
<td>-24.96021</td>
</tr>
<tr>
<td>3</td>
<td>-25.14268</td>
<td>-24.43443</td>
<td>-24.85514</td>
</tr>
<tr>
<td>4</td>
<td>-25.36830*</td>
<td>-24.44757</td>
<td>-24.99449</td>
</tr>
</tbody>
</table>

* Indicates lag order selection. AIC: Akaike Information Criterion; SBIC: Schwarz Bayesian Information Criterion & HQIC: Hannan Quinn Information criterion

Note: Author’s own calculation

After satisfying the preconditions of VAR modelling, now co-integration relationship can be examined among the macro-economic variables. Granger (1981) is the pioneer to introduce co-integration and thereafter it is extended by Engle and

$$Z_t = n + k_1 \Delta z_{t-1} + \ldots + k_p \Delta z_{t-p} + \Pi z_{t-p} + e_t$$  \hspace{1cm} (5)$$

Where, $Z_t$ is a k vector of non-stationary series of order I(1), ' n is a k vector of parameters to be estimated and $e_t$ is a k vector of innovations. Now we can express the above VAR(p) model in a Vector Error Correction Model (VECM) as below:

$$\Delta Z_t = n + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \Pi Z_{t-1} + e_i$$  \hspace{1cm} (6)$$

Where, $\Pi = \sum_{i=1}^{p} k_{i-1}$ and $\Gamma_i = - \sum_{j=i+1}^{p} k_j$

Where, matrix $\Pi$ represents long-run relationships ($p*p$ matrixes of parameters) and matrix $\Gamma_i$ provides short run coefficients to be estimated ($p*p$ matrixes of coefficients). Although, $\Pi$ can be decomposed as follows:

$$\Pi = \alpha \beta$$

Where, $\alpha$ denotes the speed of adjustment and $\beta$ represents the long-run matrix of coefficients which is equivalent to the error correction term.

Johansen test is divided into two types that uses maximum likelihood statistics namely trace test and maximum Eigen value test.

The trace test can be represented as under:

$$\hat{\lambda}_{trace} = - T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i)$$  \hspace{1cm} (7)$$

Here, T stands for number of observations, $\hat{\lambda}$ is the eigen value and n is the number of separate series to be analysed. The hypothesis can be formulated as under:  

$H_0$: number of co-integrating vector is $\leq r \hspace{1cm} (r = 0, 1, \text{ or } 2)$
Ha: number of co-integrating vector is \( r \) 
Likewise, the max eigen value test can be written as under:

\[
\lambda_{\text{max}} = -T \ln(1 - \hat{\lambda}_{r+1})
\]  

(8)

The testable hypothesis can be formulated as below:

H0: number of co-integrating vector is \( r \)
Ha: number of co-integrating vector is \( r + 1 \)

Where, the null hypothesis \( r = 0 \) is tested against \( r = 1 \) and also tested against \( r = 2 \).

Sims (1980) says that, if there is simultaneity among a number of variables then distinction between dependent and independent variables is worthless that means they are treated as endogenous and therefore, each equation has the same set of regressors for developing VAR model. It is found from the beginning that the variables are stationary at their first differences and order of integration is I(1) with optimum lag length one. The outcome of Johansen co-integration test is presented in table 4. It is found from the table that the trace statistic and max eigen statistic are insignificant based on both tests as the probabilities values are higher than five percent level of significance that means there is no evidence of co-integrating equations or long-term equilibrium relationship between the gold and stock prices during COVID-19 pandemic in India and therefore null hypothesis is accepted here and so, we can proceed for VAR modelling for examining short-run relationship.

### Table 4: Johansen Co-integration test

<table>
<thead>
<tr>
<th>Hypothesised no. of CEs</th>
<th>Eigen value</th>
<th>Rank test (Trace)</th>
<th>Rank test (Max-Eigen value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Trace Stat.</td>
<td>Critical Value (0.05)</td>
</tr>
<tr>
<td>None</td>
<td>0.105058</td>
<td>21.3021</td>
<td>29.7970 7</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.059846</td>
<td>7.98273 2</td>
<td>15.4947 1</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.004800</td>
<td>0.57739 5</td>
<td>3.84146 5</td>
</tr>
</tbody>
</table>

*Trace & Max-Eigen value tests indicate no co-integrating equations at 5% significance level; denotes rejection of the hypothesis at 5 percent level; **denotes MacKinnon-Haug-Michelis p-values

Note: Author’s own calculation
After testing co-integration it is observed absence of co-integrating equations among the gold and stock prices during COVID pandemic and thus we can proceed to develop unrestricted VAR modelling to check short run relationship among the macroeconomic variables. The VAR is an un-restricted model.

Under VAR modelling it is assumed that the macro-economic variables are treated as independent and there is simultaneity of relationship between them. In this study, three macroeconomic variables are considered (BSE, NSE and Gold). But the study also considers dummy variable that puts into the VAR modelling to examine whether the investors like to prefer gold investment during COVID-19 lockdown as compared to stock investment? Dummy variable generally takes two numerical values 1 and 0. It can be shown as below:

\[ D = 1, \text{ when investors prefer to invest in gold during COVID-19 lock-down} \]
\[ D = 0, \text{ otherwise} \]

So the above situation can be specified under VAR environment as under:

\[ \Delta \log Gold_t = \alpha_1 + \sum_{j=1}^{p} \beta_j \Delta \log Gold_{t-j} + \sum_{j=1}^{p} \gamma_j \Delta \log BSE_{t-j} + \sum_{j=1}^{p} \lambda \Delta \log NSE_{t-j} + \delta \text{Dummy}_t + \epsilon_t \quad (9) \]
\[ \Delta \log BSE_t = \alpha_2 + \sum_{j=1}^{p} \beta_j \Delta \log BSE_{t-j} + \sum_{j=1}^{p} \gamma_j \Delta \log NSE_{t-j} + \sum_{j=1}^{p} \lambda \Delta \log Gold_{t-j} + \delta \text{Dummy}_t + \epsilon_{2t} \quad (10) \]
\[ \Delta \log NSE_t = \alpha_3 + \sum_{j=1}^{p} \beta_j \Delta \log NSE_{t-j} + \sum_{j=1}^{p} \gamma_j \Delta \log BSE_{t-j} + \sum_{j=1}^{p} \lambda \Delta \log Gold_{t-j} + \delta \text{Dummy}_t + \epsilon_{3t} \quad (11) \]

Here, it is assumed that each equation in the VAR system contains p lag of the macroeconomic variables with an error term that indicates shocks or impulses under VAR(p) framework.

To estimate the above VAR model, stationary of the variables must be checked and it is observed that the variables are stationarity after first difference i.e. I(1) and the optimum lag length is one under SBIC and HQIC criterion.

Now, we can estimate the VAR(1) model as below:

\[ \Delta \log \hat{Gold}_t = \hat{\alpha}_1 + \hat{\beta}_1 \Delta \log Gold_{t-1} + \hat{\lambda}_1 \Delta \log BSE_{t-1} + \hat{\gamma}_1 \Delta \log NSE_{t-1} + \delta \hat{\text{Dummy}}_t + \epsilon_t \quad (12) \]
\[ \Delta \log \hat{BSE}_t = \hat{\alpha}_2 + \hat{\beta}_2 \Delta \log BSE_{t-1} + \hat{\lambda}_2 \Delta \log Gold_{t-1} + \hat{\gamma}_2 \Delta \log NSE_{t-1} + \delta \hat{\text{Dummy}}_t + \epsilon_{2t} \quad (13) \]
\[ \Delta \log \hat{NSE}_t = \hat{\alpha}_3 + \hat{\beta}_3 \Delta \log NSE_{t-1} + \hat{\lambda}_3 \Delta \log BSE_{t-1} + \hat{\gamma}_3 \Delta \log Gold_{t-1} + \delta \hat{\text{Dummy}}_t + \epsilon_{3t} \quad (14) \]

Where, \( \alpha \) indicates constant term. \( \beta, \lambda \) and \( \gamma \) are the slope coefficients to be estimated. \( \delta \) is the slope coefficient of the dummy variable that measures investors’ preference towards gold investment during COVID-19 lockdown if the
slope coefficient is positive and statistically significant or vice-versa. Δ is the difference operator.

The study also uses Granger causality test to find out the direction of causality between the variables under VAR environment.

The goodness or suitability of the VAR model is checked by using some well known statistical measures like serial correlation, heteroskedasticity and normality by considering the residuals.

Finally, the CUSUSM test is applied for parameter stabilization by considering the recursive residuals:

$$\theta_j = \sum_{j=k+1}^{T} \frac{\theta_j}{\hat{\sigma}^2}, \quad j = k + 1, \ldots, T$$ \hspace{1cm} (15)

with, $\hat{\sigma}^2 = \sum_{j=k+1}^{T} (\theta_j - \bar{\theta})^2 \quad \text{and} \quad \bar{\theta} = \sum_{j=k+1}^{T} w_j$,

Where, $\theta$ denotes the recursive residuals. $\sigma$ is the standard error of the regression fitted to T sample points and k is the number of coefficients to be estimated.

**Result & Analysis:**

The estimated short-run coefficients of the VAR models (Equation 12, 13 & 14) are presented in table 5. It is observed from the table (Equation 12) that the slope coefficients of BSE and NSE are statistically insignificant to influence the gold price during Corona virus outbreak in the short run. But the one period lag slope coefficient of gold is statistically significant and influences its own price significantly during COVID-19. Similarly, the slope coefficients for equations 13 and 14 are found to be insignificant meaning that the exogenous variables in the VAR equations have failed to influence the endogenous variables during the crisis period respectively. Although, the constant terms of all the VAR models are statistically significant. But, the slope coefficients of the dummy variables under the VAR models are insignificant that means that the investors don’t like to prefer gold investment during the time of COVID-19 lockdown in India or oppositely the investors like to invest in stock markets (BSE and NSE) during the specified period of COVID-19 lockdown. The macro-economic time series data are good fit into the VAR models as shown by the R² values and the models are free from autocorrelation problems as suggested by the Durbin-Watson test statistics.
Table 5: Estimation of coefficient under VAR

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Const.</th>
<th>Coefficients</th>
<th>R²</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>β₁logGold₁-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔlogGold₁ (Equation 12)</td>
<td>0.8533** (2.7024)</td>
<td>0.9113** (9.5287)</td>
<td>-0.1034 (-0.1424)</td>
<td>0.0630 (0.0850)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>λ₂logBse₁-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔlogBSEₜ (Equation 13)</td>
<td>1.6876** (2.4720)</td>
<td>2.4094 (1.5517)</td>
<td>-0.2579 (-1.2626)</td>
<td>-1.6868 (-1.0641)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>γ₁logNse₁-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔlogNSEₜ (Equation 14)</td>
<td>3.5930** (2.3809)</td>
<td>-0.8169 (-0.5258)</td>
<td>1.5451 (1.0153)</td>
<td>-0.2606 (-1.3019)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>δ₁Dummy₁-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>β₁logGold₁-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>λ₂logBse₁-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>γ₁logNse₁-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>δ₁Dummy₁-1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**significant at 5 percent level

Note: Author’s own calculation

The direction of Granger causality is presented in table 6. From the below table, it is observed that two-way or bi-directional causality is found between Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) during COVID-19. But in other cases the evidences of direction of causalities are absent.

Table 6: Granger causality test

<table>
<thead>
<tr>
<th>Null Hypothesis (H₀)</th>
<th>F-Statistic</th>
<th>Prob.</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSE doesn’t Granger cause Gold</td>
<td>0.02113</td>
<td>0.8847</td>
<td>Don’t Reject H₀</td>
</tr>
<tr>
<td>Gold doesn’t Granger cause BSE</td>
<td>0.47451</td>
<td>0.4922</td>
<td>Don’t Reject H₀</td>
</tr>
<tr>
<td>NSE doesn’t Granger cause Gold</td>
<td>0.04219</td>
<td>0.8376</td>
<td>Don’t Reject H₀</td>
</tr>
<tr>
<td>Gold doesn’t Granger cause NSE</td>
<td>0.55755</td>
<td>0.4567</td>
<td>Don’t Reject H₀</td>
</tr>
<tr>
<td>Dummy Variable doesn’t Granger cause Gold</td>
<td>2.38707</td>
<td>0.1250</td>
<td>Don’t Reject H₀</td>
</tr>
<tr>
<td>Gold doesn’t Granger cause Dummy Variable</td>
<td>0.30445</td>
<td>0.5821</td>
<td>Don’t Reject H₀</td>
</tr>
<tr>
<td>NSE doesn’t Granger cause BSE</td>
<td>4.83995**</td>
<td>0.0297</td>
<td>Reject H₀</td>
</tr>
<tr>
<td>BSE doesn’t Granger cause NSE</td>
<td>4.61574**</td>
<td>0.0337</td>
<td>Reject H₀</td>
</tr>
<tr>
<td>Dummy Variable doesn’t Granger cause BSE</td>
<td>2.36595</td>
<td>0.1266</td>
<td>Don’t Reject H₀</td>
</tr>
<tr>
<td>BSE doesn’t Granger cause Dummy Variable</td>
<td>2.08454</td>
<td>0.1514</td>
<td>Don’t Reject H₀</td>
</tr>
<tr>
<td>Dummy Variable doesn’t Granger cause NSE</td>
<td>2.66545</td>
<td>0.1051</td>
<td>Don’t Reject H₀</td>
</tr>
<tr>
<td>NSE doesn’t Granger cause Dummy Variable</td>
<td>2.00268</td>
<td>0.1596</td>
<td>Don’t Reject H₀</td>
</tr>
</tbody>
</table>

**significant at 5 percent level

Note: Author’s own calculation

The validity of the VAR models is checked and the outcomes are presented in table 7. It is found that the observed R² values of the residuals of all the VAR models based on Breusch-Godfrey test are statistically insignificant that means absence of
autocorrelation problem in the VAR models which is desirable. The heteroskedasticity test tells about rejection of null hypothesis in all the cases which is not enviable. Although, the J-B statistics of the residuals of the VAR models are found to be insignificant for rejecting the null hypothesis regarding normality which is acceptable. Finally, it may be said that the VAR models are valid based on two criterions out of three.

Table 7: Test for checking validity of the VAR

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>B-G LM test</th>
<th>B-P-G Het. Test</th>
<th>Normality Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residuals of ∆logGoldₜ</td>
<td>0.87880</td>
<td>0.2872</td>
<td>32.10889</td>
</tr>
<tr>
<td>Residuals of ∆logBSEₜ</td>
<td>0.89317</td>
<td>0.3446</td>
<td>36.56945</td>
</tr>
<tr>
<td>Residuals of ∆logNSEₜ</td>
<td>0.97139</td>
<td>0.3243</td>
<td>95.76630</td>
</tr>
</tbody>
</table>

Note: Author’s own calculation

The parameter stabilization of the VAR models is checked by applying CUSUM test and the graphs are presented in three figures. It is found that the cumulative sums of scaled recursive residuals in all the cases are inside in five percent critical lines that indicate parameter stability and absence of structural break which is acceptable.

Stability diagnostic

Figure 1: Gold
The present study seeks to examine the association between stock and gold investment during COVID-19 pandemic in India. Here, the macroeconomic time series variables (BSE, NSE and Gold) are normal and stationary at their first difference with same order of integration [I(1)] with optimum lag length of one without any co-integrated equations. So, there is no evidence of long run equilibrium relationship among the macroeconomic variables during COVID-19 pandemic. In the short-run it is observed that only one period lagged gold price significantly influence the gold price under VAR model (Equation 12). During COVID-19 lockdown, the investors like to prefer to make investment in stock as compared to gold as suggested by the dummy variable coefficients. The bi-directional causality is seen between BSE and NSE only. Various residuals tests enlighten about VAR model validity and stability.

The VAR modelling may be applied extensively in the emerging and underdeveloped countries for better understanding of the macroeconomic variables. Furthermore, this study may be helpful to the researchers, social thinkers, investors,
investment managers and policy makers to rethink again about the association between stock and gold by contributing more knowledge in this field.
REFERENCES


