Pacific Business Review International
Volume 13 issue 12 June 2021

# Commodity Volatility Indices and Select Asian Equity markets

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**Abstract**

Investigations on the relationship and spillover between equity and commodity markets are increasing as the price of one financial asset also considers the information or news about another financial asset. Furthermore, portfolio managers analyse the dependency structure of different assets to make better investment strategies. Studying the relationship between equity and commodity markets has vital inferences for investors.

This study examines the relationship between the implied volatility of two major international commodity indices and select Asian equity markets. It analysed Nifty50, Nikkei 225, SSE, Oil VIX and Gold VIX. The data period starts from 1 January 2015 to 31 May 2020.

The empirical results show the negative contemporaneous relation between the implied volatility of commodities and Nifty 50 and Nikkei 225 while no significant relation is found for SSE. Granger causality tests demonstrate bidirectional causality between the Gold VIX and countries equity indices.

The application of the EGARCH model reveals the existence of asymmetric effect in the conditional volatility of Nifty 50 and Nikkei 225. Further, the inclusion of Oil VIX and Gold VIX in the variance equation does not accentuate volatility persistence but reduces the asymmetric and ARCH effect.

**JEL Classification: C3, G1**

**Keywords: Oil, Gold, VIX, Equity, Volatility, EGARCH,**

## Introduction

Investigations on the association amid equity and commodity markets have been mounting in the financial literature, especially on account of spillover across the different class of assets. As it is seen that the price discovery of one asset also depends upon the information or news about another financial asset. Furthermore, portfolio managers analyse financial markets correlations and dependency of different assets to make better investment strategies. Studying the relationship between equity and commodity markets has important implication for the investors.

As Bekiros et al. (2016) argue the lead-lag position between the equity and commodity markets is time-varying depending upon the arrival of new information. Thus, one may expect to analyse the effect of one financial asset on another. A variety of studies like Mensi et al. 2013; Lombardi and Ravazzolo 2016; Lahmiri, Uddin and Bakiros 2017; Rossi 2012, were done to scrutinize the consequence of Oil and Gold on the equity market and vice versa using different econometrics techniques.

Boldonov, Degiannakis and Fillis (2016) suggest that the import and export of the commodities by the countries make their equity markets vulnerable to the changes in the prices of the commodity. The deviation in the commodity market affects the production activities which ultimately impact the net present value of equity. Countries need to be either heavy importer or exporter of a commodity to have a direct impact of commodity prices.

Moreover, the relationship among the financial markets has become more fragile since the global financial crises of the year 2008. Therefore, the understanding of the dynamic linkage between various markets has become more important as the contagion effect have been magnified.

The study of the linkage between commodity and stock markets can be of two types. The first focuses on the linkage between the first-order moments of commodity prices and equity market (Iscan 2015; Khan et al. 2015; Sujit and Kumar 2011; Sim and Zhou 2015). While the second category focuses on the relationship between the second-order of moments of commodity and equity market (Aziz et al. 2020; Alsufyani and Sarmidi 2020; Choi and Hammoudeh 2010; Tian and Hamori 2016; Palanska and Tereza 2018). Our study is focused on the volatility of the asset rather than the returns.

The study by Ross (1989) confirmed that studying the volatility constitution rather than returns behaviour is better for the pricing of individual assets. Studies have focused on equity-commodity volatility relations. These studies have mainly focused on using the realized volatility or GARCH model as a measure of volatility, which provides only historical information about asset volatility.

The present study utilizes the series of implied volatility indices published by CBOE, measuring the expected volatility of the asset rather than realized volatility. It includes the Oil Implied Volatility Index (OVX) and Gold Implied Volatility Index (GVIX) for the analysis. The implied volatility is based on the options markets representing not only historical information but the anticipation of the investors about the future changes in the asset prices. Thus, uncertainties indices are considered a superior gauge of volatility (Liu et al. 2013).

It gauges the investor's expectation of volatility, for instance when high risk is being perceived, the risk premium follows up and raises the option prices. Hence, studying the equity-commodity relationship through the implied volatility indices can provide additional insight into the force of the commodity market on the equity market.

This paper provides the recent picture of the interaction amid the implied volatility indices of oil and gold and equity market. The uncertainties indices and equity are interlinked through many channels. For instance, future volatility in commodity prices can cause variation in the sectoral stock return. Depending on the extent of exposure, the variation in the sectoral prices may impact the other equity markets like banks, financial institutions. Investors use the information provided by the uncertainty indices in their investment decision making. Hence, the information content of the implied volatility can be transmitted to another financial marketplace

The paper moves as follows: Section two includes a review of the literature on the relation between Gold and oil and Equity market. Section three describes the methodology used and section four discusses the findings. Lastly, Section five concludes the study.

**Review of Literature**

Kaufmann and Winters (1989) say that traditionally, gold is believed as a hedge against risk and inflation. So, central banks keep a significant proportion of the investment in gold for diversification and monetary protection. Junttila & Raatikainen (2017) argued despite the gold being a safe haven, its price volatility can impact the financial markets. For instance, the study by Baur (2012) concluded that increase in the gold prices is interpreted by the investors as uncertainty in the other financial assets and this interpretation results in higher volatility in the equity market. Arouri et al (2014) explored the return and volatility spillovers between the Chinese stock market and world gold prices. The result shows that the past gold returns significantly can explain the conditional return volatility of the stock markets. On the contrary, Lawrence (2013) found no evidence of a correlation between return on gold with return on equity and bond indices. The author cited the reason of no correlation between the variables is that return on gold is not dependent on economic activities while other financial assets are. Employing VECH MGARCH Baklaci, Suer and Yelkenci (2015) studied the cross-border dynamics of volatility transmission among gold futures in the emerging markets. The study finds significant volatility spillovers among the Taiwan, Indi and Turkey gold futures implying the prominent role of gold in a high degree of integration in an emerging market. On the other hand, China is the only exception of having bidirectional volatility transmission with only Japan and

Taiwan. Vardar, Coskun and Yelkenci (2018) applied VAR BEKK GARCH model to determine the shock transmission and volatility spillovers effect (STVS) in select emerging and developed countries together with five major commodity markets. The study noted the time-varying STVS effects over the three sub-periods i.e. pre-crisis, in crisis and post-crisis indicating crisis had a noticeable impact on the volatility spillovers. Analysing the full sample period, the primary trend is found to be the bidirectional volatility transmission between stock and commodity markets, although the STVS effects from the stock market are relatively more than the transmission from the commodity markets in both the emerging and developed economies. The study by Bhanja and Dar (2015) estimated results of wavelet correlation and regression that showed no average relationship between both the assets stipulating the weak hedge property of the gold against the uncertainties in the stock price. The wavelet coherence estimated higher power for India and the US during the dot bubble crisis (2000-01) and the Global financial crisis (2007-08), while China showed higher power solely during the 2008 financial crisis.

There exist many empirical pieces of evidence on the linkages between oil prices and the stock market. For instance, Hamilton (1983) mentioned in his article that almost all U.S recessions have been typically proceeded by the oil shocks over the period 1948-1972. Jones and Kaul (1996) analysed the effect of oil shocks on the changes in real cash flows which was used as a proxy for changes in stock returns. The result indicated that the changes in stock returns of U.S and Canada markets can be wholly attributed to the impact that oil shocks have on the real cash flows alone while Japan and U.K provided the evidence of overreaction in their stock returns. Sadorsky (1999) using VAR found evidence of changing oil price dynamics, suggesting that after 1986 a large fraction of the movement in stock price is due to the oil price movements rather than the interest rate. Moreover, the impact of oil price volatility appears to be asymmetric. Xiao et al. (2019) performed a more detailed investigation by applying the quantile regression to analyse the relationship between implied volatility of oil (OVX) and china stock market (VXFXI). The study highlighted the changing nature of the relationship between the two-time series under different market conditions. The empirical results showed a positive impact of OVX on VXFXI across all the quantiles but this impact tends to be stronger in the upper tail regions. The lagged impact of OVX is examined on the VXFXI, the study finds transmission of OVX to the VXFXI is transient thus reject the gradual information diffusion hypothesis. Maghyereh, Awartani and Bouri (2016) studied the directional connectedness between the OVX and implied volatility of 11 major stock exchanges. The spillovers measured proposed by Diebold and Yilmaz (2014, 2015 and 2016) are utilized in the study to analyse the linkage between oil and equity market. The skewness is observed in the relationship as the oil volatility had more information transmission on the equity volatility than the transmission from the opposite direction. The study also implied that equity options cannot be priced without considering the volatility in the oil market during the fragile period. Sehgal and Kapur (2012) examined the relationship between oil prices and the equity market under different economic settings. The study has been conducted over the period 1 January 1993 to 31 March 2009 and accordingly period is divided based on abnormal global economic events. The estimations showed that pre-events there was no abnormal return in any of the sample equity market implying no information leakage in oil prices. The post-event analysis suggested that irrespective of price increase or decrease in oil, high growth emerging economies had significant positive returns. Bihar and Nikolova (2009) used the EGARCH approach to study the return and volatility spillovers between the oil prices and BRIC stock market. The study found evidence of no impact of oil prices on the India and China equity market while Brazil being highly susceptible to changes in the oil prices. Miller and Ratti (2009) examined the long-run relationship between oil prices and six OECD countries over the period 1971 to 2008. The author utilised vector error correction by allowing other macroeconomic variables as additional regressors to control short-run influences and introducing structural breaks in the stochastic trend. The study found an overall long-run relationship between real stock price and world oil price but after 1999, a substantial break and reversal sign was visible suggesting a change in the relationship in the last years. Using nonlinear ARDL approach Raza, Shahzad, Tiwari and Shahbaz (2016) considered asymmetric impact of oil, gold and their volatility on the emerging stock markets. Negative short and long-run coefficients of both the commodities suggested increasing volatility in the commodity market is not a good sign for the stock markets.

**Methodology**

The study includes Nifty 50, Nikkei 225, SSE, Oil VIX and Gold VIX for the period ranges from 1 January 2015 to 31 May 2020. The total number of observations is 1237, sufficient enough to conduct further analyses. The data has been collected from Bloomberg database. The log transformation is applied to the time series.

**Variables**

| SL. No | Variables | Symbol |
|---|---|---|
| 1. | India | Nifty50 |
| 2. | China | SSE |
| 3. | Japan | Nikkei 225 |
| 4. | Implied volatility of Oil | Oil VIX |
| 5. | Implied Volatility of Gold | Gold VIX |

The central idea of selecting India, China and Japan in the study is due to the high consumption of gold and oil in these countries. India, China and Japan accountable for more than 60% of the total oil consumption in Asia and globally top consumers of oil after the USA. As per the statistical report of Oil information 2019, India and China have the largest share among the Non-OECD countries in the world oil demand. As per the World Gold Council Report-2019, China, India and Japan are among the top 10 countries having the highest reserves of gold in the world. Following the same report; China and India are responsible for 80% drop in the gold prices in the Q4 of 2019 given the high consumption of gold in Asia.

Further, we measure the information content of implied volatilities for the equity market by incorporating OVX and GVIX as an explanatory variable. Firstly, the significance of the implied volatility indices on conditional volatility is tested. Then, the degree of persistence is measured. The financial markets literature has documented asymmetry in the absorption of the new information (Liau and Yang, 2008; Samles, 2015; Chen, So and Gerlach, 2005). Therefore, the EGARCH model is augmented by using OVX and GVIX as additional variables in the conditional volatility equation. The results from the regression analysis inspect the contemporaneous relationship amid the equity and commodity markets. The results from the Granger causality explain the direction of the relationship between the commodity and equity market.

**Unit root analysis**

The ADF test checks the stationarity in the time series. A non-stationary time series will result in spurious regression. The stationarity is tested using ADF (1979):

$$\Delta y_t = \alpha + \beta_t + \gamma y_{t-1} + \delta 1 \Delta y_{t-1} + \delta 2 \Delta y_{t-2} + \cdots \ldots \delta p \Delta y_{t-p} \qquad \textbf{Eq (1)}$$

**Multiple Regression Analysis**

The regression model examines the impact of 1% change is one variable on another variable. The standard OLS regression is used to assess the contemporaneous relationship between the variables. The null hypotheses of the model states that there is no relationship between the variables.

$$X_t = c + \beta_1 Y_t + \beta_2 Y_t + \beta_3 Y_t + \beta_4 Y_t + u_t \qquad \textbf{Eq (2)}$$

**Granger Causality Test**

The lead-lag relationship is determined by the Granger Causality Test. It examines if the present value of one variable can be determined with the lags of another variable. It studies the relationship between two variables at a time thus called bivariate test. Before testing causality, the optimal lag length should be determined according to any information criteria. The null hypotheses of the test state that y doesn't granger cause x variable.

$$y_t = \theta_0 + \theta_1 y_{t-1} + \theta_2\, y_{t-2} + \cdots + \theta_n y_{n-t} + \mu_t \qquad \textbf{Eq (3)}$$

**EGARCH Model**

Further Conditional volatility is modelled using EGARCH (Nelson,1991). It is the most useful model tool when time series have heteroskedasticity in error terms and display volatility clustering. The mean and variance equations are as follows:

$$R_t = \alpha + bR_{t-1} + \varepsilon_t \qquad \textbf{Eq (4)} \qquad \varepsilon|I_{t-1} \sim N(0, h_t)$$

$$ln(h_t) = w + \alpha|\varepsilon_{t-1}/\sqrt{h_{t-1}}\,| + \gamma\left(\varepsilon_{t-1}\,/\sqrt{h_{t-1}}\right) + \beta ln(h_{t-1}) \textbf{Eq (5)}$$

**Objectives**

Objectives of the study are as follows:

To identify the contemporaneous relation among the implied volatility of commodities and Equity markets.

To establish the lead-lag relationship between the variables.

To analyse the impact of Oil VIX and Gold VIX on the asymmetric conditional volatility of stock returns and

To find out whether Oil VIX and Gold VIX can accentuate the persistence in the conditional volatility.

**Hypotheses**

Hypotheses of the study are stated as under:

H01: The contemporaneous relation does not exist between the variables.

H02: The short-run causal relationship does not exist between the variables and

H03: There is no impact of Oil VIX and Gold VIX on the conditional volatility.

**Analysis**

Analysis of data is done as follows:

Descriptive Statistics

**Table1 Descriptive Statistics**

| | LGVIX | LOVX | LNIKKIE | LNIFTY | LSSE |
|---|---|---|---|---|---|
| Mean | -0.00213 | 0.000165 | 0.00021 | 0.000133 | -0.00013 |
| Median | -0.05 | -0.00328 | 0.00061 | 0.000332 | 0.000645 |
| Maximum | 11.25 | 0.8577 | 0.077314 | 0.079295 | 0.056036 |
| Minimum | -9.5 | -0.63838 | -0.08766 | -0.086669 | -0.08873 |
| Std. Dev. | 1.032156 | 0.06684 | 0.013829 | 0.011037 | 0.015321 |
| Skewness | 0.988697 | 2.549807 | -0.36443 | 0.742604 | -1.25719 |
| Kurtosis | 28.18444 | 48.96024 | 9.735695 | 15.82496 | 10.17231 |
| Jarque-Bera | 32892.14 | 110214.1 | 2365.804 | 8591.242 | 2977.259 |
| Probability | 0.0000 | 0.0000 | 0.00000 | 0.00000 | 0.0000 |
| Sum | -2.63 | 0.204079 | 0.259158 | 0.164474 | -0.16125 |
| Sum Sq. Dev. | 1316.768 | 5.521925 | 0.236376 | 0.150553 | 0.290123 |
| Observations | 1237 | 1237 | 1237 | 1237 | 1237 |

Table 1 provides the descriptive of the five variables. It can be observed that the highest mean is found in LOVX followed by LNIKKIE and LNIFTY. The median values of indices are different from mean values implying the data is not normally distributed. Highest standard deviation is found in the LGVIX followed by LOVX and LSSE. Furthermore, the skewness parameters for all indices are not equal or close to zero signifying the non-normal distribution. The Jarque-Bera test has p-value less than 0.05 rejecting the null hypotheses of the normal distribution for all indices. The kurtosis parameter shows that the indices confirm to leptokurtic distribution displaying fat tail behaviour.

**ADF Unit root test**

**Table 2 ADF Unit root test**

| | At Level | | At first difference | | Level of Integration |
|---|---|---|---|---|---|
| | t-statistics | p-value | t-statistics | p-value | |
| LSSE | -0.344768 | 0.5610 | -33.0939 | 0.0000 | I (1) |
| LNIKKIE | 0.506069 | 0.8248 | -36.0056 | 0.0000 | I (1) |
| LGVIX | -0.329166 | 0.5669 | -35.981 | 0.0000 | I (1) |
| LOVX | -0.197091 | 0.6152 | -36.4814 | 0.0000 | I (1) |
| LNIFTY | 0.407018 | 0.8006 | -32.9683 | 0.0000 | I (1) |

Table 2 shows the initial diagnostic test of the time series to determine whether the indices have the presence of unit root. It can be observed that none of the series is stationary at levels accepting the null hypotheses of the presence of unit root.

At first differences of the null hypothesis is rejected at 5% level. It can be concluded that all the series have first order of integration.

**Regression Analysis**

**Table 3 Contemporaneous relationship between Commodity and Equity market**

| | | | | | |
|---|---|---|---|---|---|
| *Panel A: LNIFTY as dependent variable* | | | | | |
| Index | C | LSSE | LNIKKIE | LGVIX | LOVX |
| Coefficient | 8.6E-05 | 0.068790*** | 0.265241*** | -0.000691** | 0.028744*** |
| t-statistics | 0.324199 | 3.593307 | 12.10708 | -2.373736 | -6.395091 |
| p-value | 0.7458 | 0.0003 | 0.0000 | 0.0178 | 0.000 |
| *Panel B: LSSE as dependent variable* | | | | | |
| Index | C | LNIKKIE | LNIFTY | LGVIX | LOVX |
| Coefficient | -0.000212 | 0.298470*** | 150.774*** | -0.00010 | -0.009801 |
| t-statistics | -0.516822 | 8.979540 | 3.593307 | -0.228705 | -1.45445 |
| p-value | 0.6054 | 0.0000 | 0.0003 | 0.819 | 0.1461 |
| *Panel c: LNIKKIE as dependent variable* | | | | | |
| Index | C | LNIFTY | LSSE | LGVIX | LOVX |
| Coefficient | 0.000182*** | 0.4008873*** | 0.205809*** | -0.001687*** | -0.013785** |
| t-statistics | 0.534691 | 12.10708 | 8.97540 | -4.742377 | 2.460298 |
| p-value | 0.5930 | 0.0000 | 0.0000 | 0.0000 | 0.0140 |

***statistical significance at the 1% level

** Statistical significance at the 5% level

Table 3 shows the regression analysis. Equation (2) is exhibited in Panel A, B and C respectively.

In Panel A (Nifty 50 as DV), the coefficient of SSE, Nikkei225 and Oil VIX are statistically significant at the 1% level while the coefficient of Gold VIX is statistically significant at the 5% level. China and Japan have positive while both the implied volatility indices have a negative contemporaneous relationship with the Indian stock market. India is one of the top importers of the Gold and Oil, the rise in the uncertainty in the international commodity prices is expected to impact negatively Nifty 50.

In Panel B (SSE as DV), the stock returns of Japan and India have a positive significant contemporaneous relationship with the Chinese stock market. Whereas, we find no significant relationship among commodities implied volatility index and Chinese stock market highlighting exterior uncertainty shocks do not impact the Chinese stock prices.

In Panel C (Nikkei 225 as DV), the coefficient of Nifty 50, SSE and Gold VIX are statistical Significant at the 1% level while Oil VIX is statistically significant at the 5% level. The equity indices have a positive impact while the IV indices have a negative contemporaneous relationship with the Japanese equity market.

**Pair wise Granger Causality Tests**

**Table 4 Granger causality**

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| LNIKKIE → LNIFTY | 1236 | 5.64108** | 0.0177 |
| LNIFTY → LNIKKIE | | 7.31873*** | 0.0069 |
| LSSE → LNIFTY | 1236 | 0.28936 | 0.5907 |
| LNIFTY→LSSE | | 2.53672 | 0.1115 |
| LGVIX →LNIFTY | 1236 | 12.4305*** | 0.0004 |
| LNIFTY → LGVIX | | 2.84374* | 0.092 |
| LOVX→LNIFTY | 1236 | 8.50428*** | 0.0036 |
| LNIFTY→LOVX | | 2.11472 | 0.1461 |
| LSSE →LNIKKIE | 1236 | 0.08826 | 0.7665 |
| LNIKKIE→ LSSE | | 3.52143* | 0.0608 |
| LGVIX → LNIKKIE | 1236 | 19.1993*** | 0.000 |
| LNIKKIE → LGVIX | | 9.0057*** | 0.0027 |
| LOVX → LNIKKIE | 1236 | 19.2667*** | 0.000 |
| LNIKKIE → LOVX | | 4.41135** | 0.0359 |
| LGVIX → LSSE | 1236 | 3.93304** | 0.0476 |
| LSSE → LGVIX | | 3.22493* | 0.0728 |
| LOVX →LSSE | 1236 | 4.21883** | 0.0402 |
| LSSE → LOVX | | 1.47549 | 0.2247 |
| LOVX → LGVIX | 1236 | 2.60732 | 0.1066 |
| LGVIX → LOVX | | 0.15069 | 0.6979 |

Table 4 shows the granger causality results. The bidirectional causality is found between Nifty50 and Nikkie225.No significant causality is found between SSE and Nifty50. This implies that lagged Chinese stock returns provide no information content to the Indian stock returns and vice-versa. Further, the past and the present value of Nikkei 225 can influence the future values of SSE but SSE does not cause changes in the Nikkei 225. The Gold VIX has bidirectional causality with the country indices. Thus, fluctuations in the Gold VIX provide a lot of information for stock returns and vice-versa.

One-way unidirectional causality runs from Oil VIX to Nifty50 and SSE. This finding could be due to the reality that India and China are major oil importers not oil exporters countries. The bidirectional causality is found between Oil VIX and Nikkie225 implying flow of information in both the directions. Lastly, no causality is found between the Oil and Gold VIX signifying that no information content is exchanged by the uncertainties in the either commodity market.

**EGARCH Model and Correlogram**

Before modelling Conditional volatility, the returns are series are inspected for the presence of serial correlation. The Q statistics from the correlogram test are computed to test the serial correlation in Nifty50, SSE and Nikkei 225. The significant value at different lags in all the series represents the presence of serial correlation. It exhibits the phenomenon of volatility clustering, justifying the use of the GARCH model.

**Table 5 Correlogram**

| | Q-stat (4) | p-value | Q-stat (8) | p-value | Q-stat (12) | p-value |
|---|---|---|---|---|---|---|
| Nifty 50 | 292.84 | 0.0000 | 328.03 | 0.0000 | 337.00 | 0.0000 |
| SSE | 255.71 | 0.0000 | 265.47 | 0.0000 | 273.84 | 0.0000 |
| Nikkei225 | 354.31 | 0.0000 | 361.21 | 0.0000 | 369.82 | 0.0000 |

Table1 shows all the series have fat tail behaviour compared with the normal distribution. An application of the GARCH model would be more accurate to capture the volatility of the country indices.

There are several advantages of choosing EGARCH over the standard GARCH. Firstly, EGARCH doesn't restrict the estimation of the parameters to the non-negative values. Secondly, the model takes into account the negative asymmetric effect in the volatility estimation which is observed in much financial time series.

The asymmetric effect is measured by $\gamma$, the statistical significance of $\gamma$ will confirm the presence of leverage effect in the model.

The leverage hypothesis states that negative shocks generate more volatility than the positive shocks of the same magnitude. The GARCH coefficient $\beta$ measures the degree of volatility persistence. The EGARCH (1,1) is estimated along with two additional regressors in the mean equation of returns of country indices.

**Table 6 Conditional Volatility without Oil VIX and Gold VIX.**

| | Panel A: Nifty50 | Panel B: SSE | Panel C: Nikkei225 |
|---|---|---|---|
| A | 0.072468*** (5.621977) | 0.178285*** (9.515276) | 0.324024*** (13.12678) |
| B | 0.225503*** (14.31197) | 0.115861*** (5.060948) | 0.169426*** (10.25799) |
| | -0.34874*** (-4.95155) | -0.19458*** (-4.52764) | -0.60614*** (-5.45764) |
| A | 0.110751*** (3.723622) | 0.167899*** (5.951608) | 0.200117*** (5.594045) |
| Γ | -0.13494*** (-8.37871) | -0.00196 (-0.11238) | -0.15302*** (-6.36713) |
| B | 0.972263*** (153.3072) | 0.992144*** (248.6792) | 0.949895*** (85.88707) |
| Persistence | 0.972263 | 0.992144 | 0.949895 |
| Log -likelihood | 4245.161 | 3878.454 | 3895.358 |
| AIC | 4.441577 | -6.2594 | -6.28676 |
| ARCH LM | 0.08072 (0.7764) | 0.093628 (07597) | 0.072099 (0.7883) |

Table 5 represents the mean and variance equation of the EGARCH model. In panel A, the impact of SSE and Nikkei 225 on the mean returns of the Nifty50 is represented by the a and b respectively. The changes in Nikkei 225 and SSE have a significant positive impact on the returns of Nifty50. The Indian stock market is more influenced by the changes in the Japanese stock market than the Chinese stock market. The ARCH effect is significant suggesting volatility is largely influenced by the squared residuals of the lags. The leverage factor is significant and negative indicating the asymmetric effect.

The volatility of Nifty 50 is more responsive to the bad news than the good news of the same magnitude. Lastly, the GARCH term is also significant evidencing that current volatility is depended upon the lagged forecasted volatility. The value of $\beta$ is 0.972263 which is close to one. This indicates that the volatility is highly persistent so-called steady-state variance.

In Panel B, the impact of Nifty 50 and Nikkei 225 on mean returns SSE is represented by a and b respectively. The upward trend in both the indices leads to an increase in the returns in the SSE. The Chinese market is more responsive to the Japanese stock market than the Indian stock market. The ARCH and GARCH effect is statistically significant.

The volatility persistence is highest in SSE among the three indices. Contrary to the studies of Long, Tsui and Zhang, and Wang, 2019, the leverage effect is not statistically significant in the forecasting of the conditional volatility rejecting the presence of the asymmetric effect.

In Panel C, the impact of Nifty 50 and SSE on mean returns of the Nikkei 225 is represented by the a and b respectively. Both the countries return has a significant positive impact on the Nikkei 225. Though, Nifty 50 has a greater effect on Nikkei 225. The model has a statistically significant ARCH and GARCH effect. Though, Nikkei 225 has the least volatility persistence among the three countries. The leverage effect is also found statistically significant and negative indicating volatility responding more to the negative shocks than positive shocks.

The diagnostic test ARCH LM accepted the null hypothesis of no serial correlation in all the models estimated suggesting the model is well specified.

**Table 7 Conditional volatility with Oil VIX and Gold VIX**

| | Nifty 50 | SSE | Nikkei225 |
|---|---|---|---|
| A | 0.070207***<br>(5.013813) | 0.178313***<br>(0.178313) | 0.331087***<br>(13.09657) |
| B | 0.227027***<br>(13.65964) | 0.115933***<br>(5.10311) | 0.175071***<br>(10.63235) |
| c | -0.23953***<br>(-5.33276) | -0.19473***<br>(-4.54121) | -0.55166***<br>(-5.47487) |
| A | 0.081862***<br>(3.147141) | 0.167603***<br>(5.903215) | 0.167472***<br>(4.70377) |
| Γ | -0.09955***<br>(-6.22798) | -0.00382<br>(-0.2042) | -0.13081***<br>(-5.53562) |
| β | 0.981341***<br>(248.7447) | 0.992119***<br>(247.2022) | 0.953305***<br>(94.99709) |
| OVX$\theta_t$ | 0.571093<br>(1.396485) | -0.21766<br>(-0.47334) | 1.313589***<br>(0.009) |
| Gold VIX$\delta_t$ | 0.056847**<br>(2.040333) | 0.007488<br>(0.235204) | 0.01296<br>(0.441813) |
| Persistence | 0.981341 | 0.992119 | 0.953305 |
| Log-likelihood | 4252.802 | 3875.908 | 3897.967 |
| AIC | -6.86144 | -6.25713 | -6.29283 |
| ARCH LM | 0.249548<br>(0.6175) | 0.129147<br>(0.7194) | 0.034153<br>(0.8533) |

Table 6 represents the mean and variance equation with the inclusion of OVX and Gold VIX. The effects of contemporaneous Oil VIX and Gold VIX on the stock volatility of SSE, Nifty 50 and Nikkei 225 have been studied through EGARCH model by including the Oil VIX and Gold VIX in the variance equation. Once again, the asymmetric effect is found statistically significant and negative for the Nifty 50 and Nikkei 225. But the economic magnitude of the asymmetric parameters has reduced with the inclusion of Oil VIX and Gold VIX implies that commodity IV indices explain the asymmetry effect in the conditional volatility of the Nifty50 and Nikkei225 though not entirely. Surprisingly, Gold VIX is found statistically significant and positively associated only with the conditional variance of Nifty 50 whereas Oil VIX has been found statistically significant only in the case of Nikkei 225. The conditional volatility of SSE is neither impacted by the Oil VIX nor Gold VIX. The volatility persistence has increased in all of the variance equation signifying that the no information content provided by the Oil VIX and Gold VIX in the long-term volatility of the country indices. Although, the magnitude of the ARCH term is reduced by a great margin for the Nifty 50 and Nikkei 225 implying information from the commodity implied volatility explain the magnitude of the news in the respective stock markets.

The diagnostic test ARCH LM accepted the null hypothesis of 'no serial correlation' in all the models estimated suggesting the model is well specified. The log-likelihood of the Nifty 50 and Nikkei 225 has increased. Moreover, the values of AIC are more negative in all the models indicating the EGARCH model with the inclusion of Oil VIX and Gold VIX is preferred over the model that does not include Oil VIX and Gold VIX.

**News Impact Curve**

Lastly, the graphs of Engle and Ng (1993) news impact curve exhibits the effect of the news on the conditional volatility. In figure1, 2 and 3 the positive values on the x-axis represent the good news while negative values represent the bad news. On the other hand, the y-axis measures the conditional volatility using EGARCH model augmenting OVX and GVIX. The figure supports the asymmetric effect on the conditional volatility of the Nikkie225 and Nifty50 as the slopes are much steeper in the negative values. Whereas SSE has a symmetrical curve confirming no leverage effect.

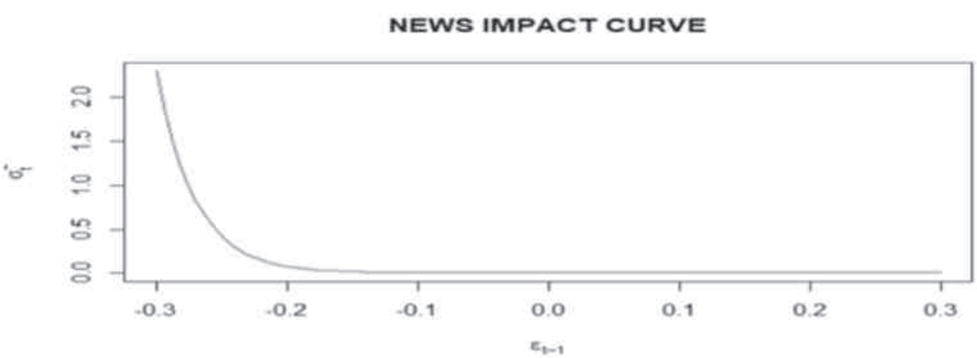


**Figure 1 OVX and GVIX augmented EGARCH News Impact Curves for Nikkei 225**

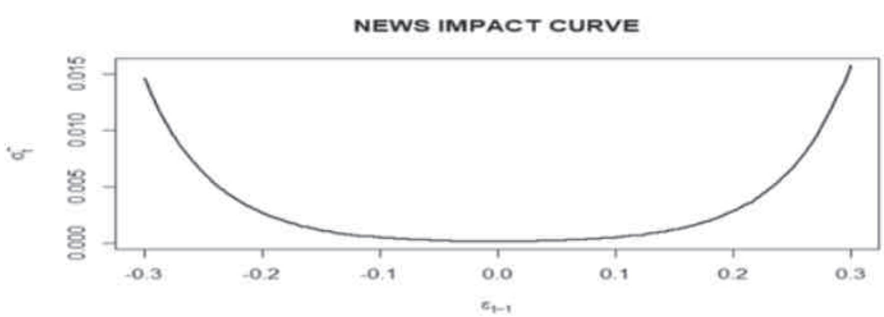


**Figure 2 OVX and GVIX augmented EGARCH News Impact Curves for SSE**

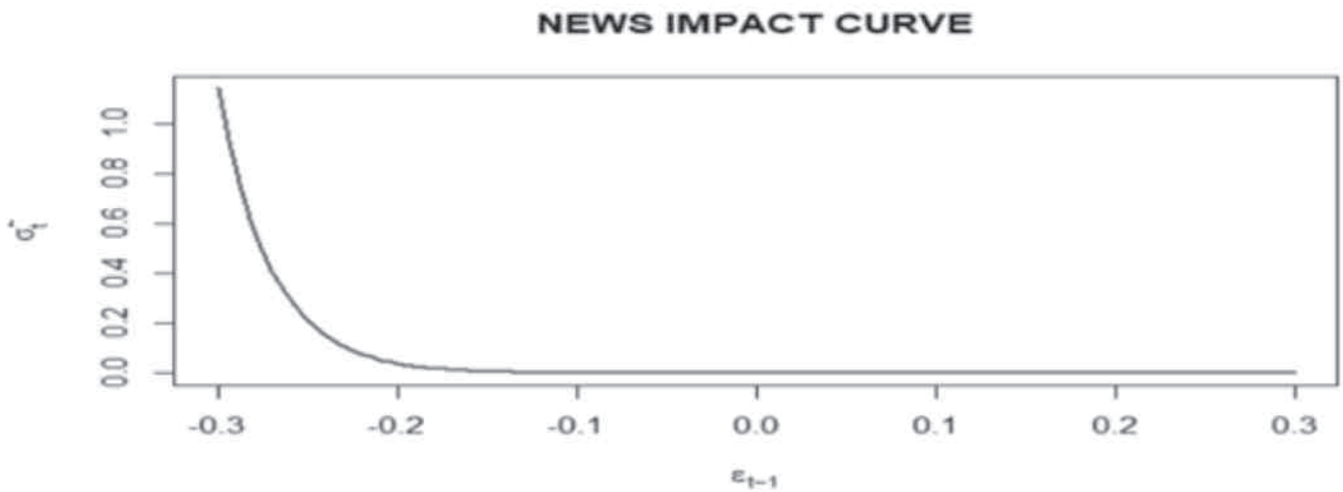


**Figure 3 OVX and GVIX augmented EGARCH News Impact Curves for Nifty 50**

## Conclusion

The study investigates the dynamic interaction between the implied volatility indices of Oil and Gold and major equity markets of Asia region. The incremental information content of the implied volatility is also tested through the degree of persistence. The regression results exhibited the existence of negative contemporaneous relation between commodities implied volatility (OVX and Gold VIX) and Stock returns (Nifty 50 and Nikkei 225).

Though, no significant relationship found between Chinese stock returns (SSE) and Commodities implied volatility. The lead-lag relationship suggested the bidirectional causality between Gold VIX and Nifty 50, SSE and Nikkei 225 while one-way causality is found between OVX and Nifty 50 and Nikkei 225 indicating OVX causes variation in the stock returns and not vice-versa.

The results from the EGARCH model suggest that the model fit well for the Nifty 50 and Nikkei 225 as the leverage factor was significant and negative. The contemporaneous OVX and Gold VIX are significant and positively associated with the volatility dynamics of Nikkei 225 and Nifty50 respectively. The asymmetric and ARCH effect is reduced in the variance equation.

However, the inclusion of contemporaneous OVX and Gold failed to accentuate the degree of persistence in the variance model. The economic magnitude of persistence has increased with the inclusion of OVX and Gold VIX. Thus, providing the evidence of no significant information contribution by the commodities implied volatility in the long-term volatility.

The findings of the study are imperative to understand the role of select commodity's volatility that have a bearing on the forecasting of the equity volatility and further using the information in the volatility-based trading strategies. The asymmetric analysis provides a better understanding of the role of bad news from the commodity to the equity markets.

## References

Alsufyani, M., & Sarmidi, T. (2020). The Inter-Relationship Between Commodity Energy Prices And Stock Market Volatility In Saudi-Arabia. Journal of Nusantara Studies (JONUS),5(1), 270-293. doi:10.24200/jonus.vol5iss1pp270-293

Arouri,M.,A.,Nguyen,D.,(2015). World gold prices and stock returns in China: Insights for hedging and diversification strategies. Economic Modelling, 44, 273-282.

Bhar, R., & Nikolova, B. (2009). Oil Prices and Equity Returns in the BRIC Countries. World Economy,32(7), 1036-1054. doi:10.1111/j.1467-9701.2009.01194.x

Aziz, T., Sadhwani, R., Habibah, U., & Janabi, M. A. (2020). Volatility Spillover Among Equity and Commodity Markets. SAGE Open,10(2), 215824402092441. doi:10.1177/2158244020924418

Baklaci, H. F., Süer, Ö., & Yelkenci, T. (2015). Volatility Linkages Among Gold Futures in Emerging Markets.

Emerging Markets Finance and Trade,52(1),1-9, doi:10.1080/1540496x.2015.1062292

Baur, D. G. (2012). Asymmetric Volatility in the Gold Market. The Journal of Alternative Investments,14(4), 26-38. doi:10.3905/jai.2012.14.4.026

Bekiros, S., Nguyen, D. K., Uddin, G. S., & Sjö, B. (2016). On the time scale behavior of equity-commodity links: Implications for portfolio management. Journal of International Financial Markets, Institutions and Money,41,30-46. doi:10.1016/j.intfin.2015.12.003

Bhanja, N., & Dar, A. B. (2015). "The beauty of gold is, it loves bad news": Evidence from three major gold consumers. Economic Change and Restructuring, 48(3-4), 187-208. doi:10.1007/s10644-015-9160-z

Boldanov, R., Degiannakis, S., & Filis, G. (2016). Time-varying correlation between oil and stock market volatilities: Evidence from oil-importing and oil-exporting countries. International Review of Financial Analysis,48, 209-220. doi:10.1016/j.irfa.2016.10.002

Jones, C.M. and Kaul, G. (1996). Oil and the stock markets The Journal of Finance, 51(2), 463-491.

Chen, C. W., So, M. K., & Gerlach, R. H. (2005). Asymmetric response and interaction of U.S. and local news in financial markets. Applied Stochastic Models in Business and Industry,21(3), 273-288. doi:10.1002/asmb.600

Choi, K., & Hammoudeh, S. (2010). Volatility behavior of oil, industrial commodity and stock markets in a regime-switching environment. Energy Policy,38(8), 4388-4399. doi:10.1016/j.enpol.2010.03.067

Diebold, F.X., Yilmaz, K., 2012. Better to give than to receive: predictive directional measurement of volatility spillovers. Int. J. Forecast. 28 (1), 57–66.

Diebold, F.X., Yilmaz, K., 2014. On the network topology of variance decompositions: measuring the connectedness of financial firms. J. Econ. 182 (1), 119–134.

Engle, F.R., & Ng, V.K. (1993). Measuring and testing the impact of news on volatility. Journal of Finance, 48(5), 1749–1778.

Hamilton, J. D. (1983). Oil and the Macroeconomy since World War II. Journal of Political Economy,91(2), 228-248. doi:10.1086/261140

Iscan, E. (2015). The Relationship Between Commodity Prices And Stock Prices: Evidence From Turkey. International Journal of Economics and Finance Studies,7(2),17-26.

Junttila, J., Pesonen, J., & Raatikainen, J. (2018). Commodity market based hedging against stock market risk in times of financial crisis: The case of crude oil and gold. Journal of International Financial Markets, Institutions and Money,56, 255-280. doi:10.1016/j.intfin.2018.01.002

Kaufmann, Thomas D. & Winters, Richard A., 1989. "The price of gold : A simple model," Resources Policy, 15(4), 309-313.

Khan, A. P., Kabir, S. H., Bashar, O. K., & Masih, A. M. (2015). Time Varying Correlation Between Islamic Equity and Commodity Returns: Implications for Portfolio Diversification. The Journal of Developing Areas,49(5), 115-128. doi:10.1353/jda.2015.0069

Ks, Sujit & Kumar, Rajesh. (2011). Study on dynamic relationship among gold price, oil price, exchange rate and stock market returns. International Journal of Applied Business and Economic Research, 9, 145-165.

Lahmiri, S., Uddin, G. S., &Bekiros, S. (2017). Nonlinear dynamics of equity, currency and commodity markets in the aftermath of the global financial crisis. Chaos, Solitons & Fractals,103, 342-346. doi:10.1016/j.chaos.2017.06.019

Lawrence, C. (2003) Why Is Gold Different from Other Assets? An Empirical Investigation. the World Gold Council, Accecced from http://www.spdrgoldshares.com/media/GLD/file/colin_lawrence_report.pdf

Liau, Y., & Yang, J. J. (2008). The mean/volatility asymmetry in Asian stock markets. Applied Financial Economics,18(5), 411-419. doi:10.1080/09603100600959878

Liu, M., Ji, Q., & Fan, Y. (2013). How does oil market uncertainty interact with other markets? An empirical analysis of implied volatility index. Energy,55, 860-868. doi:10.1016/j.energy.2013.04.037

Lombardi, M. J., &Ravazzolo, F. (2016). On the correlation between commodity and equity returns: Implications for portfolio allocation. Journal of Commodity Markets,2(1), 45-57. doi:10.1016/j.jcomm.2016.07.005

Long, L., Tsui, A. K., & Zhang, Z. (2014). Conditional heteroscedasticity with leverage effect in stock returns: Evidence from the Chinese stock market. Economic Modelling,37, 89-102.

doi:10.1016/j.econmod.2013.11.002

Maghyereh, A. I., Awartani, B., &Bouri, E. (2016). The directional volatility connectedness between crude oil and equity markets: New evidence from implied volatility indexes. Energy Economics,57, 78-93. doi:10.1016/j.eneco.2016.04.010

Mensi, W., Beljid, M., Boubaker, A., &Managi, S. (2013). Correlations and volatility spillovers across commodity and stock markets: Linking energies, food, and gold. Economic Modelling,32, 15-22. doi:10.1016/j.econmod.2013.01.023

Miller, J. I., &Ratti, R. A. (2009). Crude oil and stock markets: Stability, instability, and bubbles. Energy Economics,31(4), 559-568. doi:10.1016/j.eneco.2009.01.009

Nelson, D. B. (1991). Conditional Heteroskedasticity in Asset Returns: A New Approach. Econometrica,59(2), 347. doi:10.2307/2938260

Palanska,Tereza(2020). Measurement of Volatility Spillovers and Asymmetric Connectedness on Commodity and Equity Markets. Journal of Economics and Finance,70 (1), 42-69.

Raza, N., Shahzad, S. H., Tiwari, A. K., &Shahbad, M. (2016). Asymmetric impact of gold, oil prices and their volatilities on stock prices of emerging markets. Resource Policy,49, 290-301. doi:https://doi.org/10.1016/j.resourpol.2016.06.011

Ross, S. A. (1989). Information and Volatility: The No-Arbitrage Martingale Approach to Timing and Resolution Irrelevancy. The Journal of Finance,44(1), 1-17. doi:10.1111/j.1540-6261.1989.tb02401.x

Rossi, B. (2012). The Changing Relationship Between Commodity Prices and Equity Prices in Commodity Exporting Countries. IMF Economic Review,60(4), 533-569. doi:10.1057/imfer.2012.20

Sadorsky, P. (1999). Oil price shocks and stock market activity. Energy Economics,21(5), 449-469. doi:10.1016/s0140-9883(99)00020-1

Sehgal, S., &Kapur, R. (2012). Relationship between Oil Price Shocks and Stock Market Performance: Evidence for Select Global Equity Markets. Vision: The Journal of Business Perspective,16(2), 81-92. doi:10.1177/097226291201600201

Sim, N., & Zhou, H. (2015). Oil prices, US stock return, and the dependence between their quantiles. Journal of Banking & Finance,55, 1-8. doi:10.1016/j.jbankfin.2015.01.013

Tian, S., & Hamori, S. (2016). Time-varying price shock transmission and volatility spillover in foreign exchange, bond, equity, and commodity markets: Evidence from the United States. The North American Journal of Economics and Finance,38, 163-171. doi:10.1016/j.najef.2016.09.004

Vardar, G., Coşkun, Y., &Yelkenci, T. (2018). Shock transmission and volatility spillover in stock and commodity markets: Evidence from advanced and emerging markets. Eurasian Economic Review,8(2), 231-288. doi:10.1007/s40822-018-0095-3

Wang, L. (2019). Research on Leverage Effect and Risk Fluctuation of Shanghai and Shenzhen Stock Markets Based on GARCH Family Model. IOP Conference Series: Materials Science and Engineering,688, 055001. doi:10.1088/1757-899x/688/5/055001

Xiao, J., Hu, C., Ouyang, G., & Wen, F. (2019). Impacts of oil implied volatility shocks on stock implied volatility in China: Empirical evidence from a quantile regression approach. Energy Economics,80, 297-309. doi:10.1016/j.eneco.2019.01.016