Interaction between Gold Price, Crude Oil Price and Indian Stock Market

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ABSTRACT

This study is targeting three main variables: Gold price, Crude Oil price and the Stock market as they have an important position within today's economy and play a vital role in the overall development of the economy. Indian stock market is prone to fluctuations with changes in macro-economic variables like gold prices, crude oil prices etc. In this study, we will try to investigate the two major-economic indicators(Crude and Gold) on the performance of the Indian Stock Market.

BUSINESS UNDERSTANDING

Objective

1. To study the inter dependency of crude oil prices, gold prices and Indian Stock market indices (Nifty 50).
2. To analyze how crude oil and gold prices impact the Indian Stock Market indices.

Situation Assessment and Project Goals

One of the most challenging thing for any investor is the inter relationship between the markets for these parameters. The market for stock can be called as the financial market and the market for gold may be called as the commodity market. The prices of stocks and the commodities plays a very important role in the Indian economy. The prices of these commodities are affected by a variety of parameters which is directly related to the commodity or the stock itself. We can say that the crude oil price gets

greatly influenced by the geopolitical and weather related factors. The stock market prices is affected by various parameters like political and social. Gold as we all know is also considered as an asset that can compete with money. Gold acts as an indicator of inflation(1). The volatility in gold and oil prices is important in evaluating the risk of investment as volatility presents opportunities for traders to buy assets cheaply and sell them when they are overpriced. In other words, it indicates important shifts in market and therefore clever analysis between the given variables (gold prices, oil prices and stock market indices) may provide clues for investors. It will be highly ambitious to say that we will be able to identify whether gold price and crude oil price have an impact on stock market index given the time frame we have at hand. We will try to come up with something close that will help us to better understand the relations between the three parameters we have at hand.

LITERATURE REVIEW

To explain the links between gold prices, oil prices and stock market prices the economics play a major role. There have been many studies devoted to finding out the relationship between oil price, gold price and macroeconomic variables.

A number of studies has shown an inverse relationship between stock indices and crude oil prices for example, Filis, 2010; Cunado Perez de Garcia, 2014 whereas some literatures also found a positive relationship between oil price and stock indices for example, Boyer and Filion (2004); Sadorsky (2001); Constantinos et al., 2010; Hasan Mahbobi, (2013).

To examine the relationship among crude price, gold price and financial variables Bhunia (2013) envisaged that there subsist a long term co integration between the financial variables taken for the study of both NSE and BSE. The period of the study was taken from 1991 to 2012. Studies finding fluctuations in commodities like gold and crude and its impact on Indian stock market (2018) had tested the data on ADF and used descriptive statistics found that crude oil price has a direct relationship with the Stock index and gold price has no significant relationships with the stock index.

Sharma (2012) has done a A Comparative Study Of BSE With NYSE for Crude Oil Price Velocity and Stock Market Ripple concluded that the oil price changes have significant effect on performance of stock returns.

Siddiqui(2015) observed that stock returns have negative mean return while crude oil prices have positive average returns and a very weak correlation, about 3.21 percent, was observed. The literature review thus threw a light upon relationships and impact of commodities in the stock market, though there are empirical studies in India investigating upon these relationships but the results may differ for different sample periods. Majority of the studies researched western and developed countries context, while India is an emerging economy and exhibits peculiar characteristics like high degree of inflation , frequent revision in interest rates, import bill on crude etc. Therefore to understand the impact of the above listed prominent macro-economic

variables and its impact Indian stock indices we studied these variables and Indian stocks with different data analytic models .

DATA UNDERSTANDING

Data Collection

We have collected data for gold price, crude oil and stock market index. The links to the data sets are provide in the section "References for Data". In this section we will provide a brief idea about the organization of the data and how we would like to combine them into a bigger relational table to satisfy our objective. The collected data has been collated using Microsoft Excel.

Structure of Data

Data Time Frame

Though we have gold, crude oil and stock market price data for varying time frames from year 1995 to 2020 collected from various sources such as Yahoo finance, official websites of NSE and BSE, significant events occurred which shaped the economy and then decided to go with the period of 2005 to 2020. The period which was selected is an interesting one due to the fact that in 2005 foreign companies started to invest in India. Also, for government employees, the 6th pay commission was approved, which was the largest increase in payment of employees. This was the period when the Mutual fund's industry also started to have an impact and people started to think that the Share Market is less vulnerable. Due to such phenomenal events, the correlation between gold prices and stock prices is a positive one despite it being otherways throughout the past.

Data Frequency

For all three data types, we have daily, weekly and monthly data points during the above mentioned time frame.

Data Format

The gold data contains two columns one for the date and one for the price. The stock market contains the opening, closing and high and low for a stock for the given period. It also contains the volume which refers to the number of shares traded in a specific market(2). A higher volume indicates that the contract or commodity is

more actively traded or is more liquid. In a chart the volume helps to identify the price trd which can be helpful to us. The columns are same for crude oil.

Data Cleaning

The data collected for Gold was available in Dollar which was converted in INR. For this we collected Dollar-INR prices over the required time period and then got the data in Indian Currency.

Tools Used

We have used various tools for data preparation, visualization and analysis:

- Tools: MS-Excel for data preparation
- Programming Language: Python
- Libraries: scikit-learn, Matplotlib for modelling and visualization

Data Visualization

The Figure 1 shows the fluctuations of Crude Oil, Gold and Stock Market prices with time over the period of 2010-2020, respectively. In each plot, blue line is the regression line and R^2 (coefficient of determination) w.r.t. to this line is shown on the plot.

Data Interpretations

The study has taken daily, monthly and yearly data of gold, crude oil and nifty 50(for stock market index) from 2010 to 2020 constituting 6448 observations for daily, 132 observations for monthly and 11 observations for yearly basis.

- Gold price has increased consistently to reach around 2.5x valuation during the observation window. Among the 3 variables, gold prices have shown the least drop on average.
- Crude oil prices have shown the least increment of the 3 variables. In fact, it peaked in 2013 and then there was a sharp decrease in prices till 2016. Prices peaked since then till 2018 and then started to decline again.
- Like gold prices, the Nifty 50 stock index price has continuously increased to reach around 2.5x valuation. However, there has been more fluctuation in its price compared to gold prices.

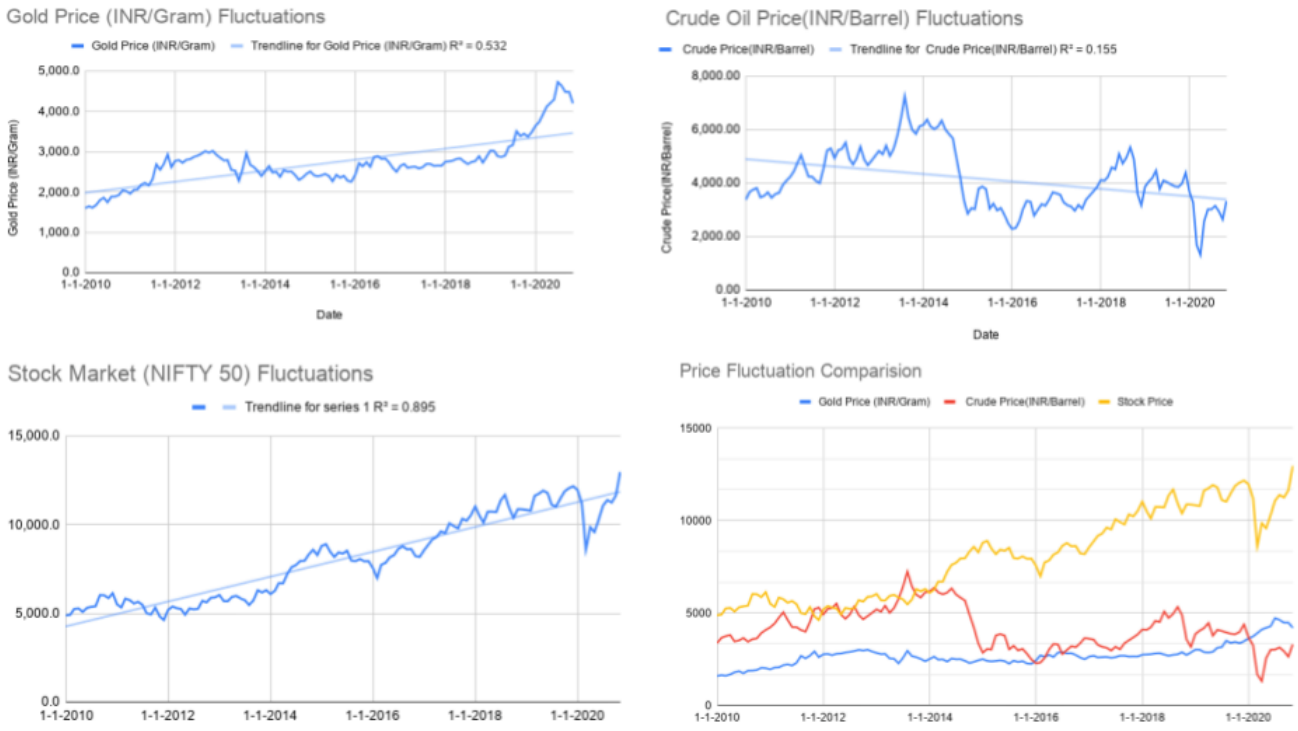

Figure 1: Price fluctuations from 2010-2020

MODELLING

Correlation Matrix

Correlation is a way to determine how two variables are related. Co-variance can determine whether relation is positive or negative but it is impossible to measure the degree to which the variables are related. But correlation also tells the degree to which the variables are related to each other. The correlation formula is given as-

$$\rho_{xy} = Correlation\ (x, y) = \frac{cov(x, y)}{\sqrt{var(x)}\sqrt{var(y).}}$$

- Correlation matrix values range from -1 to 1.
- Values closer to +1 means that both variables move closely together and in the same direction.
- A value of 0 means that there is no relationship between the variables.
- While a negative correlation indicates that the variables move in different directions. The closer to -1 the stronger the inverse relationship.

	Gold Price	Stock Price	Crude Price
Gold Price	1.000000	0.647460	0.377296
Stock Price	0.647460	1.000000	0.088441
Crude Price	0.377296	0.088441	1.000000

Figure 2: The correlation matrix for the given variables

Figure 3: Correlation Matrix

The above correlation matrix shows that Crude oil prices and Gold Prices impacts the Stock prices in India. The impact of Gold and Stock market is found to be positive here, as mentioned in few literature too. Stock and Gold has correlation of 0.65 over the years 2010-2020. Hence, the correlation results reveal that NIFTY50 lead to increase in gold price and rise in gold price lead to increase in NIFTY50. The results of econometric regression reflected that gold prices had a significant impact on stock market indicator NIFTY50. While the impact of Crude Price on Stock market is comparatively lesser, it has a correlation of 0.38. The correlation between Crude and Stock is also positive. This shows the dependency relationship among the variables taken under study.

Multi Variate Regression

A multiple regression model can be proposed to find out the impact of chosen variables (gold prices, oil prices) on Indian Stock Market Indices. The regression equation or the relationship between the dependent(Y) and independent variables(Xi) will be in the form given below:

$$\boldsymbol{Y = a + c1.X1 + c2.X2} \quad (3)$$

where

- $\boldsymbol{Y}$ =indices of Indian Stock Market

- ***X1*** = crude oil prices
- ***X2*** = gold prices
- ***c1, c2*** = coefficients of estimated model

Considering Gold and Crude prices as independent variables and dependent variable as Stock Prices. The equation obtained on using multi-linear regression is-

$$Y(NIFTY50) = 622.86 + 0.0081 * X1(GoldPrice) + 0.0260 * X2(CrudeOilPrice)$$

Analysis of regression results

We have tried to predict the price of gold using the other two features likely the prices of crude oil and stock. In the data set we have the prices for gold in two different units. The first unit is grams and the second is troy ounce. We have found the use of both these units during our literature survey. The results that we obtained are presented in the table 1. In the table we can see that the absolute error when we try to predict the price of gold with gram as the unit is much lower than what we get with troy ounce as the unit. Before the regression analysis we have also performed the comparison of the features with one another. As shown in the figures 4, 5 and, 6 we can see that it seems easy to fit a regression line when wee consider the features keeping one axis fixed for the price of gold in each case. The price of gold is considered in grams as well as in troy ounce.

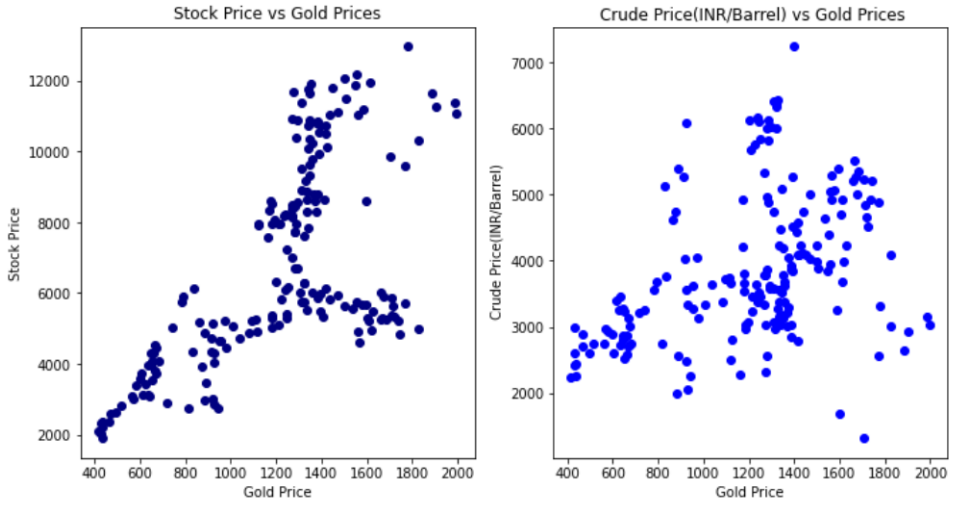

Figure 4: X-axis: Gold prices in INR, Y-axis: Remaining features

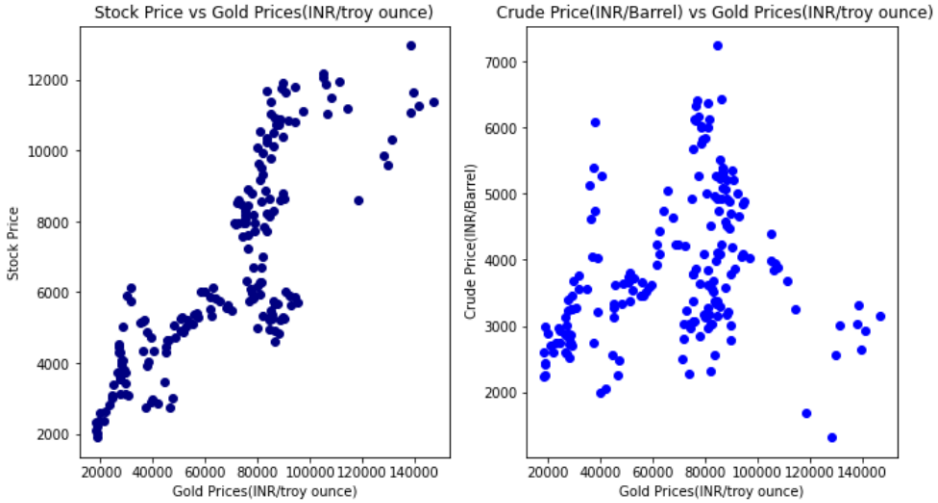

Figure 5: X-axis: Gold prices in troy ounce, Y-axis: Remaining features

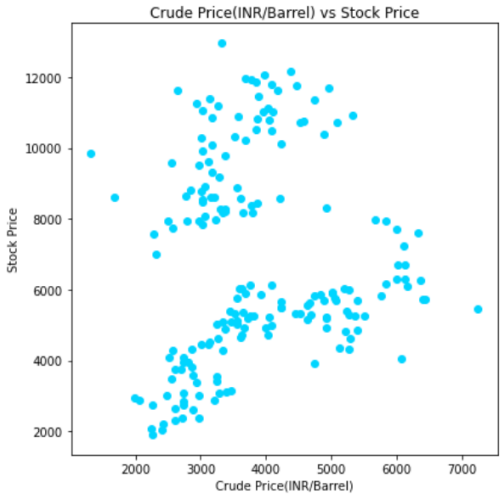

Figure 6: X-axis: Crude oil, Y-axis: Stock

Predicted feature	Mean Absolute error
Gold INR	235.66
Gold troy ounce	11507.900
Stock(with Gold INR)	4892.94
Stock(with Gold ounce)	4240.45
Crude Oil(with Gold INR)	4871.10
Crude Oil(with Gold troy ounce)	4795.49
Gold INR(data shuffled)	192.37
Gold troy ounce(data shuffled)	65199.79

Table 1: The mean absolute error of different experiments.

Clustering

Clustering is the task of dividing the population or data points into a number of groups such that data points in the same groups are more similar to other data points in the same group than those in other groups. In simple words, the aim is to segregate groups with similar traits and assign them into clusters. Here are we using K-MEANS CLUSTERING (K=4) for analyses -

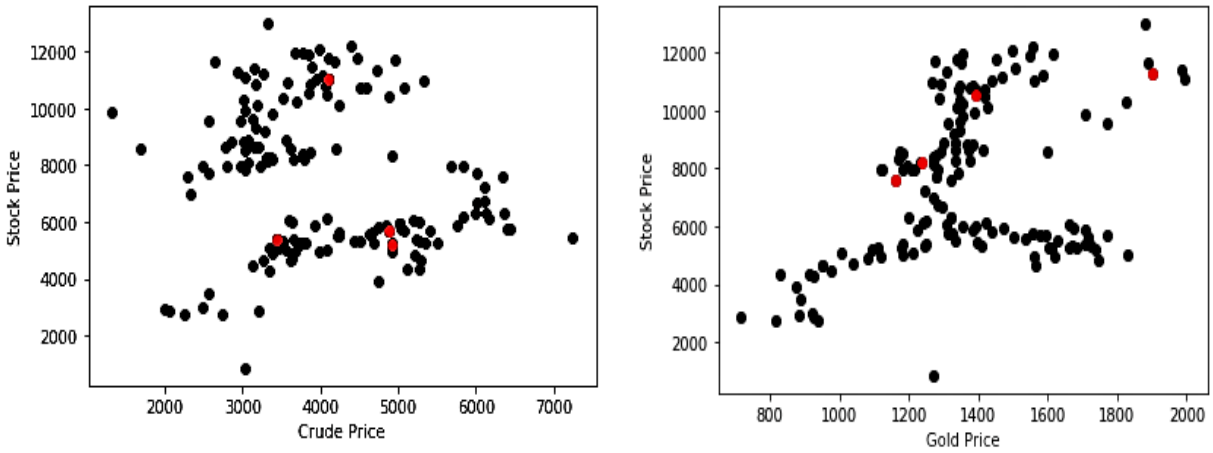

Figure 7: Clusters before updation of centroids

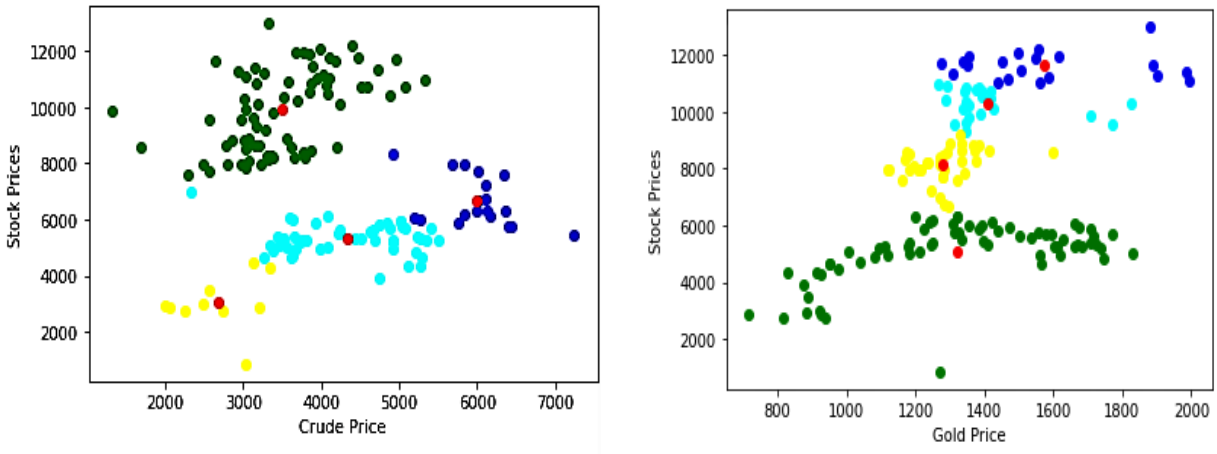

Figure 8: Clusters after updation of centroids

Analysis of clustering for Crude Oil Prices -

- For cluster1 (yellow) (all values in INR)- when crude prices are in the range (2000-3000), corresponding stock prices lie in the range (2000-4000)
- For cluster2 (green)- when crude prices are in the range (3000-4000), corresponding stock prices lie in the range (10000-12000)

- For cluster3 (cyan) -when crude prices are in the range (4000-5000), corresponding stock prices lie in the range (4000-6000)
- For cluster4 (blue) –when crude prices are in the range (6000-7000), corresponding stock prices lie in the range (6000-8000)

The overall analysis shows that, initially stock prices increases linearly with increase in crude oil prices, then the stock prices shoot up when crude prices lie in the (3000-4000), then gradually stock prices decreases with increase in crude oil prices in the range (4000-5000) and beyond this, the two factors reveal a linear relationship.

Analysis of clustering for Gold Prices -

- For cluster1 (yellow) (all values in INR) - when Gold prices are in the range (1200-1400), corresponding stock prices lie in the range (8000-10000)
- For cluster2 (green) -when gold prices are in the range (1200-1400), corresponding stock prices lie in the range (4000-6000)
- For cluster3 (cyan) -when gold prices are in the range (1400-1600), corresponding stock prices lie in the range (10000-12000)
- For cluster4 (blue) -when gold prices are in the range (1600-1800), corresponding stock prices lie in the range (10000-12000)

The overall cluster analysis shows that even when gold prices remain almost steady in the range (1200-1400), the stock prices increase rapidly , when gold prices lie in the range (1400-2000), the stock prices show almost linear relationship with gold.

CONCLUSIONS

In the study, dynamic relationship between Stock, Gold and Crude prices is examined. We established that Crude Prices and Oil Prices do have an effect over stock prices in India. Crude oil is one of the most basic global commodities. Fluctuation in the crude oil prices has both direct and indirect impact on the global economy. Therefore, the prices of crude oil are tracked very closely by investors the world over. The price variation in crude oil impacts the sentiments and hence the volatility in stock markets all over the world. The rise in crude oil prices is not good for the global economy. Price rise in crude oil virtually impacts industries and businesses across the board. Higher crude oil prices mean higher energy prices, which can cause a ripple effect on virtually all business aspects that are dependent on energy (directly or indirectly). Gold is also an important standard commodity traded across the global markets. Since gold is also a seasonal commodity, it is exposed to lot of volatility. Results shows that Crude has a positive relationship with the stock prices. Though Gold prices are known to have an inverse relationship with Stock market prices, but to our

surprise the relationship from 2010-2020 of Gold prices and Stock Market prices is also positive. So, while buying or selling any stocks or constructing a portfolio the market participants should take the momentum in gold and crude prices seriously.

REFERENCES FOR DATA

- Gold Prices: The gold price data (per gram) is collected from `https://www.gold.org/goldhub/data/gold-prices`
- Crude Oil Prices: The data is collected from `https://in.finance.yahoo.com/quote/IOC.NS/history?period1=829526400&period2=1607817600&interval=1d&filter=history&frequency=1d&includeAdjustedClose=true`
- NIFTY 50 Historical Data: `https://in.investing.com/indices/s-p-cnx-nifty-historical-data?end_date=1607858342&interval_sec=monthly&st_date=282335400`
- Stock Market Prices: Yahoo Finance `https://in.finance.yahoo.com/quote/%5ENSEI/history?p=%5ENSEI`
- Stock Exchange of India: `https://www1.nseindia.com/products/content/equities/indices/historical_index_data.html`

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