Commodity Price Volatility and Stock Market Returns in India: A Comparative Analysis before and during the COVID-19 Pandemic

Master's Dissertation

Submitted to

Department of Economics

Birla School of Social Sciences and Humanities

Birla Global University

In partial fulfilment of the requirement of the Degree

Master of Arts in Economics

By

Akash Thangaraj

Roll No.: 041901006

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Faculty Guide

Dr. Debi Prasad Bal

Declaration - I

I hereby declare that the work in this thesis entitled “Commodity Price Volatility and Stock Market Returns in India: A Comparative Analysis before and during the COVID-19 Pandemic” is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature Name: Akash Thangaraj

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Date: 03/06/2021

ACKNOWLEDGEMENT - II

I sincerely feel it would be impossible for me to say that I alone deserve credit for the work done in this thesis. This project is the result of a combined effort of a number of people who have supported throughout this long and arduous process. I would like to express my gratitude to all those involved in helping me finish this otherwise extremely difficult task.

I would first and foremost like to thank my faculty guide Dr. Debi Prasad Bal, Assistant Professor, Department of Economics, Birla School of Social Sciences and Humanities, Birla Global University, for his valuable insight and guidance, without which this project would not have come to fruition.

I would also like to express my gratitude to my professors Dr. Seba Mohanty and Dr. A. K. Dash for their encouragement and support. I would also like to thank my classmates and my peers for the experience they have granted me.

I would also like to take this opportunity to thank Prof. (Dr.) Parameswar Nayak, Dean, Birla Schools of Social Sciences and Humanities as well as Prof. (Dr.) P.P. Mathur, Honorable Vice-Chancellor and Prof. (Dr.) B.K. Das, esteemed Registrar of BGU for their continuous support and valuable advice.

I would also like to acknowledge the help and encouragement of my Father.

Akash Thangaraj

Birla Global University, Bhubaneswar

Roll Number: 041901006

M.A. Economics 2019-21

Certificate - III

This is to certify that the master thesis entitled "Commodity Price Volatility and Stock Market Returns in India: A Comparative Analysis before and during the COVID-19 Pandemic" submitted to the Department of Economics, Birla School of Social Science and Humanities, Birla Global University in partial fulfillment for the award of the degree of Master in Economics is a record of bona fide work carried out by Mr. Akash Thangaraj, Roll No. 041901006 under my supervision and guidance.

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Assistant Professor

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List of Abbreviations

Abbreviation	Explanation
VAR	Vector Auto Regression
GARCH	Generalized Auto Regressive Heteroskedasticity
IRF	Impulse Response Function
WHO	World Health Organization
WB	World Bank
MOSPI	Ministry of Statistics and Programme Implementation
UNESCWA	United Nations Economic and Social Commission for Western Asia
ADF	Augmented Dickey-Fuller Test
GDP	Gross Domestic Product
CPI	Consumer Price Index
PMI	Purchasing Managers' Index
FII	Foreign Investment Inflows
CFD	Contract for Difference
RBI	Reserve Bank of India
GVA	Gross Value Added
IMF	International Monetary Fund
CII	Confederation of Indian Industry
OECD	Organization for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
AR	Auto Regressive

Variables in the Study	Explanation
LRSENSEX	Returns of SENSEX
LCPSENSEX	Log of Closing price of SENSEX
LSPCOPPER	Log of Spot Price of Copper
LSPCOTTON	Log of Spot Price of Cotton
LSPCRUDE	Log of Spot Price of Crude Oil
LSPGOLD	Log of Spot price of Gold
VOLCOPPER	Volatility of Copper
VOLCOTTON	Volatility of Cotton
VOLCRUDE	Volatility of Crude Oil
VOLGOLD	Volatility of Gold

CHAPTER-1

Introduction and Background of the study

CHAPTER – 1

1.1 Introduction and Background of the study:

In this time of economic uncertainty and hardship, it is of utmost importance to achieve some measure of stability and predictability. It would be an understatement to say that the Covid-19 pandemic has been anything short of devastating for the public health and economy of India. Especially, given the recent horrendous impact of the "Second-Wave" of the Covid-19 pandemic in India on the lives and livelihoods of Lakhs of Indians, it is important to take stock of our position in the fight against the pandemic and its devastating aftermath.

One such horrific effect of the pandemic is its impact on the Indian economy. It has led to record unemployment, a rare recession, destruction of supply chains, and the almost complete wiping out of some sectors of the economy.

The earliest Macro-indicators of such an impact were seen back in March 2020, when the first lockdown was announced. One of them was the Stock Market Return Indices. In many ways the returns indices of the stock markets represent our financial stability and global competitiveness, and hence, is an important indicator of study with regards to our recovery from the pandemic.

In this study, we will be Analysing the relationships between the Stock Market Returns and the prices of Commodities on the Commodity market. It is already well known, courtesy of several prior studies on the subject that high trade volume commodities such as Gold and Crude Oil are traditional determinants of Stock Prices in India. This study aims to build on prior knowledge on the subject and explore some previously unexplored commodity-stock market relationships and try to observe and interpret their interactions within the context of the Covid-19 pandemic and the eventual economic recovery.

Before delving into the study, some context about the Indian Economy before and after the impact of the Covid-19 pandemic is elucidated here, as well as policy responses and their consequences that have occurred during the period of the study i.e., 2nd May 2016 to 30th April 2021.

1.2 State of the Indian Economy Pre-Covid:

Before the outbreak of the pandemic, the Indian economy wasn't without its fair share of problems. Inflation had reached substantially high levels with the Consumer Price Index of December 2019, growing to a staggering 150.4 points. There were suspicions of India entering a period of stagflation. Certain sectors such as the Automobiles sector were facing record losses for prolonged periods and were observing an increasing drop in demand. It was fair to say that the Indian economy was in a period of economic slowdown.

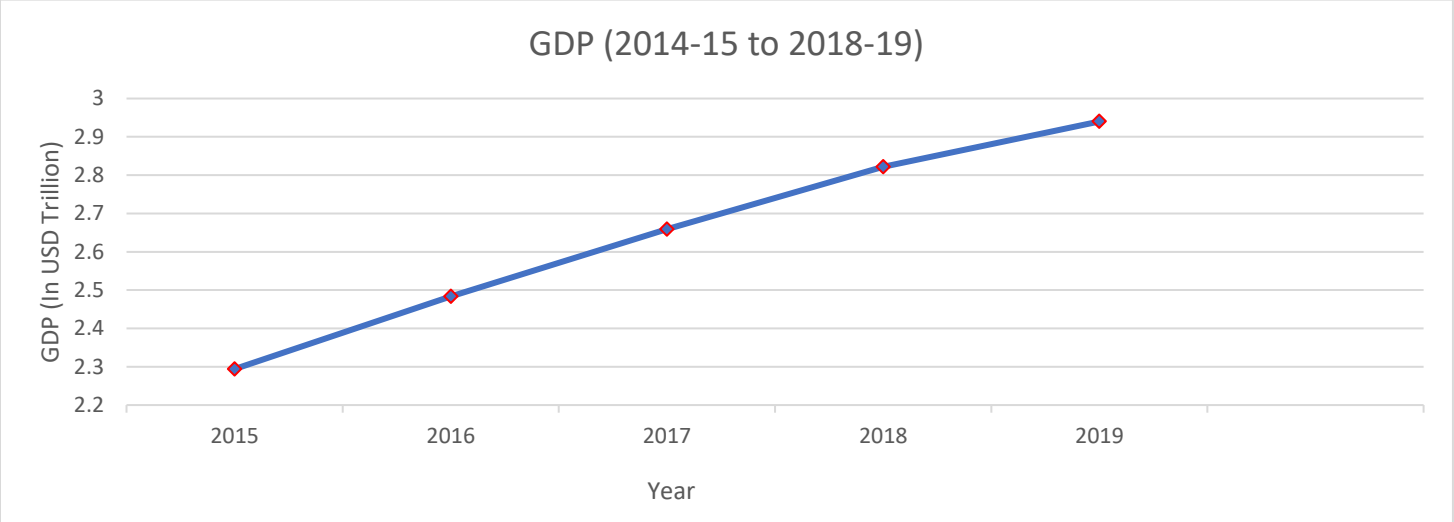
The Gross Domestic Product (GDP) growth of the country was at a five-year low point (Refer Table: 1.1 and Figure:1.1) According to data from the ministry of statistics, the GDP figures from the financial year 2014-15 are as follows:

Table 1.1: GDP figures of India

FINANCIAL YEAR	GDP (IN $ TRILLION) (2010 CONSTANT)	GDP GROWTH (IN %)
2014-15	2.294	7.996
2015-16	2.484	8.256
2016-17	2.659	7.043
2017-18	2.822	6.119
2018-19	2.94	4.18

Source: World Bank

Figure 1.1:

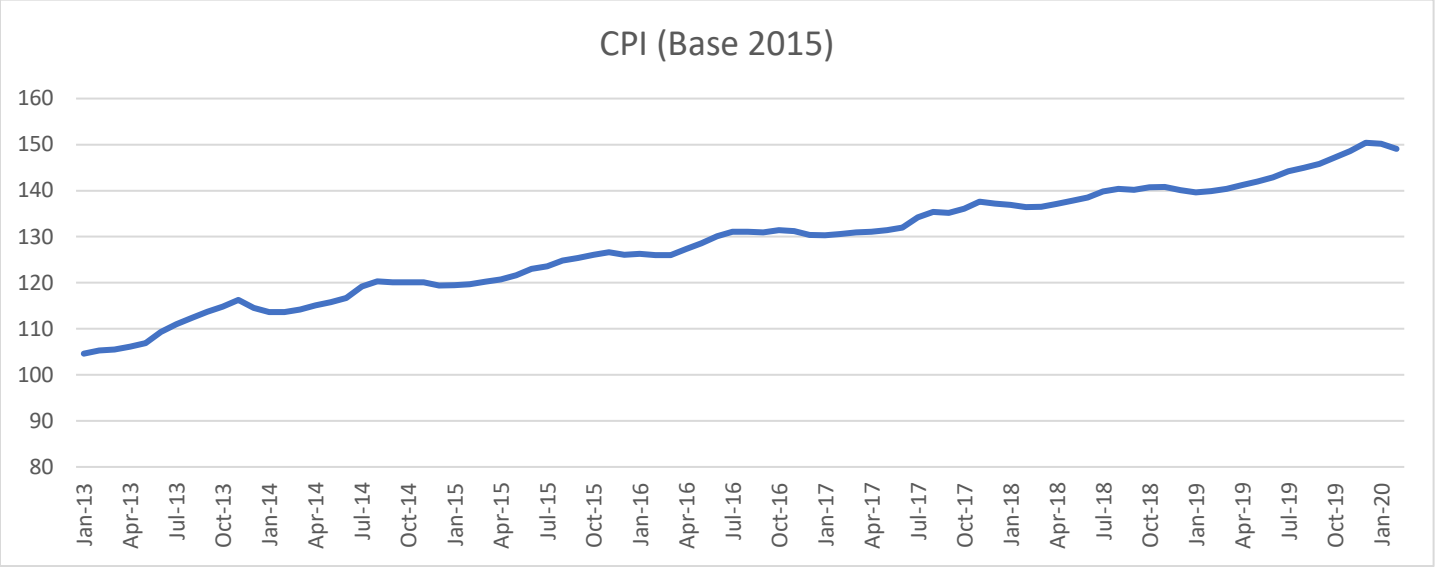


Source: World Bank

Another worrying factor was the ever-creeping inflation (Refer Figure: 1.2) that has been plaguing the economy for the better part of a decade. The CPI print for August came in at 6.7%

(YoY), which means that over the previous nine months (except April) inflation had hovered above the 6% upper band inflation target range of the Reserve Bank of India (RBI).

Figure 1.2:



Source: Ministry of Statistics and Programme Implementation

For almost a year before the COVID-19 Pandemic, India has been seeing a steady but alarming rise in inflation, mainly due to a fall in market demand, so much so that, Dr. Manmohan Singh warned that India may experience a prolonged period of inflation known as Stagflation.

This was first noticed in the form of food inflation, wherein, the prices of many vegetables and food products rose rapidly owing to various factors including floods and unfavourable monsoon, and lack of storage facilities. The commodities most affected by this rise in prices were onions and garlic.

1.3 Covid Outbreak and 1st Lockdown:

The now infamous Covid-19 outbreak first came into public view on December 31st, 2019, in Wuhan, China. It was a mysterious disease that was not paid much attention to at the get-go. It wasn't until much later when the disease had spread to various provinces throughout China, did the respective governments and institutions first take notice. It was declared a Public Health Emergency of International Concern on January 30th, 2020, by the World Health Organization.

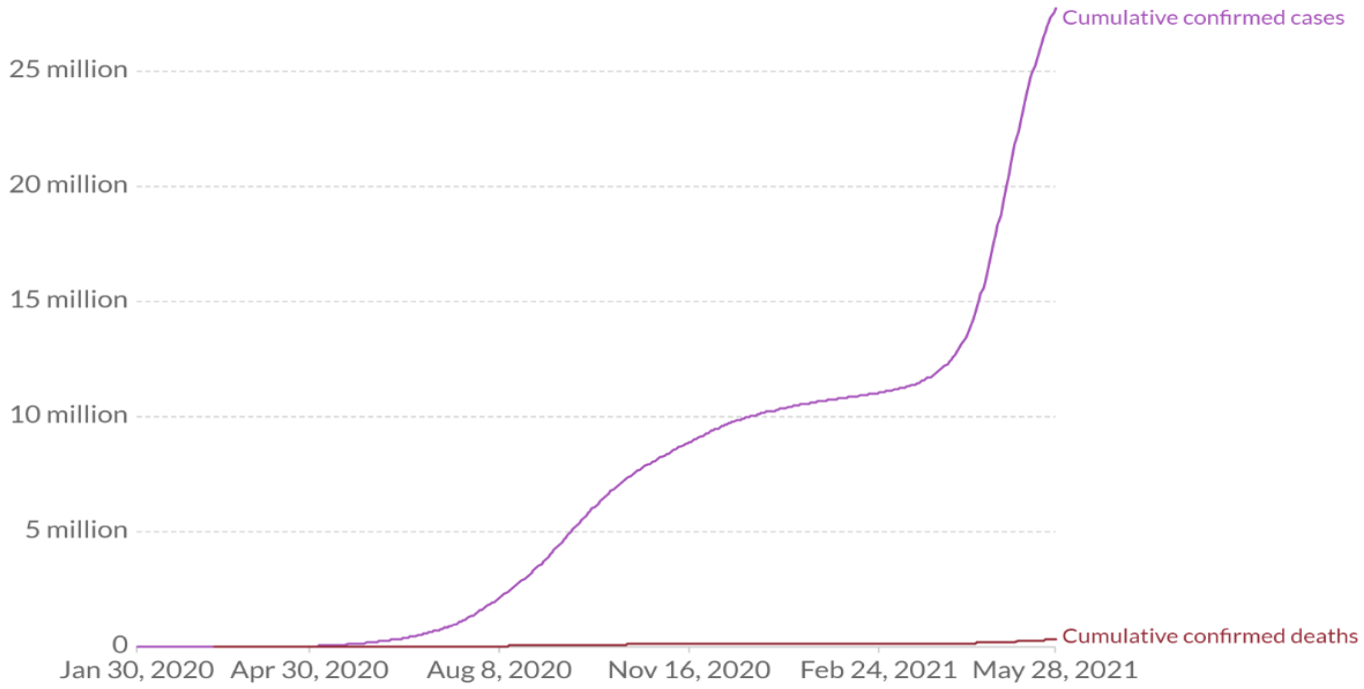
The first case of COVID-19 in India, which originated from China, was reported on 30 January 2020. India currently has the largest number of confirmed cases in Asia. As of 23 May 2021, India has the second-highest number of confirmed cases in the world (after the United States) with 26.7 million reported cases of COVID-19 infection and the third-highest number of COVID-19 deaths (after the United States and Brazil) at 307,231 deaths.

Beginning from the 2nd week of march some states including Odisha and Kerala announced limited lockdowns to curb the spread of Covid-19, albeit unsuccessfully. In mid-March 2020, the first nationwide lockdown was announced by the prime minister of India. The lockdowns imposed were some of the strictest in the history of the country. All "non-essential" institutions, companies, and businesses were shut down. A strict curfew was put in place and large gatherings of any sort were prohibited. Although the initial lockdowns were imposed to curb the spread of Covid-19, the inevitable became obvious and they were then used to buy time to bulk up the health infrastructure to manage the oncoming onslaught of the pandemic.

This sudden, unpredicted, unprecedented and complete halt of economic activities sent the economy of the country spiraling downward. The latent effects of which we are still suffering today. Unemployment hit unprecedented levels, the stock markets were halted, educational institutions were shut down and students and education providers were forced to adapt to the online mode of education, the same happened with incorporation with regards to their employees. The transition from offline to online work and study has been less than smooth. With less than 34.4% of the population having internet access, there has been unequal access to education, work opportunities, and other important services. These inequalities have disproportionately affected the poorer classes of society as well as women.

And then there is the direct health impact, where a total of 3.23L Indians have lost their lives at the time of writing this document (Refer Table: 1.2 & Figure: 1.3). The indirect effects of this will plague us for years to come as the mental health and well-being of the bereaved and even of those who have recovered is probably a pain that in all probability will go unnoticed amid the chaos of the pandemic.

Figure 1.3: Cumulative Covid cases and deaths in India



Source: John's Hopkins University CSSE Covid Data

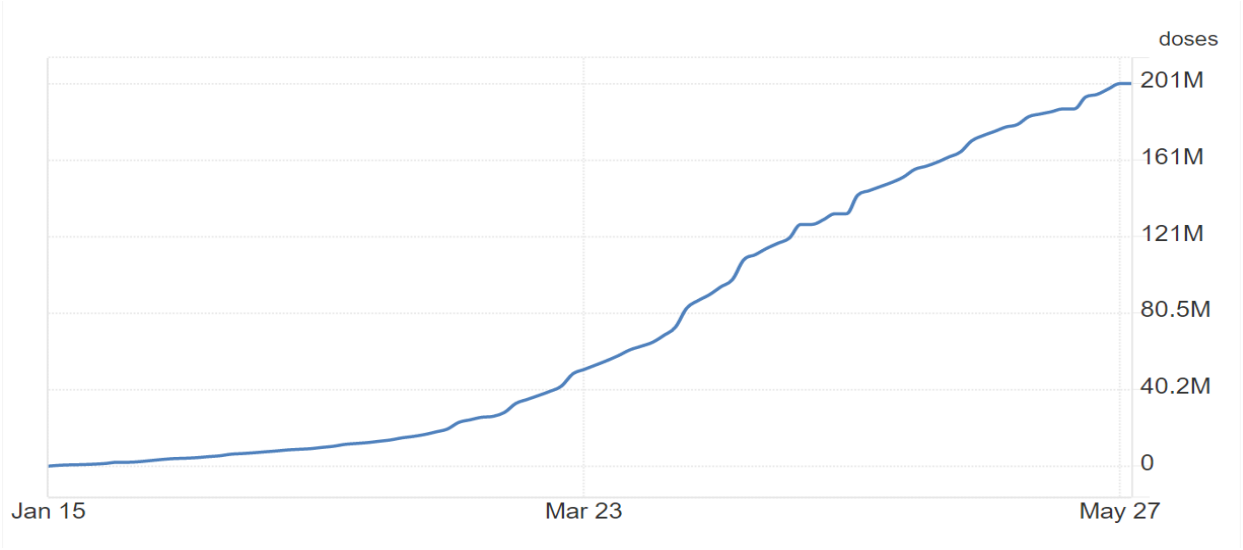
Table 1.2: Comparison of Covid in numbers of the Top 4 worst affected Nations

Country	Total Cumulative Cases	Total Cumulative Deaths
Global	168599045	3507477
U.S. A	32869009	586890
India	27555457	318895
Brazil	16274695	454429
France	5535701	108354

Source: World Health Organization

As of today, India has the second-highest number of reported Covid-19 cases in the world and the third-highest number of reported Covid-19 deaths. This has caused a riptide effect that has torn through the very fabric of Indian society and threatens to not only linger but even worsen over time. The overburdened health system, the slowly recovering economy, and the greatly devastated job market have shown us that the flimsy foundations of our infrastructure have crumbled under the weight of the pandemic.

Figure 1.4: Total Covid-19 Vaccinations Given



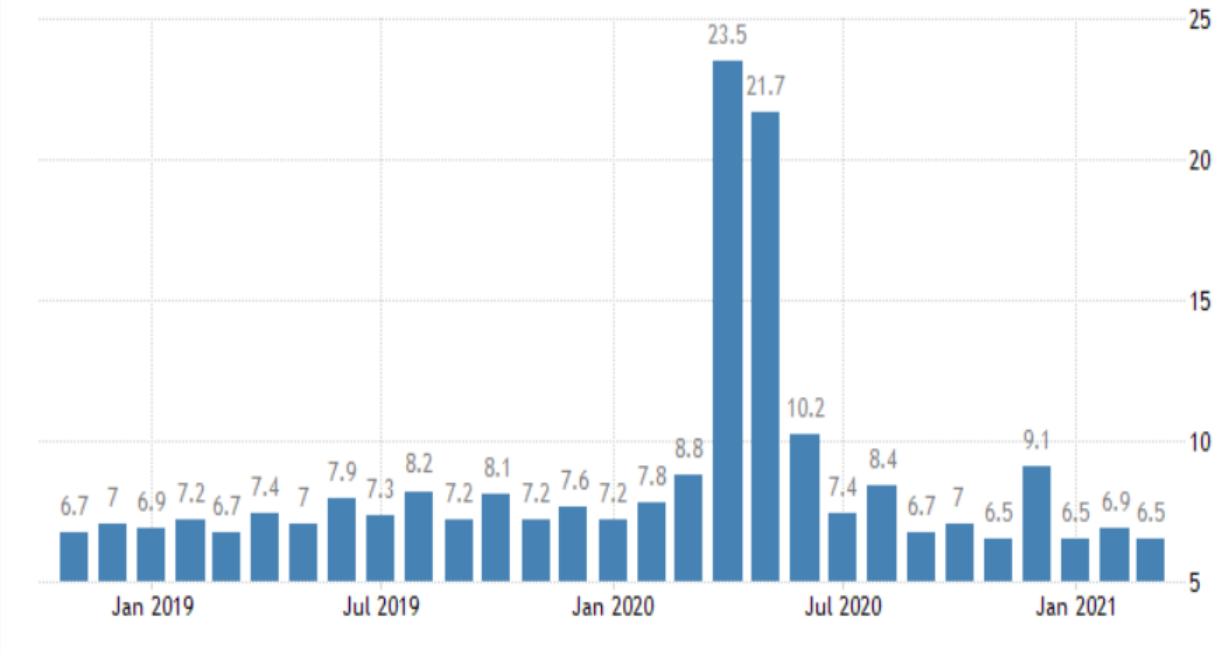
Source: https://ourworldindata.org

But despite all this, there is hope yet as the vaccine promises to be an effective force in fighting the pandemic (Refer Figure: 1.4). That coupled with a rallying stock market and resilient economy remains the only source of hope that there may yet be a way forward.

1.4 Impact of Covid-19 Pandemic on Economy:

According to the Centre for Monitoring Indian Economy, Unemployment had reached 26% across India by the end of April 2020. Around 140,000,000 (14 crores) Indians lost employment during the lockdowns (Refer Figure: 1.5). More than 45% of households across the nation reported an income drop as compared to the previous year. Various businesses such as hotels and airlines cut salaries and laid-off employees. Apart from salaried employees, several young startups were devastated by the negative impacts of the pandemic and the associated lockdowns. With many of those startups still being in the "Growth Stage", the economic halt of the nation left them in a state of limbo and uncertainty. Venture capital investments had fallen by a staggering 50% (Quarter on Quarter) by June 2020, according to a report by KPMG.

Figure 1.5: Unemployment rate of India



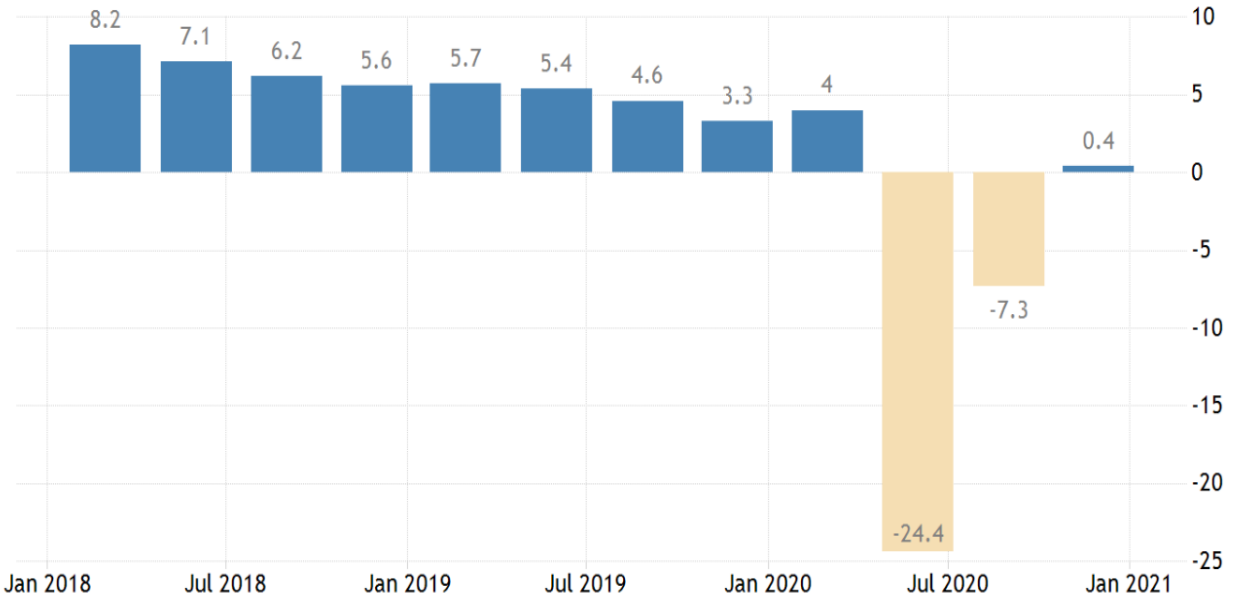
Source: Centre for monitoring Indian Economy

Given the reduced and sometimes halted economic activity during this period, the energy consumption of the nation went far below normal levels, with electricity consumption being reduced to 30%-8% below normal levels between April 2020 and June 2020. By this time the

economic impact had already been estimated to be between $160 billion (5.6 percent of GDP) and $175 billion (6.0 percent of GDP).

Given the plethora of problems in the economy, public revenue fell to all-time low figures for the first quarter of FY 2020-21. It had got to the point where the government was not even able to pay their employees on time. This led to serious downsizing efforts and the educational sectors bore the brunt of these consequences. Be it in the form of lack of funding, cancellation of programs, nonpayment of government staff, or even the cancellation of essential and life-defining examinations.

Figure 1.6: India GDP Growth Rate (Year on Year)



Source: Ministry of Statistics and Programme Implementation

The Indian economy was expected to lose over ₹32,000 crores (US$4.5 billion) every day during the first 21 days of the lockdown, according to Acuité Ratings. World Bank report said that the pandemic has "magnified pre-existing risks to India's economic outlook". In mid-April, the International Monetary Fund projection for India for the FY21 of 1.9% GDP growth was still the highest among G-20 nations. Confederation of Indian Industry (CII) estimated that India's GDP for FY21 will be between 0.9% and 1.5% (Refer Figure: 1.6).

1.5 Impact on exports:

Given that ours was not the only country to shut down in light of the pandemic, other countries also had limited imports during the beginning of the pandemic. Due to the combined effect of the global economic slowdown and the various cross-border restrictions on trade imposed by

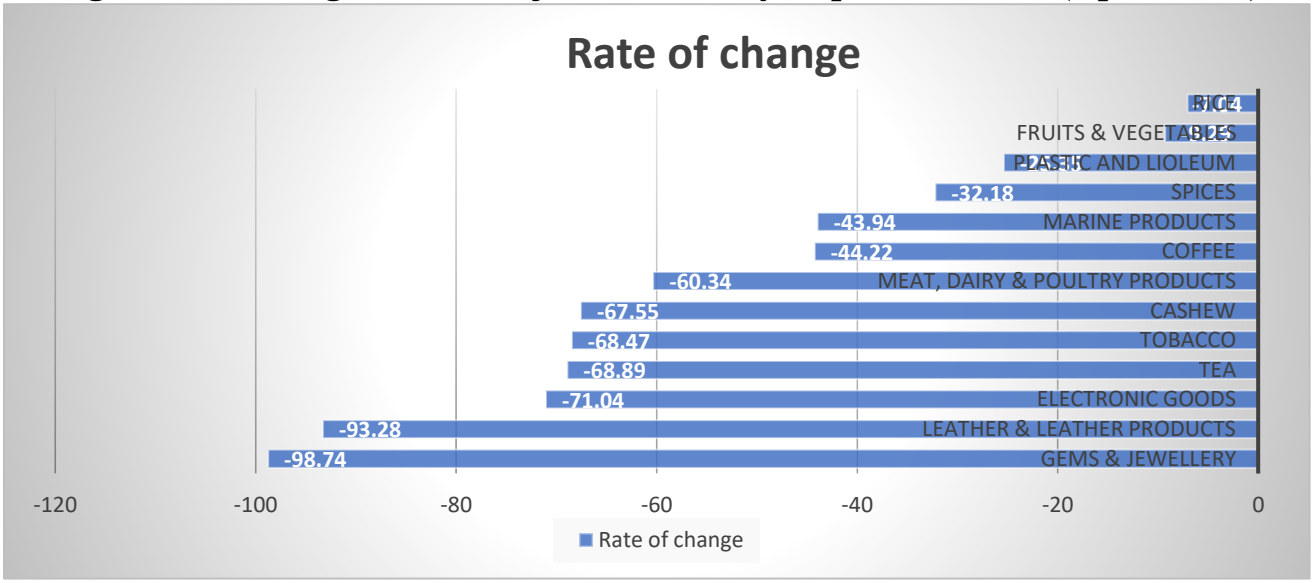
countries around the world, India's exports had invariably fallen (Refer Table: 1.3 and Figure: 1.7). The growth rate for our exports reached a low of 2.4% for the FY 2019-20.

Table 1.3: Growth of services exports by Category (USD $ Million)

Service Type	2016-17	2017-18	2018-19	2019-20
ICT	77044	79840	86344	96110
Travel	23244	28255	28441	29998
Transport	15851	17441	19464	20988
Financial Services	5099	5164	4858	4734
Insurance	2206	2506	2661	2431
Construction	2144	2256	3388	3096
Recreation Services	1392	1618	1853	2207
Transfer of IP	568	732	692	934
Other Services	32964	37346	39112	45716
Total	164197	195089	208000	213191
Growth (Y-on-Y)	6.4	18.8	6.6	2.4

Source: Reserve Bank of India

Figure 1.7: Change rate of major Commodity Exports of India (April, 2020)



Source: Ministry of Commerce and Industry

Although India's exports were disrupted during the onset of the pandemic, they have since stabilized.

1.6 Impact on Agriculture:

The suddenness and the veracity with which the lockdown was imposed at the beginning of the pandemic caused a lot of confusion and uncertainty. This in turn disrupted the supply chain and transport lines of most if not all agricultural products (Refer Table: 1.4). This invariably caused a rise in food prices as well as the rise in prices of other agricultural commodities (Refer Figure: 8 for Food Inflation). The price was further driven up due to the disruption to farm activities and operations. Retail prices of pulses, wheat flour, and milk were 1–5% higher a month post-lockdown, prices of edible oils and staple cereals such as rice and wheat were down by 4-9%, owing to the removal of import restrictions and government interventions like free distribution of food grains. Vegetable prices rose with tomato prices increasing by 77–78% in a week and 114–117% a month post lockdown. Markets saw increased arrivals in May owing to distress sales and market reforms insulated farmers from lower prices. Rural areas saw higher price rises than urban areas. It was reported that around three-fourths of the consumers reported a price rise in food commodities during the lockdown (Cariappa, Acharya, Adhav, Sendhil, and Ramasundaram, 2021)

Figure: 8 – Food Inflation (Index) of India

Source: Ministry of Statistics and Programme Implementation

Looking at the scale of COVID-19 spread and the panic created, food prices were quite resilient (except for vegetables). The resilience of the sector might be partly due to time short-term policy support and have thusly avoided a price spike so far. COVID-19 induced lockdown in India disrupted food markets which forced consumers to alter their consumption patterns. Consumers prioritized what they wanted and what they needed.

Table: 1.4 – Immediate impacts of lockdown

Regions Affected (Segregated by agricultural productivity)	Effects of the Lockdown
Areas of high productivity (E.g., Tamil Nadu, U.P, Punjab, Haryana)	1. Shortage of Labour
	2. Reverse Migration
	3. Fear of infection to continue working outdoors
Areas of Relatively lower productivity (E.g., Odisha, Puducherry, Karnataka)	1. Disruption to Input Supply
	2. Reverse Migration
	3. Fear of Infection to work outdoors

Source: Compilation from survey results (Cariappa et al., 2020a)

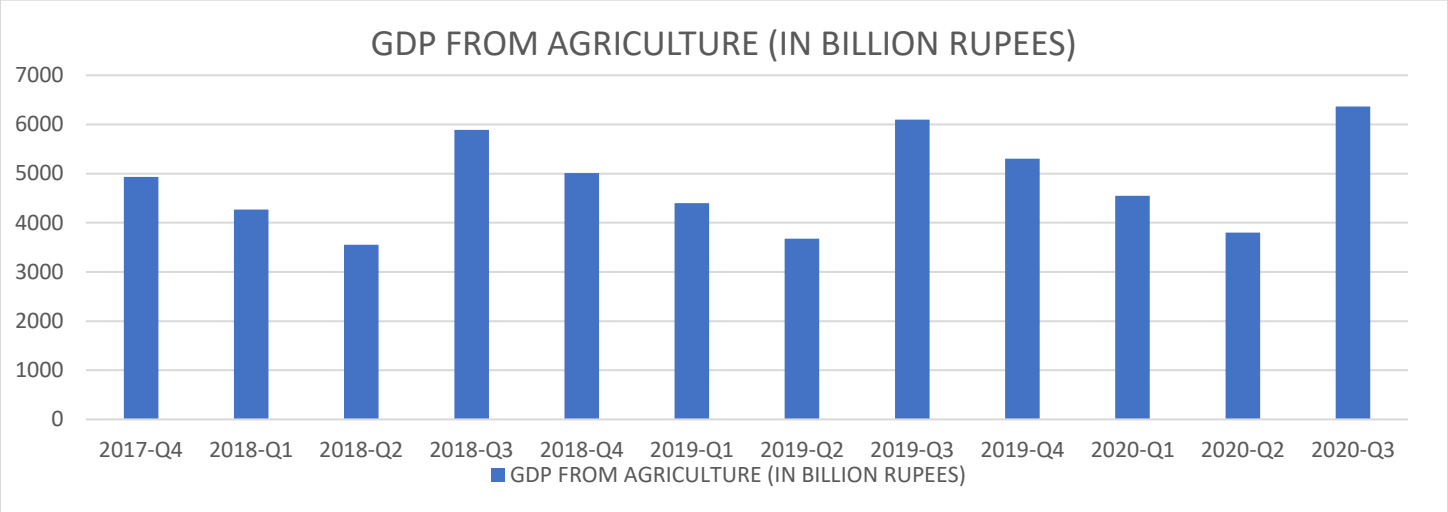
But despite all these setbacks over the first few weeks of the lockdown, the agricultural sector rallied together soon and proved to be quite resilient against the negative economic effects of the pandemic. It has been one of the most consistent performers during this time of stress and uncertainty. Subsequently, with the pandemic being less forgiving with other sectors coupled with strong policy decisions to help agriculture in the short run, there has been significant improvement in the agricultural sector since the lockdowns (Refer Table: 1.5 and Figure: 1.9 for Figures on GDP from Agriculture).

Table: 1.5 – GDP from Agriculture (constant prices) (Base 2011-12)

QUARTER	GDP FROM AGRICULTURE (IN BILLION RUPEES)
2017-Q4	4932.08
2018-Q1	4271.77
2018-Q2	3552.83
2018-Q3	5886.79
2018-Q4	5011.99
2019-Q1	4398.43
2019-Q2	3677.58
2019-Q3	6098.53
2019-Q4	5306.26
2020-Q1	4546.58
2020-Q2	3802.39
2020-Q3	6364.44

Source: Ministry of Statistics and Programme Implementation

Figure: 1.9 – GDP from Agriculture (constant prices) (Base 2011-12)



Source: Ministry of Statistics and Programme Implementation

1.7 Impact of Covid-19 on Manufacturing industry:

Manufacturing in India has come to a near standstill. As the sector with the maximum amount of backward and forward linkages, manufacturing crucially sustains and propels economic recovery. But restrictions on account of the surge in COVID-19 cases have led to a massive deceleration in the manufacturing sector. And the worst is yet to come both in terms of the spread of the coronavirus and the slowdown of manufacturing.

The IHS Markit India Manufacturing PMI was at 55.5 in April 2021, little changed from 55.4 in the previous month, beating the market consensus of 51.6, indicating a solid improvement in the health of the sector. Both new orders and output expanded at the slowest pace in eight months, due to an intensification of the COVID-19 crisis. Growth was attributed to a pick-up in demand and marketing efforts, though hampered by the COVID-19 pandemic. (Refer Table: 1.6 and Figure: 1.11 for Manufacturing Sector PMI).

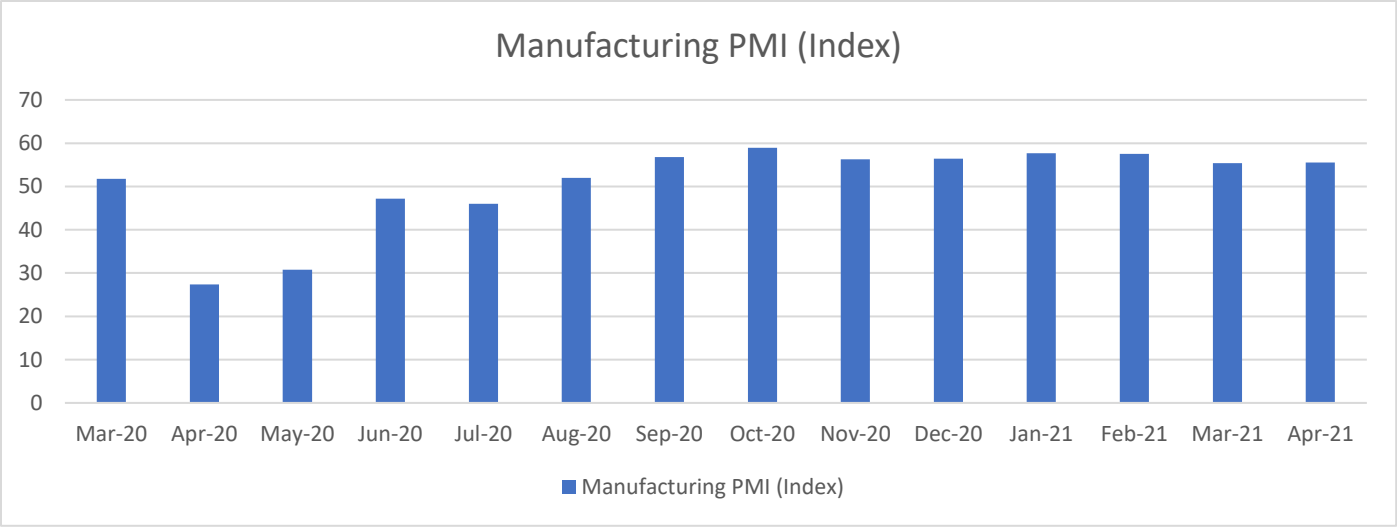
Table: 1.6 – Indian Manufacturing PMI

MONTH	MANUFACTURING PMI (INDEX)
MARCH-20	51.8
APRIL-20	27.4
MAY-20	30.8
JUN-20	47.2
JUL-20	46
AUG-20	52
SEP-20	56.8
OCT-20	58.9

NOV-20	56.3
DEC-20	56.4
JAN-21	57.7
FEB-21	57.5
MAR-21	55.4
APR-21	55.5

Source: IHS Markit

Figure: 1.10 – Indian Manufacturing PMI



Source: IHS Markit

At the same time, new export orders surged to the fastest since last October, and buying levels expanded at one of the sharpest rates seen for nine years. Meanwhile, employment declined for a 13th straight month and the weakest in the current sequence of job shedding. On the price front, the rate of input cost inflation accelerated to the fastest pace since July 2014, while selling prices increased to the highest in seven-and-a-half years. Finally, business sentiment strengthened in April.

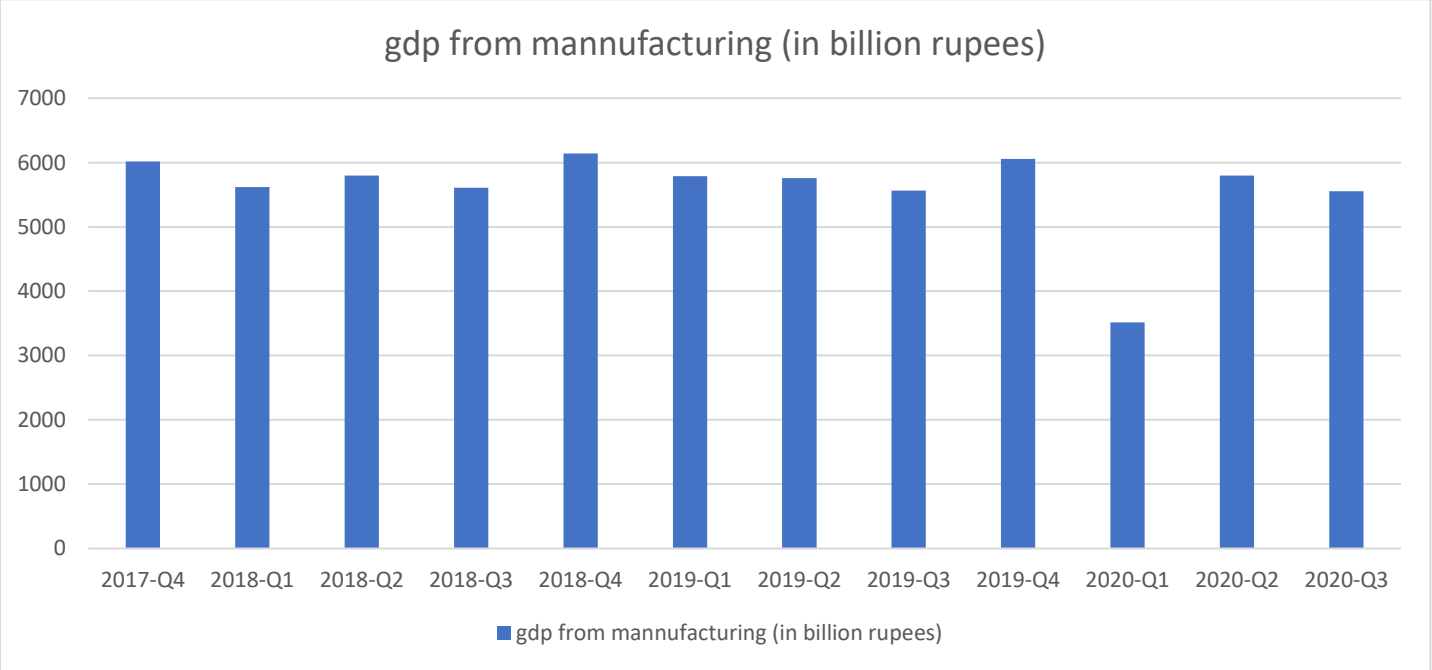
India's GDP for the first quarter (Q1) of 2020-21 contracted by 23.9% and the share of the manufacturing sector in total gross value added (GVA) which was 17.5% in Q1 of 2019-20 shrunk to 13.8% in this quarter. The growth rate in the manufacturing sector has plunged to -39.3% in Q1 of 2020-21. For consecutive eight quarters manufacturing growth rate has declined, indicating a lack of demand and a deeper structural crisis in the sector worsened by the pandemic-induced lockdowns. GDP From Manufacturing in India decreased to 5555.96 INR Billion in the fourth quarter of 2020 from 5796.83 INR Billion in the third quarter of 2020 (Refer Table: 1.7 and Figure: 1.12 for GDP from Manufacturing).

Table: 1.7 – GDP from Indian Manufacturing

QUARTER	GDP FROM MANNUFACTURING (IN BILLION RUPEES)
2017-Q4	6015.37
2018-Q1	5618.75
2018-Q2	5796.49
2018-Q3	5607.19
2018-Q4	6144
2019-Q1	5789.36
2019-Q2	5761.12
2019-Q3	5564.94
2019-Q4	6057.38
2020-Q1	3513.96
2020-Q2	5796.83
2020-Q3	5555.96

Source: Ministry of Statistics and Programme Implementation

Figure: 1.11 – GDP from Indian Manufacturing



Source: Ministry of Statistics and Programme Implementation

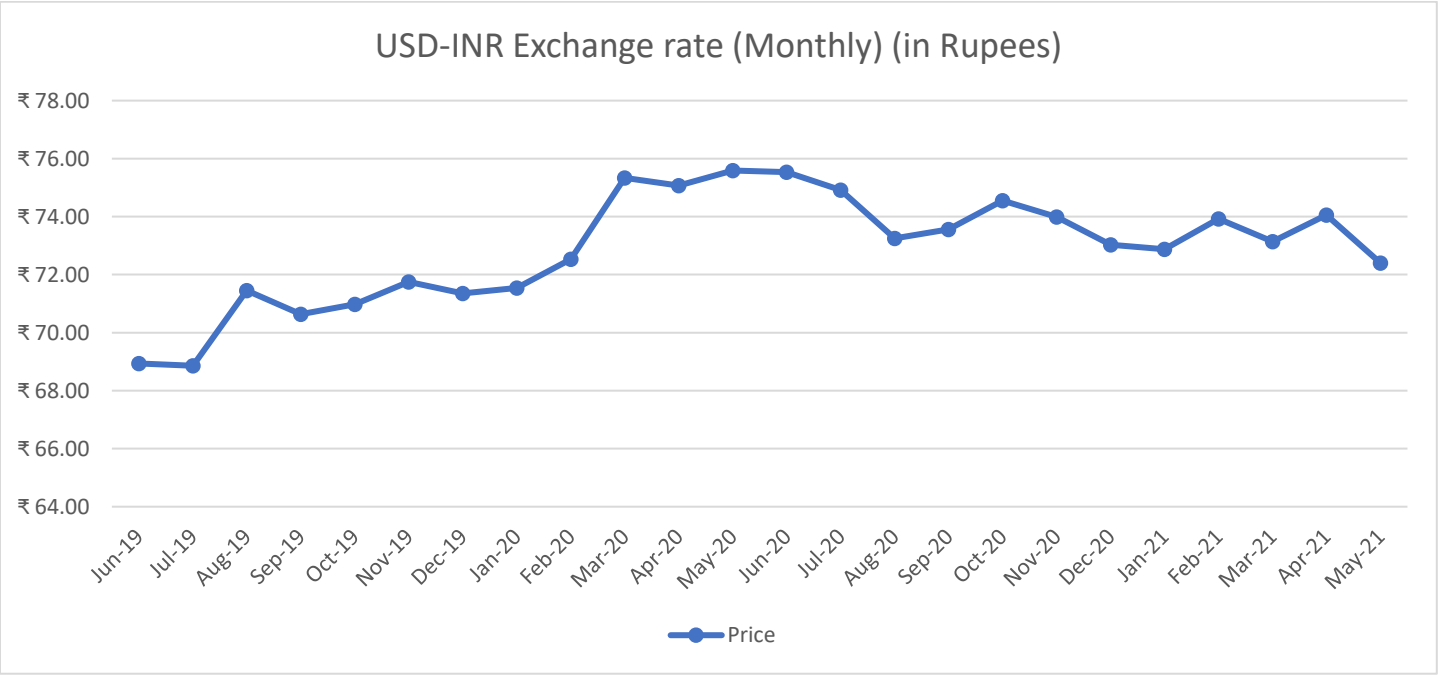
Imports of heavy machinery and equipment on which our manufacturing and other industries are crucially dependent have been going down. The import of these capital goods is important for maintaining a threshold on output expansion, as many sectors that feature in India's major exports are also in India's top imports. But big 'Make in India' projects have simply not taken off.

And the manufacturing crisis has been worsened by COVID-19. Fiscal stimulus from the 'Atmanirbhar Bharat' initiative has not been enough. Almost exclusively supplying to other industries, the MSME (Micro, Small, and Medium Enterprises) sector is labor-intensive and the lifeline of India's manufacturing sector. Production cuts in the manufacturing sector have had a percolating negative impact on the component industries, predominantly suspending operations. As intermittent lockdowns are imposed once again a majority of the manufacturing workers have returned to their hometowns because of uncertainty and a lack of income.

1.8 Impact of Covid Pandemic on Exchange Markets:

The Indian rupee hit 72.6 per USD at the end of May, hovering around its strongest level in two months and heading for a near 2% monthly gain (Refer Figure: 1.13 – For USD-INR Exchange rate). The recent gains have been supported by signs that India's second wave of coronavirus infections is slowing, hopes of a global economic recovery, and broad dollar weakness. Meanwhile, economic data released earlier this month showed India's consumer price inflation rate slowed to a three-month low in April, remaining within the central bank's 2-6 percent target. Elsewhere, the RBI announced on May 5th a series of liquidity measures to help banks support the healthcare infrastructure and small borrowers hit by the COVID crisis.

Figure: 1.12 - USD-INR Exchange rate (Monthly) (in Rupees)

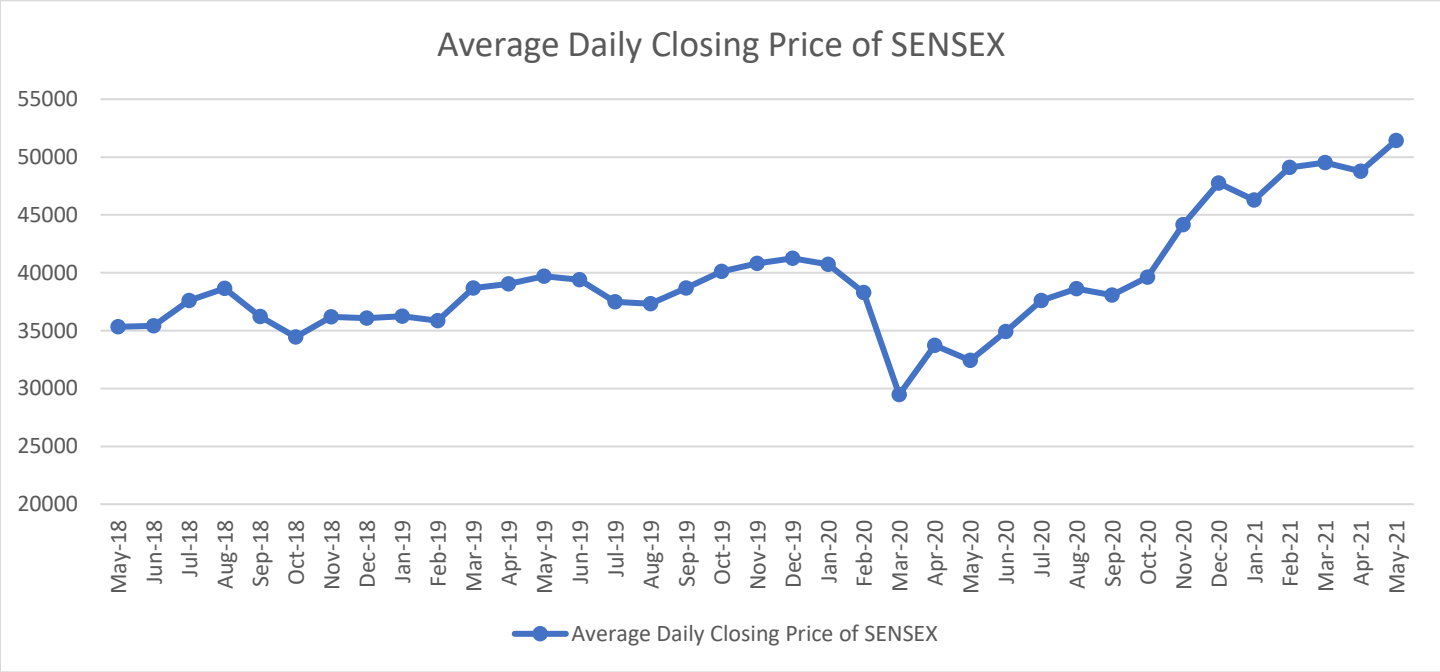


Source: www.bloomberg.com

1.9 Impact of Covid Pandemic on Stock Markets:

On 23 March 2020, stock markets in India post the worst losses in history. SENSEX fell 4000 points (13.15%) and NSE NIFTY fell 1150 points (12.98%). However, on 25 March, one day after a complete 21-day lock-down was announced by the Prime Minister, SENSEX posted its biggest gains in 11 years, adding a value of ₹4.7 lakh crore for investors. On 8 April, following positive indication from Wall Street that the pandemic may have reached its peak in the US, the stock markets in India rose steeply once again. The SENSEX increased 3672 points or 7.69% since the beginning of 2021, according to trading on a contract for difference (CFD) that tracks this benchmark index from India (Refer Figure: 1.14 for the Monthly Sensex Closing Price).

Figure: 1.13 – SENSEX Monthly Closing Price (in Rupees)



Source: Bombay Stock Exchange

Observing the Bombay Stock Exchange there is a drop in the SENSEX Index by around 22% in March 2020. This can be tracked down to a single day i.e., the 23rd of March, 2020. On this day the BSE experienced the highest single-day fall in the SENSEX in almost two decades (Mandal, 2020). A similar occurrence can also be observed in that of the NIFTY Index around the same time. This was the result of the sudden, unanticipated, and unplanned lockdown. The immediate effects of which were immediately observable in the stock market returns and the long-term effects such as the shutting down of several businesses, disruption of supply chains, and the fall in consumer demand can still be observed today.

This response from the stock market is understandable because, as we know, if there is one thing investors hate it is uncertainty. And the pandemic and its associated controlling measures did bring just that at the beginning.

Since then, however, the stock markets have rallied and seem to have recovered and are displaying an upward trend seemingly picking up where they left off before the pandemic. This again can be explained by the uncertainty factor, as there is now a fairly planned and predictable system of measures in place for controlling the pandemic and at least from the perspective of investors, this provides them some assurance of certainty.

We can however observe an exponential rise in the SENSEX index from the point of the unlock. This exponential rise has been a topic of debate, as the stock market recovery was several times faster and smoother than the recovery of the country's GDP. This sudden exponential rise can be chalked down to the pent-up demand of investors and the rise in exports.

1.10 Impact of 2008 Global Financial Crisis on Indian Stock Market:

At the onset of the new year in 2008, the world was hit by what is now referred to as the "2008 Global Financial Crisis". This crisis was triggered by the crash of the real estate markets of the U.S.A. The financial crisis hit India shortly after. The first effects of the crisis in India were felt in the stock markets. The total Foreign Investment Inflows received by India during 2017 which amount to around $17.7 million turned into a liability in the form of disinvestment the following year.

This sudden and unanticipated withdrawal of the FII's led to a snowball effect wherein, the capital inflows were the next to slow down owing to the uncertainty. The crisis was then reflected in the Foreign Exchange Market, where the value of the Rupee went into a free fall. Given the falling price of the rupee and the crashing stock market, the RBI engaged in damage control by selling Foreign Exchange Reserves. All this led to a "credit crunch", wherein domestic banks responded by hiking up the interest rates. This, in turn, led to a fall in imports and exports (Mathew J, 2009).

The unprecedented event sent our financial system spiraling downwards. The suddenness of the impacts of external forces on the financial markets can again be chalked up to uncertainty.

The situation of the financial markets during the Global Financial Crisis is somewhat analogous to the current situation vis-à-vis the covid pandemic. The highly volatile responses of the stock market to uncertainty can be devastating as the country not only faces the consequences of the immediate crashes but also would suffer long-term consequences of the same.

CHAPTER – 2

Literature Review

CHAPTER-2

Literature Review

2.1 Introduction:

As shown in previous chapters it is undeniable that the Covid-19 pandemic has caused devastation and disruption in the economy and has destabilized our trading markets. With the purpose of this study being centered around the impact of price volatility of commodity markets on the returns of the stock markets, before and after the onset of the pandemic. To this effect a vast amount of existing literature on the subject matter has been reviewed and their findings have been taken into consideration in the development of this study.

In the literature review we will go through the various research done around the areas included but not limited to the volatilities of commodity markets, their effects on the stock market, stock market returns in times of economic stress, the economic impacts and challenges of the covid pandemic, the impact of metals, crude oil and gold in the context of stock markets, etc.

2.2 Important Studies reviewed and considered based on the criteria of the present study:

Thoss & Agnese (2012) performed a study on gold and bitcoin, in order to gage their interdependence and significance as an alternative investment during times of financial turbulence such as the Covid pandemic. They have used an impulse-response function and variance decomposition analysis approach to this issue. They had found that there was an increasing degree of interdependence between gold and bitcoin after the onset of the covid pandemic and that bitcoin served as a viable alternative investment option for investors during this time.

Liu, Wang & Lee (2020) performed a time varying analysis study to determine the effect of the covid pandemic on crude oil and stock markets in the U.S.A. In order to employ a time varying approach, they used a time-varying parameter vector autoregression (TVP-VAR). Their results indicated a negative relationship between crude oil and stock returns and that the pandemic exerted a significantly positive force on crude oil and stock returns.

Zevallos & del Carpio (2015) did a study to explore the impact of metal returns on mining stock returns and stock market volatility in the Peruvian stock market. They used univariate GARCH models to model individual volatilities, and the Exponentially Weighted Moving Average (EWMA) method and multivariate GARCH models with time-varying correlations to model co-

movements in returns. They found that there exist important correlations between metal returns and mining stock returns.

Joëts, Mignon & Razafindrabe (2015) did a study to analyze the impact of macroeconomic uncertainty on commodity markets. They used a structural threshold VAR (TVAR) model to assess whether the effect of macroeconomic uncertainty on commodity price returns depends on the degree of uncertainty. They found that the safe-haven role of precious metals to hold true but, agricultural and industrial markets were highly sensitive to the variability and the level of macroeconomic uncertainty.

Kang, Ratti & Yoon (2014) performed a study to examine the impact of structural oil price shocks on the covariance of U.S. stock market return and stock market volatility. They recovered the conditional volatility using Stochastic Volatility Models and recovered implied volatility from the option prices. They found that positive shocks to aggregate demand and to oil-market specific demand are associated with negative effects on the covariance of return and volatility and that supply disruptions of crude oil are associated with positive effects on the covariance of return and volatility.

Aloui, Jammazi & Imen (2008) performed a study to analyse the volatility spill overs between crude oil market and stock market. The used a multivariate GARCH model for the purpose of this study. They found that price volatility of crude oil has a negative impact on stock market behaviour.

Vu, Thanh (2019) performed a study to investigate the relationship between crude oil indices and stock markets in Southeast Asia. They used E-GARCH and jump-GARCH models to establish the linkage of oil markets in Southeast Asia. They found that while price volatility of crude oil had a positive effect on stock returns, the increase in price uncertainty of crude oil had negative impacts on the stock market. They also found that negative shocks have greater affect on the volatility of stock returns when compared to positive shocks.

Contuk, Burucu & Güngör (2013) performed a study to analyse the volatility of gold prices using MGARCH model. They found that gold and stock exchange are affected by their own volatility as well as each other's volatility.

Mishra, Das & Mishra (2010) performed a study to analyse the causal relationship between price volatility of gold and stock market returns in India. They used Granger Causality test and Vector Error Correction model to analyse the feedback causality between the variables. They found that gold prices granger-causes stock returns and vice versa.

Bora & Basistha (2020) performed a study analyzing the impact of the Covid pandemic on the volatility of stock prices in India using GARCH model. They found that stock market returns were higher before the covid pandemic.

Joseph, M (2009) performed a study to analyse the impact of the 2008 Global Financial Crisis on the Indian stock markets.

Rahmanto, Riga & Indriana (2016) performed a study to analyze the effects of price volatility of crude oil on the Indonesian stock market. They used linear as well as asymmetrical regression models in their study. They found that the price volatility of crude oil had a positive effect across all sectors.

Ahmed, Syed, Kamal, López-García, Ramos-Requena & Gupta (2021) performed a study to analyse the impact of the covid pandemic on Indian stock markets and Indian commodity markets during the various phases of lockdown. The also made a comparative analysis of price of commodities between the first and second waves. They used the multivariate GMM model for this study. They found that the covid pandemic had a negative impact on the oil prices as well as the stock market returns and a positive effect on gold prices. From their findings they could infer that there was significant spillover of the effects of Covid-19 pandemic into the stock markets and commodity markets of India.

Veeramani & Anam (2021) performed a study to examine the impact of the pandemic on aggregate, sectoral and mode-wise services exports from India. They found that India's export of services was severely affected by the pandemic.

Varshney, Roy & Meenakshi (2020) performed a study to assess the impact of the covid pandemic and its associated lockdowns on agricultural markets. They found that while all agricultural prices spiked initially, most of those spikes subsided by April. From this they inferred the relative resilience of the agricultural industry.

Cariappa, Acharya, Adhav, Sendhil & Ramasundaram (2021) performed a study to assess the impacts of the pandemic and the lockdowns on the agricultural industry. They also go on to explore the reason for the resilience of the agricultural sector during the pandemic.

Alam, Alam & Chavali (2020) performed a study to investigate the impact of the pandemic on the stock market in India. They use the Market Model Event study methodology. They found that the market response to the Average Abnormal Returns were largely positive during the subsequent lockdowns as investors could predict the lockdowns and its effects. During the pre-pandemic period however, the market response to AAR was found to be negative as investors were in a state of panic and could not predict what was going on.

Meher, Hawaldar, Mohapatra & Sarea (2020) performed a study to assess the impact of the covid pandemic on the price volatility of crude oil. While calculating the average leverage effect, they found that there is presence of leverage effect of COVID-19 on the price volatility of crude oil.

CHAPTER – 3

Objectives, Data collection, Research Methodology, Analysis & Results

CHAPTER – 3

Objectives, Data collection, Research Methodology, Analysis & Results

3.1Objectives of the Study:

3.1.1 Introduction:

Given the economic devastation brought on by the pandemic, it is of utmost importance that all our efforts are put into achieving economic recovery. Also given that we are dealing with forces outside our sphere of control we must be able to understand these forces and formulate appropriate reactions to mitigate their adverse effects.

From the above discussion, we have seen that the sudden impacts of such external crises are often caused by hasty decision-making owing to uncertainty. These sudden impacts are usually followed by periods of prolonged economic sluggishness and unbalanced decision-making owing to the stakeholders still getting to grips with the situation and trying to understand the new environment.

3.1.2 Aim of the Study:

- To observe the effects of price volatility of commodity markets on the stock returns.
- To map out the impulse responses of the price volatility of commodities on stock returns.
- To compare the behavioural changes of the above interactions before and after the onset of the Covid pandemic.
- To provide a measure of certainty with regards to the causative factors and resulting consequences of stock return impulses.

3.2 Data Collection:

In order to investigate the effects that commodity prices have on stock market, in the context of India and comparing the results to see if there is any change observed before and after the onset of the pandemic, we take into consideration the relevant daily data of stock market price and commodity prices.

For stock market data, we have taken the primary benchmark stock index of the country i.e., SENSEX. This is mainly because SENSEX accounts for more than 50% of total turnover in stock trade in the entire country (Ghosh and Kanjilal, 2016). The SENSEX is comprised of 30 of the largest and most actively-traded stocks on the BSE, providing a gauge of India's economy, the SENSEX is also the oldest stock index in India, for these reasons analysts and investors use it to observe the cycles of the country's economy and the development and decline of particular industries. Since September 2003, the Sensex has been calculated based on a free-float capitalization method, which provides a weighting for the effect of a company on the index. This is a variation of the market cap method, but instead of using a company's outstanding shares, it uses its float, which is the number of shares that are readily available for trading. The daily closing price of the S&P BSE SENSEX is taken and transformed into logarithmic form. The logarithmic prices are then differenced with their lagged value in order to generate the stock return of SENSEX, the stock returns shall from here on in be denoted as LRSENSEX. The formula for the generation of the return series is as follows:

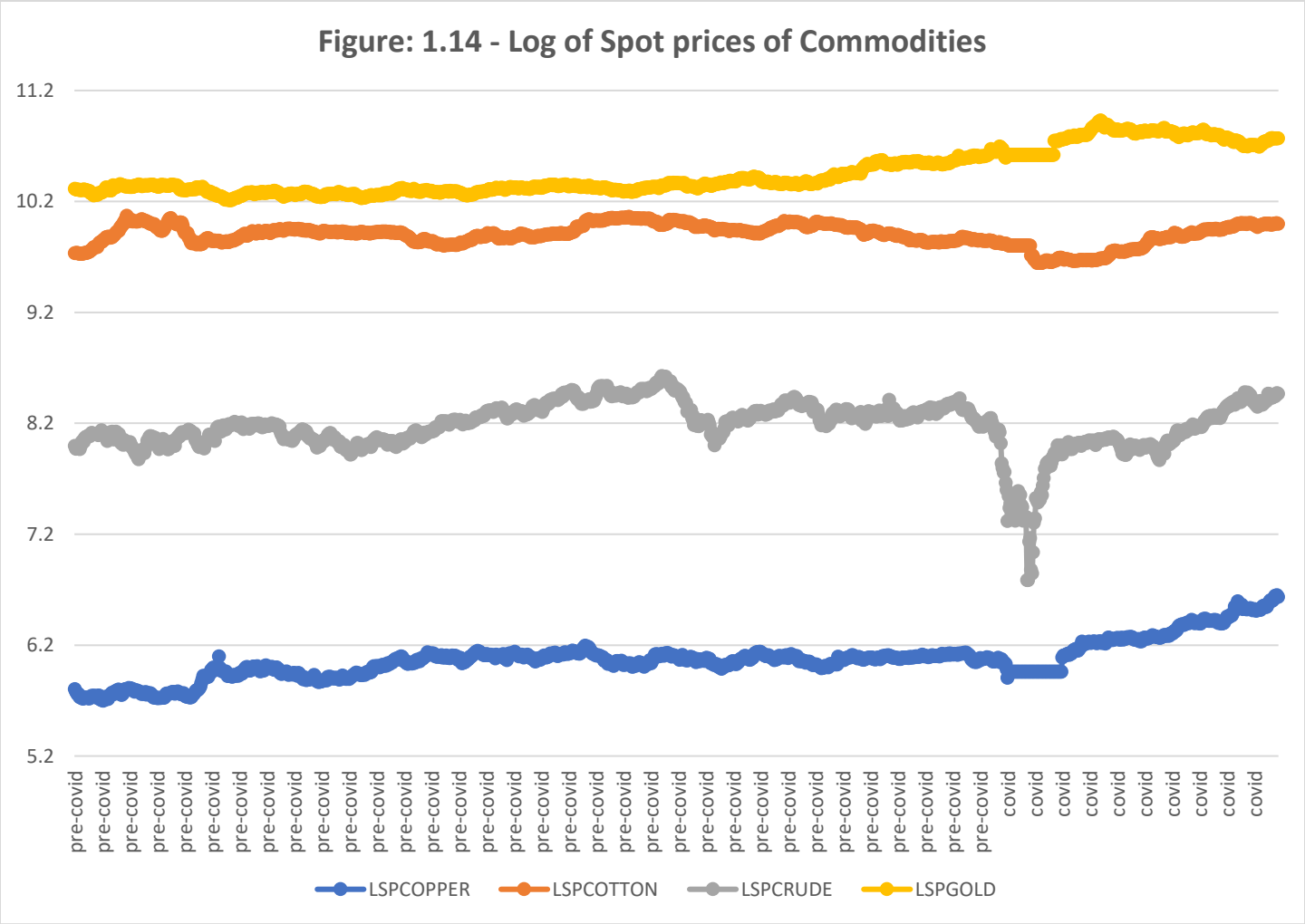
$$LRSENSEX = Log(Daily\ closing\ price)_t - Log(Daily\ closing\ price)_{t-1}$$

Where, t = Time period

For Commodity prices, the daily spot prices of copper, crude oil, gold and cotton have been taken. The above four commodities have been chosen on the basis of them being one of the highest in their respective categories in terms of trade volume. The daily spot prices taken is the average of the spot prices of both the sessions for each commodity. For copper, the price is measured per 1Kg, the price of gold is measured per 10 Grams, the price of cotton is measured per bale and the same for crude oil is measured per Barrel. The spot prices taken are then transformed into their logarithmic form, which will be denoted from now as LSPCOPPER, LSPCOTTON, LSPCRUDE and LSPGOLD for each of copper, cotton, crude oil and gold respectively. These log spot prices are then used to generate their respective volatility series through volatility modelling using GARCH process. The process of generating the volatility series will be elucidated later on in the study. The generated volatility of the spot prices of the commodities will from now be denoted as VOLCOPPER, VOLCOTTON, VOLCRUDE, VOLGOLD for each of copper, cotton, crude oil and gold respectively.

The data collected is for the time period between 3rd May, 2016 and 30th April 2021. As we would like to compare our results in order to investigate any changes in behaviour of the variables before and during the Covid pandemic, the data is separated into two parts. The first part would span from 3rd May 2016 until 28th February 2020, and would represent the data before the Covid

pandemic. The second part would span from 1st March 2020 till 30th April 2021, and this section of the data would represent the time period during the covid pandemic.

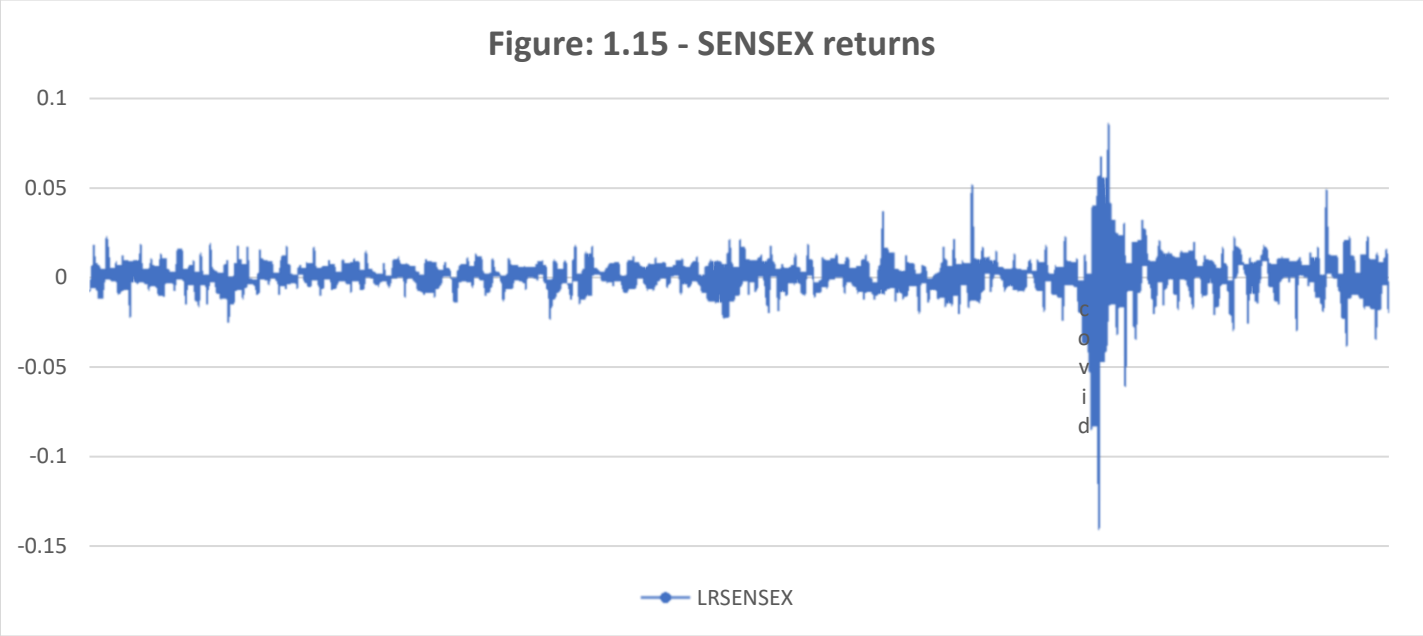


Source: MCX

An initial graphical analysis of the log of daily spot prices of the four chosen commodities (copper, cotton, crude oil and gold) shows the overall trend of their spot prices over the years. During the pre-covid period while cotton and gold have remained fairly constant and stable through the years, given that the consumption of cotton is heavily domestic, this is not surprising. Gold on the other hand is a commodity that is traditionally considered stable and is commonly referred to as a "safe haven" good by investors. Whereas copper and crude oil have been relatively volatile and display an overall upward trend in their spot prices. Given that the consumption of cotton is heavily domestic, this is not surprising as India is heavily dependent on imports of crude oil to meet its requirements and hence, the price of which is largely at the mercy of the global market prices, the case of copper is a peculiar one as prior to 2016, India was a major exporter of refined copper, but that has changed recently and since 2017, India is now a net importer of copper, hence the volatility.

The analysis of the spot prices since the onset of the covid pandemic shows heavy price fluctuations among all the commodities. The prices of copper, crude oil and cotton plummeted

almost immediately. This is understandable given the sudden halt in economic activity impacting the possibilities of imports and export as well as negatively affecting demand. Although, the price of crude oil plummeted drastically, this could be explained by net exporters of oil experiencing an unprecedented double blow; a global economic contraction driven by the COVID-19 pandemic and an oil market collapse (OECD, "The impact of Coronavirus (COVID-19) and the global oil price shock on the fiscal position of oil-exporting developing countries", 2020). After the fall in prices of the above three mentioned commodities, there has been a quick recovery. Post the recovery the prices seem to still be climbing at an accelerated pace, this is due to global supply chains being affected, reduced productivity in the respective industries and investors acting on pent up demand. Coming to the case of gold, the covid pandemic had a reverse affect on the price of gold. Post-March,2020 the price of gold increased and has kept increasing at a steady pace. This is expected as the uncertainty and panic of the pandemic caused many investors to pull their investments out of "more volatile" investments and invest in the "safe haven" that is gold.



Source: Bombay Stock Exchange

The pre-covid returns of the SENSEX display moderate volatility and show fairly consistent return from May-05-2016 till Feb-28-2020, save for a few solitary spikes that subside immediately after. This story however changes immediately after the onset of the pandemic and the associated lockdowns. The period between the 1st lockdown and the 1st unlock is characterised by high volatility in stock returns, this is typical of periods of panic and uncertainty. However, the market returns do not seem to have stabilized to pre-covid levels even till today. This can be attributed to a combination of a number of factors such as the similarly unstable state of the global markets, the persistent nationwide restrictions and also the healthcare crisis following the second wave of the covid pandemic.

3.3 Research Methodology:

First the appropriate statistical outputs such as descriptive statistics and correlation tables will be estimated and will be analysed from a comparative stand point between the two time periods being considered in the study. Then the variables under consideration will be subjected to the Augmented Dickey-Fuller (ADF) Test and the results will let us know about the stationarity of the variables. The ADF test is based on the estimate of the following regression (With variable specific lags added to it):

$$\Delta Y_t = \alpha + \beta_1 Y_{t-1} + \sum_{i=1}^{s} \gamma_i Y_{t-i} + \pi\tau + \epsilon_t$$

Given that the purpose of the study is to investigate and explore the effects of the price volatility of commodities on the stock returns, we first had to extract the volatility of the spot prices of the commodities. In order to perform the volatility modelling of the spot prices, we have decided to use traditional GARCH volatility modelling methods. The volatility of the commodity prices will be modelled for the respective prices for both pre-covid and covid periods. The aim of volatility modelling is for us to capture the spontaneous fluctuations in the spot prices and map the reactions of the stock market returns to impulses of the former. Post volatility modelling, the so obtained volatilities of the spot prices of the commodities during both periods will be represented graphically and will be analysed and interpreted. The general form of the volatility modelling equation is given below:

$$h_t = \alpha + \beta_i \sum_{i=1}^{p} h_{t-i} + \gamma_j \sum_{i=1}^{q} u_{t-j}^2$$

The model is then constructed using an unrestricted Vector Auto Regressive (VAR) model for both pre covid and covid periods separately. The estimated output is then individually and comparatively analysed. The VAR model is also tested for stability. Finally, the model is used to map out the impulse responses of the stock market returns to the volatility of the commodity prices. The graphical representations of these impulse responses are then interpreted as the main objective of the study.

3.4 Analysis:

3.4.1 Descriptive Statistics:

Pre-covid period:

Table: 2a – Descriptive statistics of pre-covid period variables

D. Statistics	Pre-Covid				
	LRSENSEX	**VOLCOPPER**	**VOLCOTTON**	**VOLCRUDE**	**VOLGOLD**
Mean	0.000450	0.000160	0.000040	0.000420	0.000039
Median	0.000608	0.000147	0.000032	0.000366	0.000034
Maximum	0.051859	0.001118	0.000316	0.001507	0.000181
Minimum	-0.037122	0.000072	0.000013	0.000193	0.000013
Std. Dev.	0.007795	0.000103	0.000034	0.000199	0.000017
Skewness	0.1401	5.3344	3.5881	1.8775	3.4253
Kurtosis	6.1983	39.1437	19.9401	7.7060	20.1745
Jarque-Bera	403*	55506*	13228*	1417*	13362*
Observations	938	938	938	938	938

Source: Author's Calculation

The above table shows the descriptive statistics of the pre-covid variables. The standard deviation shows us that the LRSENSEX deviates a fair bit from its mean, whereas the rest of the variables have a relatively very small standard deviation from their respective means. This shows that the stock return of SENSEX has been quite volatile during the sample period. All variables above are shown to be sharply platy-kurtic. The skewness tells us that the LRSENSEX is mostly normally skewed whereas all the other variables are highly positively skewed i.e., they have a long right tail.

Table: 2b – Correlation table of pre-covid variables

	LRSENSEX	**VOLCOPPER**	**VOLCOTTON**	**VOLCRUDE**	**VOLGOLD**
LRSENSEX	1				
VOLCOPPER	-0.002643691	1			
VOLCOTTON	-0.018574571	-0.019392349	1		
VOLCRUDE	0.028574742	0.147788371	0.102863574	1	
VOLGOLD	-0.027088399	0.035189964	0.105361896	0.194064691	1

Source: Author's Calculation

We will mostly be considering only the first column of the above correlation table as we are only interested in the relationships of the volatility of commodity prices with the stock returns. The correlation analysis shows us that there is significant correlation among all the variables

with the stock market returns of SENSEX. Also, except the volatility of crude oil all other variables are negatively correlated with the stock market returns of SENSEX.

Covid period:

Table: 2c – Descriptive Statistics of covid period variables

D. Statistics	Covid				
	LRSENSEX	**VOLCOPPER**	**VOLCOTTON**	**VOLCRUDE**	**VOLGOLD**
Mean	0.000833	0.000195	0.000052	0.004794	0.000117
Median	0.002711	0.000159	0.000051	0.000444	0.000118
Maximum	0.085947	0.003609	0.000208	0.074930	0.000244
Minimum	-0.141017	0.000000	0.000051	0.000081	0.000000
Std. Dev.	0.020032	0.000228	0.000009	0.012359	0.000020
Skewness	-1.5788	12.7225	16.4225	3.7663	0.3102
Kurtosis	14.7595	183.0795	274.5622	17.8035	21.4959
Jarque-Bera	1761*	392778*	888545*	3276*	4067*
Observations	285	285	285	285	285

Source: Author's Calculation

The above table shows all the values of the descriptive statistics of the variables being considered during the covid period. There is a significant increase in the Standard deviation among LRSENSEX, VOLCOPPER and VOLCRUDE. This shows that the rate of fluctuations of the volatility of these variables during the covid period is significantly higher than before. The skewness of LRSENSEX during the covid period is now significantly negatively skewed i.e., it has a long-left tail. While the positivity of skewness has increased among VOLCOPPER, VOLCOTTON and VOLCRUDE, VOLGOLD has now achieved fairly symmetrical skewness. The sharpness of the kurtosis has increased for all variables involved.

Table: 2d – Correlation table of variable during covid period

	LRSENSEX	**VOLCOPPER**	**VOLCOTTON**	**VOLCRUDE**	**VOLGOLD**
LRSENSEX	1				
VOLCOPPER	0.02409602	1			
VOLCOTTON	0.057756027	-0.003661374	1		
VOLCRUDE	-0.002716886	-0.000418267	0.309958684	1	
VOLGOLD	-0.175322114	-0.027324227	0.015971781	0.125269694	1

Source: Author's Calculation

The strength of correlation is greatly increased in the case of volatility of copper on LRSENSEX. And there is a decrease in the value off correlation between volatility of crude oil and LRSENSEX. Previously (i.e., in the pre-covid period) volatility of crude oil prices used to be positively correlated to the stock returns but is now negatively correlated. The correlation value

of volatility of gold prices to stock market returns has increased significantly denoting strong correlation between volatility of gold prices and stock market return during the covid period.

3.4.2 Stationarity Test:

Table: 2e – Stationarity test

Pre-Covid period		Covid period	
Variable	**ADF Test (level)**	**Variable**	**ADF Test (level)**
LRSENSEX	-28.33923*	**LRSENSEX**	-12.28032*
VOLCOPPER	-4.969610*	**VOLCOPPER**	-16.61364*
VOLCOTTON	-5.659895*	**VOLCOTTON**	-16.17425*
VOLCRUDE	-3.867665**	**VOLCRUDE**	-3.984599**
VOLGOLD	-5.666904*	**VOLGOLD**	-7.713127*
*Denotes significance at 1% level; **Denotes significance at 5% level			

Source: Author's Calculation

All the variables under consideration are shown to be stationary at their level form. This is expected as financial returns and volatility series are traditionally known to be stationary at level form. The only point to note here is that crude oil both before and during covid periods are shown to be stationary at level form but at the 5% level of significance, this is most likely due to the sharper upward trending of the spot prices of crude oil relative to the spot prices of the other commodities.

3.4.3 Volatility Modelling:

The specific models used for extracting the volatility of each of the spot prices will be explained below.

Pre-Covid Commodity Price Volatility:

We have used GARCH (1,1) for all the commodities.

Copper Volatility modelling:

Mean equation:

$$\Delta LSPCOPPER_t = 0.000163 + (-0.099031) \sum_{i=1}^{1} \Delta LSPCOPPER_{t-i} + u_t$$

Variance Equation:

$$h_t = 3.31652 + 0.938603 \sum_{i=1}^{1} h_{t-i} + 0.041990 \sum_{i=1}^{1} u_{t-i}^2$$

Cotton Volatility modelling:

Mean Equation:

$$\Delta LSPCOTTON_t = -7.755244 + 0.493478 \sum_{i=1}^{1} \Delta LSPCOTTON_{t-i} + (-0.235689) \sum_{j=1}^{1} u_{t-j} + u_t$$

Variance Equation:

$$h_t = 1.76678 + 0.099149 \sum_{i=1}^{1} u_{t-i}^2 + 0.860177 \sum_{i=1}^{1} h_{t-i}$$

Crude oil volatility modelling:

Mean Equation:

$$\Delta LSPCRUDE_t = 0.000596 + (-0.021272) \sum_{i=1}^{1} \Delta LSPCRUDE_{t-i} + u_t$$

Variance Equation:

$$h_t = 8.11858 + 0.047229 \sum_{i=1}^{1} u_{t-i}^2 + 0.935063 \sum_{i=1}^{1} h_{t-i}$$

Gold volatility modelling:

Mean Equation:

$$\Delta LSPGOLD_t = 0.000290 + 0.084559 \sum_{i=1}^{1} \Delta LSPCRUDE_{t-i} + u_t$$

Variance Equation:

$$h_t = 2.76186 + 0.067571 \sum_{i=1}^{1} u_{t-i}^2 + 0.863967 \sum_{i=1}^{1} h_{t-i}$$

Covid Period Commodity Price Volatility:

We have used GARCH (1,1) for all the commodities.

Copper volatility modelling:

Mean Equation:

$$\Delta LSPCOPPER_t = 0.000874 + 0.002919 \sum_{i=1}^{1} \Delta LSPCOPPER_{t-i} + u_t$$

Variance Equation:

$$h_t = 0.000165 + (-0.063034)\sum_{i=1}^{1} h_{t-i} + 0.219733\sum_{i=1}^{1} u_{t-i}^2$$

Cotton volatility modelling:

Mean Equation:

$$\Delta LSPCOTTON_t = 0.000468 + 0.226136\sum_{i=1}^{1} \Delta LSPCOTTON_{t-i} + 0.243799\sum_{j=1}^{3} \Delta LSPCOTTON_{t-j} + u_t$$

Variance Equation:

$$h_t = 5.1353 + 0.020135\sum_{i=1}^{1} u_{t-i}^2 + (-0.013287)\sum_{i=1}^{1} h_{t-i}$$

Crude oil volatility modelling:

Mean Equation:

$$LSPCRUDE_t = 131.2228 + 0.999981\sum_{i=1}^{1} LSPCRUDE_{t-i} + 0.225371\sum_{j=1}^{1} u_{t-j} + u_t$$

Variance Equation:

$$h_t = 3.042023 + 0.206272\sum_{i=1}^{1} u_{t-i}^2 + 0.829557\sum_{i=1}^{1} h_{t-i}$$

Gold volatility modelling:

Mean Equation:

$$\Delta LSPGOLD_t = 7.3924 + (-0.030091)\sum_{i=1}^{1} \Delta LSPCRUDE_{t-i} + u_t$$

Variance Equation:

$$h_t = 1.54665 + (-0.007387)\sum_{i=1}^{1} u_{t-i}^2 + 0.872002\sum_{i=1}^{1} h_{t-i}$$

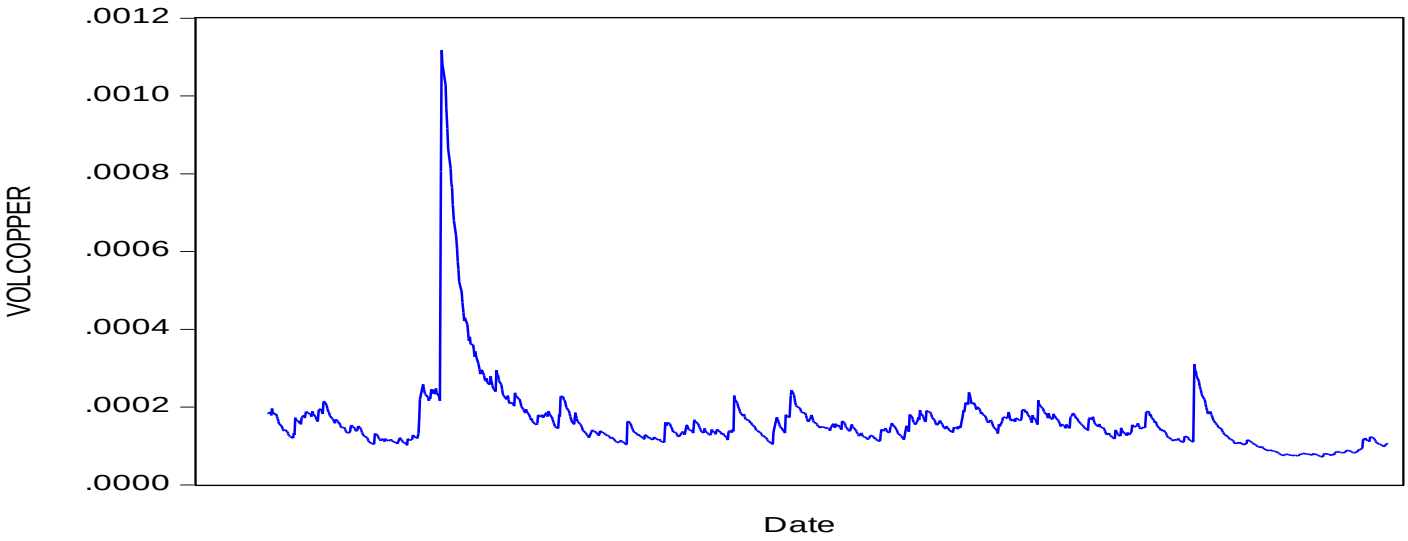
3.4.4 Volatility Graphs:

After volatility modelling and extracting the GARCH variance series of the variables, the obtained data is taken as the volatility of the commodity prices. These volatility series have been represented graphically below as follows:

Pre-Covid period:

Copper Volatility:

Figure: 2a – Volatility of copper prices in pre-Covid period

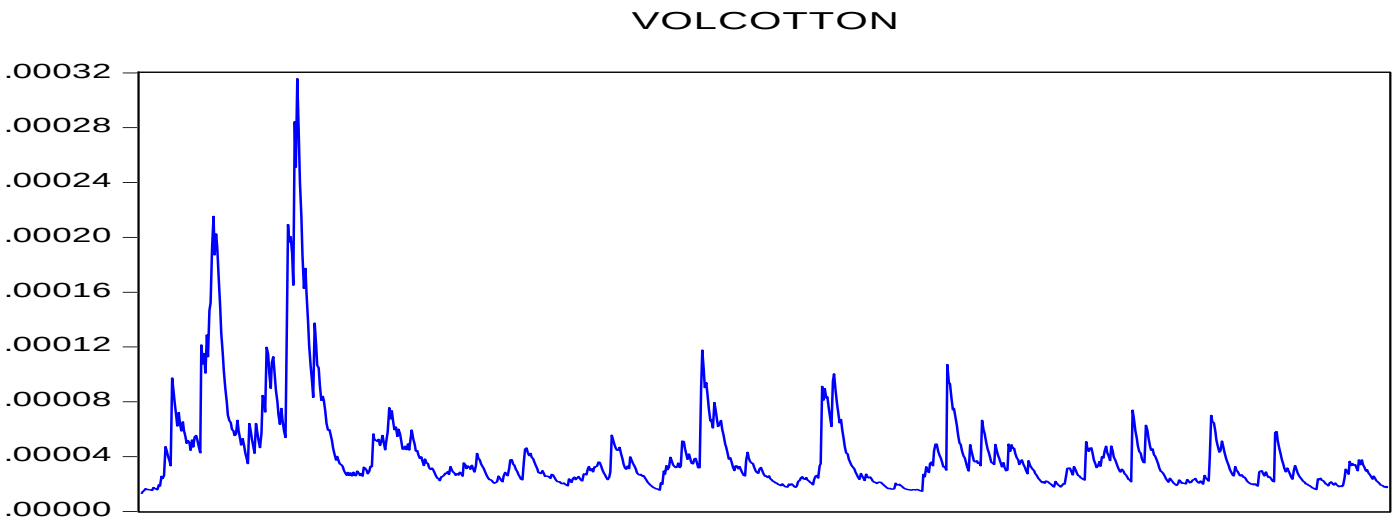


Source: Author's Calculation

The above table shows the volatility of copper. There is one aberrant spike clearly observable between the period of 15th to 30th June, 2016. This was an eventful period and the volatility of the commodity market can be most explained by investors rushing to invest in it as it was seen as an efficient hedge against inflation. Further market instability during this period may have been caused by Raghuram Rajan, the erstwhile governor of the RBI suddenly leaving his post leaving the market in flux. Further the panic over Brexit and the cabinet reshuffle may have had a hand in it.

Cotton Volatility:

Figure: 2b – Volatility of Cotton prices in pre-Covid period

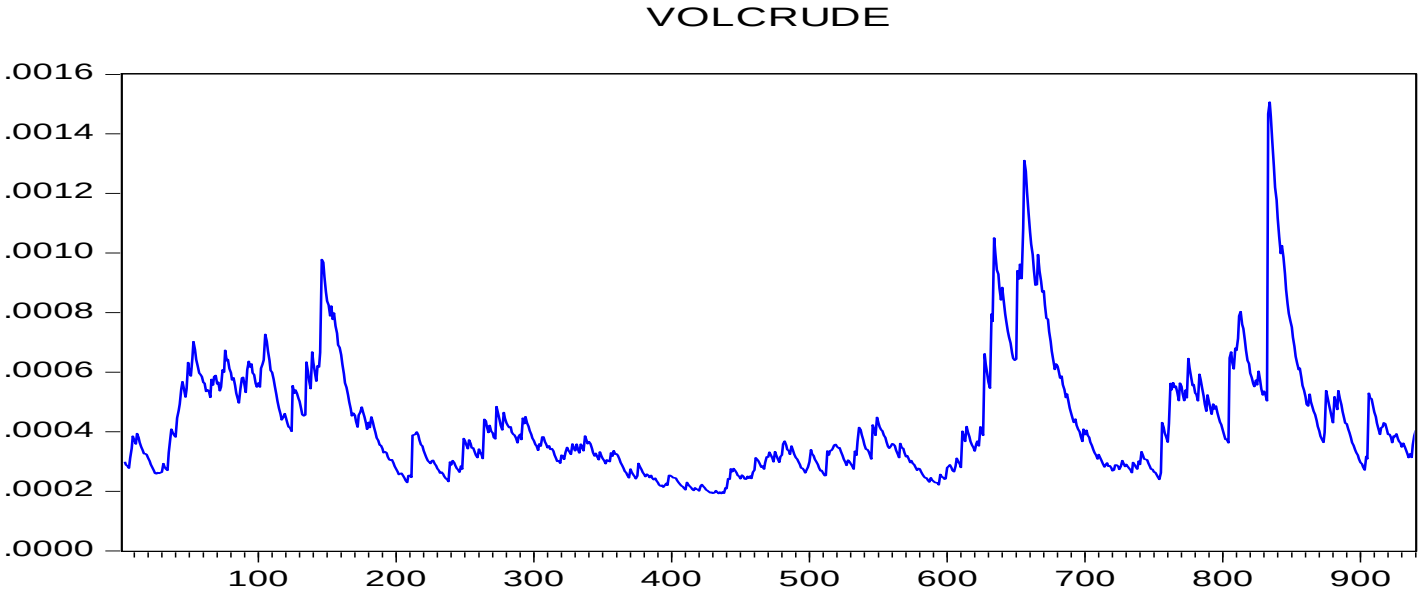


Source: Author's Calculation

The above graph shows the volatility of cotton during the pre-covid period. The two volatility spikes observed are found between July and September 2016. The first of these spikes can be explained by the fall in production of cotton which led to the government increasing the export tariffs on cotton which further led to a reduction in exports of the commodity. The second spike was caused by the increase in the production of cotton which led the government to reduce the tariff on exports to previous levels, this spurred an increase in exports.

Crude Oil Volatility:

Figure: 2c - Volatility of Crude oil prices in pre-Covid period



Source: Author's Calculation

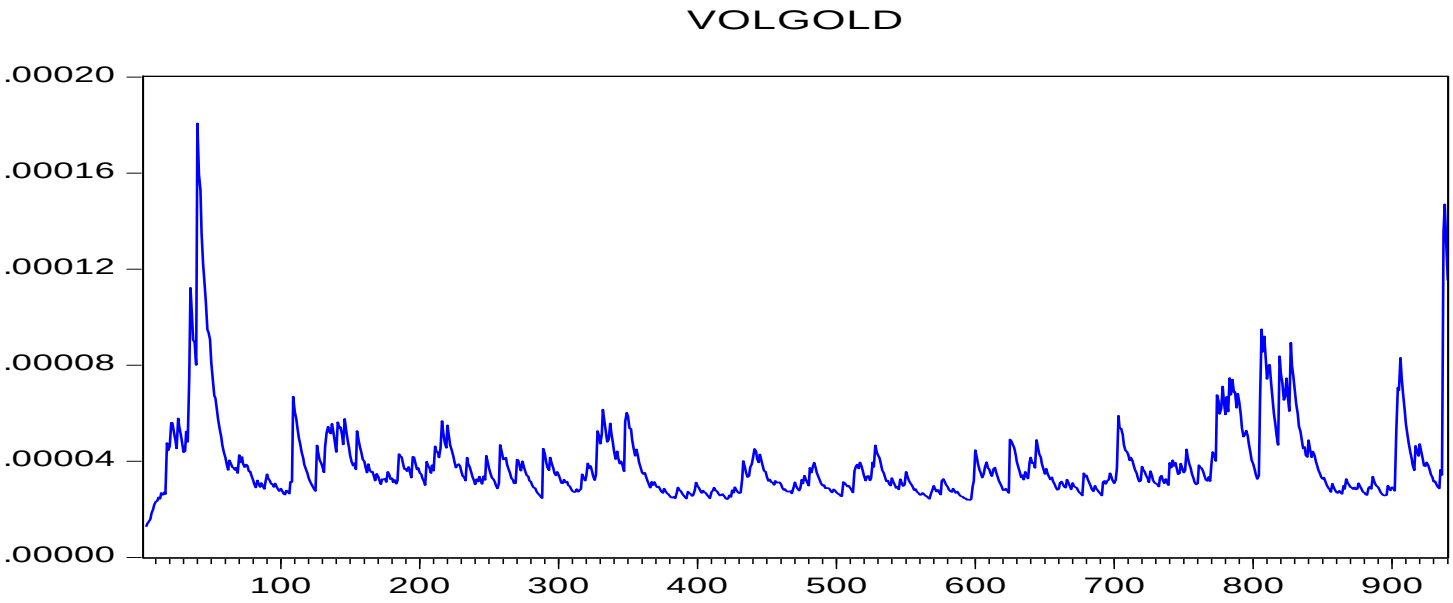
The above graph represents the volatility of crude oil during the pre-covid period. The first spike can be found between June 2016 and Jan 2017. This was a long period of volatility. This can be explained by many factors including a price hike in oil driven by producers in Russia and Saudi Arabia during September 2016, a rise in prices as a result of OPEC deliberately reducing production during January 2017, a bullish crude oil market driven by a 33% increase in crude oil imports rising to $37.85 Billion.

The second spike would be found between the period dating from December 2018 and January 2019. This second spike was caused mainly by U.S sanctions on Venezuela which led to decreases in return of major crude oil producers Chevron and Valero. The volatility was further unstable due to rise in prices driven by reduction in production by OPEC and an increase in U.S crude oil market returns.

The final spike was between October and November 2019. The volatility during this period was driven by an increase in optimism in global markets due to hopeful U.S China trade talks and also investors investing largely in Chinese markets following the Chinese Stimulus. The volatility the stayed up due to the failing U.S China trade talks.

Gold Volatility:

Figure: 2d – Volatility of Gold prices in pre-Covid period



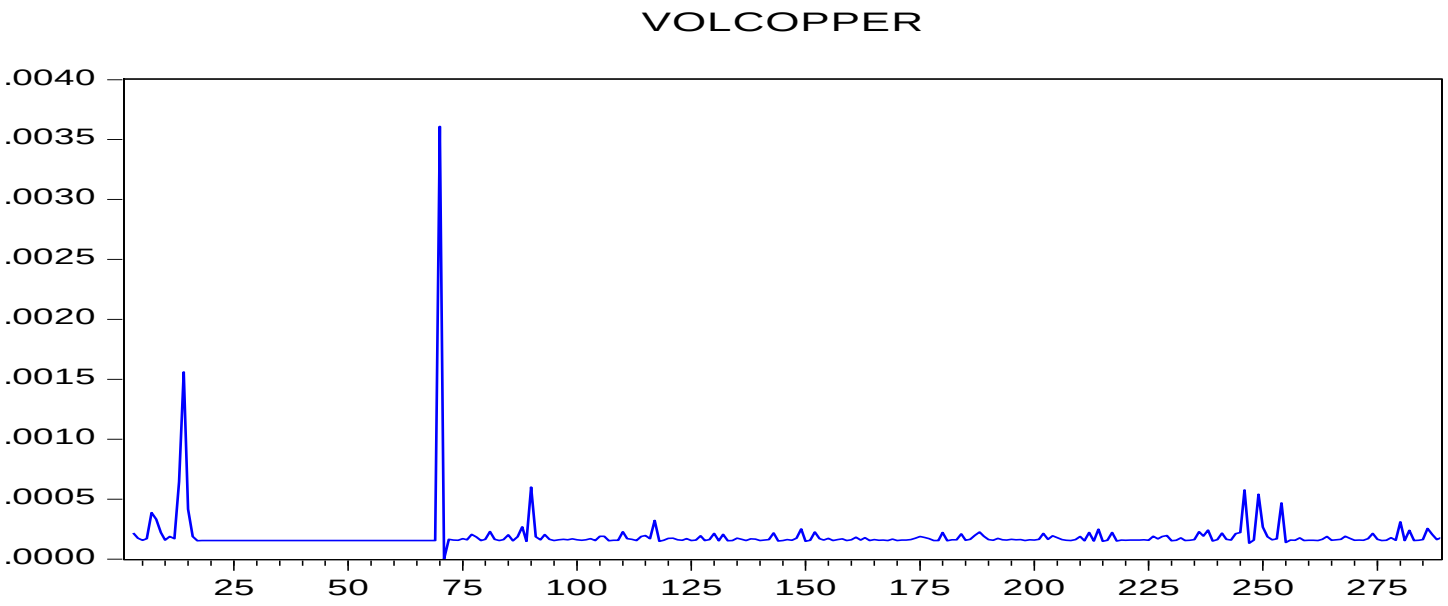
Source: Author's Calculation

The traditionally "stable good" shows a significant spike during the period between June and July 2016. The demand for gold was at a high during this time. Despite price rises the demanded for gold continued to surge. Gold imports during the period between Jan - July increased by 131% (compared to same period of previous year). The gold imports for May 2016 rose by 237% (compared to May 2015) to $4.95 B.

During Covid period:

Copper Volatility:

Figure: 3a Volatility of Copper prices in Covid period

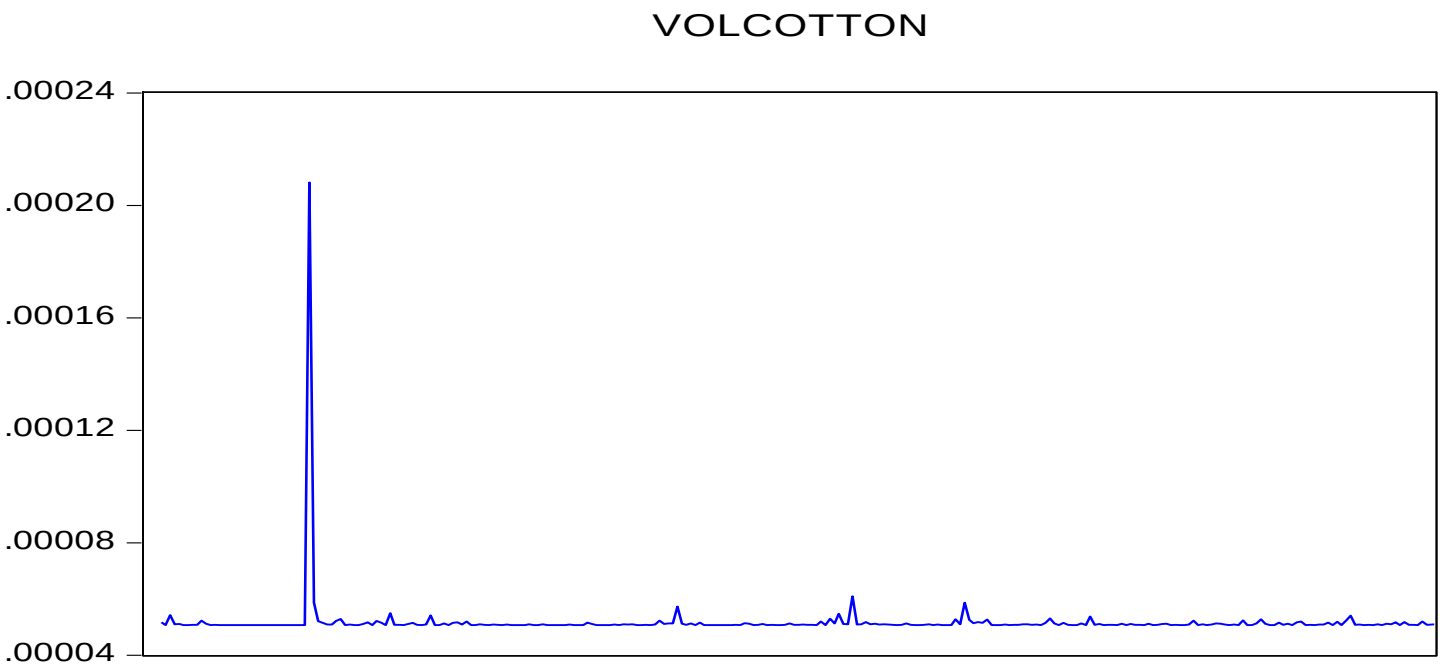


Source: Author's Calculation

The above graph represents the volatility of copper during the Covid period. From the above graph it is noticed that except for two noticeable spikes, the volatility of copper is relatively stable throughout this period. During this period of volatility "stability" copper spot price has shown an upward trend given its rise in demand as investors perceive it as a safe hedge against inflation and other long lasting negative effects of the pandemic. The first spike is found to be between mid-March till the end of the month, this saw a freefall in the spot price of copper. This was due to the onset of the covid pandemic and the first of the lockdowns. This period left investors in a state of panic and uncertainty as they rushed to liquidate all their remaining stocks. The demand fell to such lows that the supply surplus was estimated to be around 12000 tons, according to a report by Goldman Sachs. The second spike was found to be between the period between the first week of June and the last week of June 2020. This was the period immediately following the 1st of the unlocks. This led to an increase in demand for copper as industries opened up and started operation. The price of copper was further driven up by the stimulus packages of most countries, namely U.S.A, China and Europe. The price rise can also be attributed to the huge demand for copper from China as they had got the pandemic "Under control" by this point in time.

Cotton Volatility:

Figure: 3b – Volatility of Cotton prices in Covid period

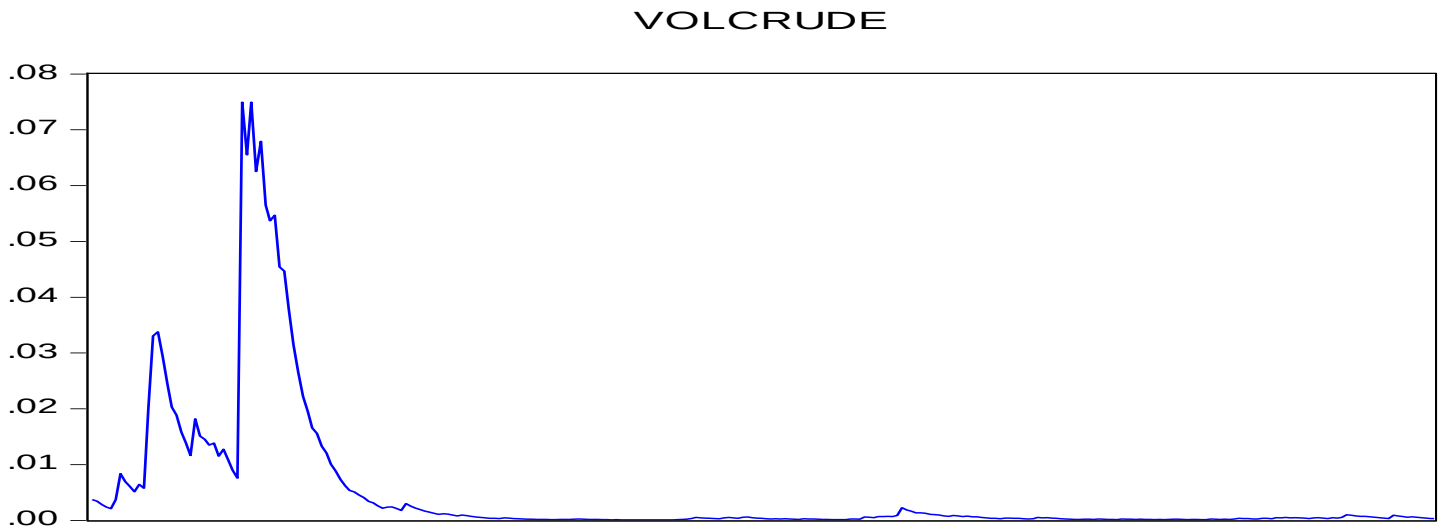


Source: Author's Calculation

The above graph represents the volatility of cotton spot prices during the Covid period. The graph clearly shows the presence of one significant spike followed by a period of relatively low volatility. This spike in volatility is found to be between the period dating from 24th May 2020 till 4th May 2020. This period coincides with the first unlocks. The price of cotton plummeted due to the closure of textile mills all around the country and the mass reverse migration which led to a shortage of labour in cotton allied industries. Cotton prices in some countries hit a decade low during this period. Even in India, the price of raw cotton per Kg dropper from around Rs. 44 to Rs.30.

Crude Oil Volatility:

Figure: 3c – Volatility of Crude Oil prices in Covid period

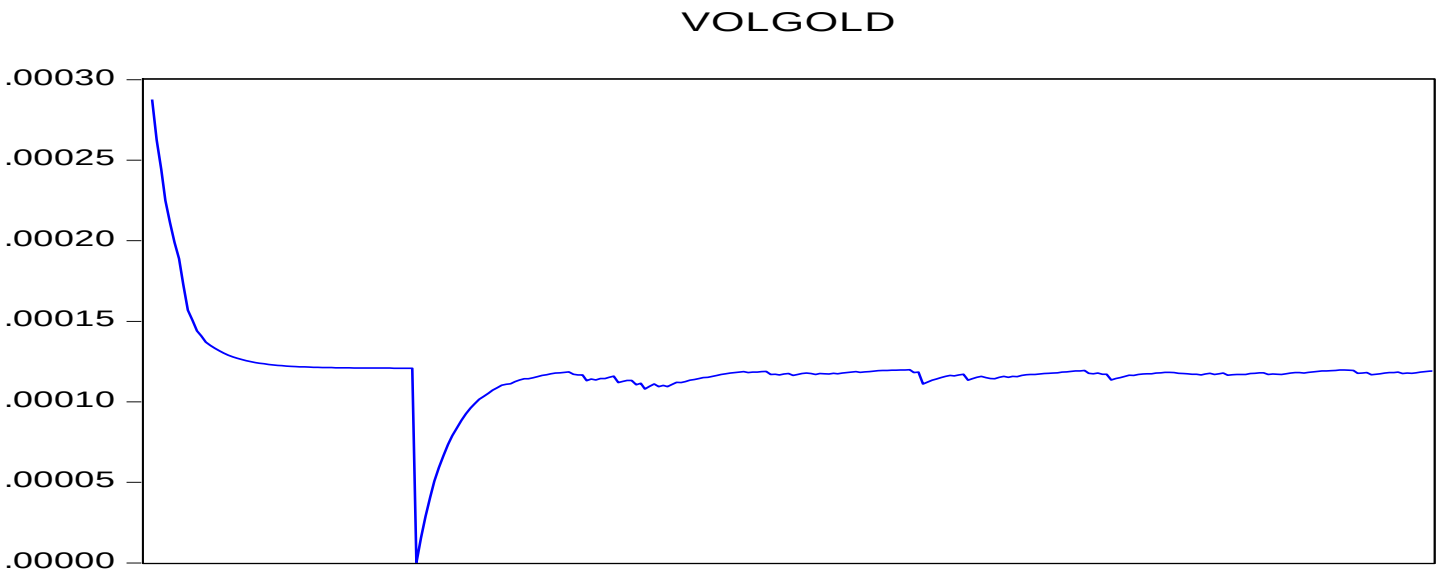


Source: Author's Calculation

The above graph represents the volatility of crude oil during the Covid period. There are two noticeable spikes in the volatility of crude oil spot prices followed by a period of calm (in terms of spot price volatility). The first of these spikes is found to be in the final week of March 2020. This period coincides with the onset of the Covid pandemic in India and the initiation of the first of the lockdowns. During this period the spot price of crude oil plummeted for reasons including the onset of the pandemic, the halt of economic activity caused by the lockdowns, the low demand due to the halt of economic activity and also due to the increase in crude oil prices driven by Russia and Saudi Arabia. The second spike which followed shortly after is found to be between 24th April 2020 and 26th May 2020. During this time the lockdown restrictions were still in full force but there was a rise in demand nonetheless due to India's heavy dependance on crude oil imports and due to certain relaxations afforded to crude oil imports. The rise in prices during this period is due to a combination of a rise in domestic demand, rise in Chinese demand and Chinese exports and also increase in prices driven by Saudi Arabia.

Gold Volatility:

Figure: 3d – Volatility of Gold prices in Covid period



Source: Author's Calculation

The above graph represents the volatility of gold during the covid period. Unlike other commodities, gold is relatively non-volatile. The spikes in volatility observed can be explained by investors choosing the liquidate their other "risky" assets and rush to invest in what they perceive to be a "safe-haven" asset, which drives up demand and import of the commodity. This constant tug of war between demand and price of the commodity has led it to be in a state on constant volatility. Despite the lack of volatility throughout the period, we can still observe two spikes. The first of these spikes come between 2nd march 2020 and 16th march 2020. Here there was the presence of a prior high volatility which seemed to decline possibly due to the fall in demand and subsequent fall in imports of the country. This was also coupled by the onset of the pandemic and the initiation of the lockdowns which caused panic in the minds of the investors, who made a "dash for cash" and quickly sought the liquidation of their assets and to invest in gold which was considered a relatively stable commodity. The second spike is a peculiar one in that it is not an increase in volatility but is in fact a decrease in volatility of gold. The volatility of gold plummeted to near stable level for a short period most likely due to the announcement of stimulus packages around the world to combat covid pandemic which may have caused investors to reinvest in other stocks. This "stability" however was short lived as the volatility of gold had bounced almost immediately back up to previous levels mainly due to the boosted domestic demand for gold.

3.5 Results:

3.5.1 VAR Model:

A Vector Auto Regressive (VAR) model is used in this study in order to map the impulse response forecast of the returns of stock to the impulses of the volatility of commodity spot prices. For this purpose, an unrestricted VAR model is used with lag intervals of 1 and 2 as determined by the appropriate information criterion. The VAR system of equations is given below:

$$\begin{bmatrix} LRSENSEX \\ VOLCOPPER \\ VOLCOTTON \\ VOLCRUDE \\ VOLGOLD \end{bmatrix} = \begin{bmatrix} \alpha_{1,11} \\ \alpha_{2,11} \\ \alpha_{3,11} \\ \alpha_{4,11} \\ \alpha_{5,11} \end{bmatrix} + \sum_{i=1}^{2} \begin{bmatrix} \alpha_{1,1} & \alpha_{1,2} \\ \alpha_{2,1} & \alpha_{2,2} \\ \alpha_{3,1} & \alpha_{3,2} \\ \alpha_{4,1} & \alpha_{4,2} \\ \alpha_{5,1} & \alpha_{5,2} \end{bmatrix} \begin{bmatrix} LRSENSEX_{t-i} \\ LRSENSEX_{t-i} \\ LRSENSEX_{t-i} \\ LRSENSEX_{t-i} \\ LRSENSEX_{t-i} \end{bmatrix} + \sum_{j=1}^{2} \begin{bmatrix} \alpha_{1,3} & \alpha_{1,4} \\ \alpha_{2,3} & \alpha_{2,3} \\ \alpha_{3,3} & \alpha_{3,4} \\ \alpha_{4,3} & \alpha_{4,4} \\ \alpha_{5,3} & \alpha_{5,4} \end{bmatrix} \begin{bmatrix} VOLCOPPER_{t-j} \\ VOLCOPPER_{t-j} \\ VOLCOPPER_{t-j} \\ VOLCOPPER_{t-j} \\ VOLCOPPER_{t-j} \end{bmatrix}$$

$$+ \sum_{k=1}^{2} \begin{bmatrix} \alpha_{1,5} & \alpha_{1,6} \\ \alpha_{2,5} & \alpha_{2,6} \\ \alpha_{3,5} & \alpha_{3,6} \\ \alpha_{4,5} & \alpha_{4,6} \\ \alpha_{5,5} & \alpha_{5,6} \end{bmatrix} \begin{bmatrix} VOLCOTTON_{t-k} \\ VOLCOTTON_{t-k} \\ VOLCOTTON_{t-k} \\ VOLCOTTON_{t-k} \\ VOLCOTTON_{t-k} \end{bmatrix} + \sum_{l=1}^{2} \begin{bmatrix} \alpha_{1,7} & \alpha_{1,8} \\ \alpha_{2,7} & \alpha_{2,8} \\ \alpha_{3,7} & \alpha_{3,8} \\ \alpha_{4,7} & \alpha_{4,8} \\ \alpha_{5,7} & \alpha_{5,8} \end{bmatrix} \begin{bmatrix} VOLCRUDE_{t-l} \\ VOLCRUDE_{t-l} \\ VOLCRUDE_{t-l} \\ VOLCRUDE_{t-l} \\ VOLCRUDE_{t-l} \end{bmatrix}$$

$$+ \sum_{m=1}^{2} \begin{bmatrix} \alpha_{1,9} & \alpha_{1,10} \\ \alpha_{2,9} & \alpha_{2,10} \\ \alpha_{3,9} & \alpha_{3,10} \\ \alpha_{4,9} & \alpha_{4,10} \\ \alpha_{5,9} & \alpha_{5,10} \end{bmatrix} \begin{bmatrix} VOLGOLD_{t-m} \\ VOLGOLD_{t-m} \\ VOLGOLD_{t-m} \\ VOLGOLD_{t-m} \\ VOLGOLD_{t-m} \end{bmatrix}$$

All the above endogenous variables have been regressed with the others and themselves at their first and second lags. The output of the above VAR system of equations of the pre-covid variables is given below (Table: 5a and Table: 5b)

3.5.2 VAR Estimation output results:

Pre-Covid period:

Table: 3a – VAR Co-efficient results (pre-Covid period)

		$LRSENSEX$	$VOLCOPPER$	$VOLCOTTON$	$VOLCRUDE$	$VOLGOLD$
$LRSENSEX_{t-1}$	**Co-efficient**	0.06215	-0.00001	-0.00005	-0.00021	-0.00009
	S. E	0.03326	0.00010	0.00004	0.00021	0.00003
	t-statistic	1.86833	-0.10233	-1.17241	-1.00462	-3.29600
$LRSENSEX_{t-2}$	**Co-efficient**	0.00434	0.00001	0.00007	-0.00031	0.00003
	S. E	0.03345	0.00010	0.00004	0.00021	0.00003
	t-statistic	0.12963	0.13916	1.53034	-1.48279	1.11738
$VOLCOPPER_{t-1}$	**Co-efficient**	11.12169	1.28596	0.00039	0.00188	-0.00404
	S. E	10.08552	0.03094	0.01347	0.06312	0.00869
	t-statistic	1.10274	41.5687	0.02862	0.02978	-0.46422
$VOLCOPPER_{t-2}$	**Co-efficient**	-12.37134	-0.32997	-0.00179	-0.01059	0.00327
	S. E	10.07508	0.03090	0.01345	0.06305	0.00868
	t-statistic	-1.22791	-10.6775	-0.13311	-0.16795	0.37625
$VOLCOTTON_{t-1}$	**Co-efficient**	-5.15335	-0.10037	0.92077	-0.08953	-0.00331
	S. E	24.59272	0.07543	0.03284	0.15390	0.02120
	t-statistic	-0.20955	-1.33055	28.0403	-0.58172	-0.15593
$VOLCOTTON_{t-2}$	**Co-efficient**	0.03957	0.10052	0.03098	0.10986	-0.00216
	S. E	24.57039	0.07537	0.03281	0.15376	0.02118
	t-statistic	0.00161	1.33376	0.94438	0.71446	-0.10222
$VOLCRUDE_{t-1}$	**Co-efficient**	-2.25066	-0.02619	0.00568	0.99415	0.00121
	S. E	5.25232	0.01611	0.00701	0.03287	0.00453
	t-statistic	-0.42851	-1.62594	0.81031	30.2457	0.26721
$VOLCRUDE_{t-2}$	**Co-efficient**	4.01335	0.03271	-0.00596	-0.03073	-0.00195
	S. E	5.23884	0.01607	0.00700	0.03278	0.00452
	t-statistic	0.76608	2.03528	-0.85269	-0.93725	-0.43287
$VOLGOLD_{t-1}$	**Co-efficient**	-22.36573	-0.12578	0.01597	0.30172	0.94255
	S. E	38.25583	0.11734	0.05108	0.23940	0.03297
	t-statistic	-0.58464	-1.07190	0.31272	1.26031	28.5868
$VOLGOLD_{t-2}$	**Co-efficient**	12.88472	0.16115	0.01802	0.01227	-0.01661
	S. E	39.00565	0.11964	0.05208	0.24410	0.03362
	t-statistic	0.33033	1.34689	0.34600	0.05025	-0.49411
C	**Co-efficient**	0.00045	0.00000	0.00000	0.00000	0.00000
	S. E	0.00089	0.00000	0.00000	0.00001	0.00000
	t-statistic	0.50185	1.11740	0.88361	0.80054	4.78003

Source: Author's Calculation

Table: 3b – Regression estimates (pre-Covid period)

Regression estimates	$LRSENSEX$	$VOLCOPPER$	$VOLCOTTON$	$VOLCRUDE$	$VOLGOLD$
R^2	0.00904	0.94619	0.90720	0.94024	0.83980
Adjusted- R^2	-0.00168	0.94561	0.90620	0.93959	0.83807
Sum Squ, Resid	0.05638	0.00000	0.00000	0.00000	0.00000
S. E	0.00781	0.00002	0.00001	0.00005	0.00001
F- Statistic	0.84344	1626.62561	904.27475	1455.27079	484.89252

Source: Author's Calculation

Covid period:

VAR Estimation output results:

Table: 4a – VAR Co-efficient results (Covid period)

		$LRSENSEX$	$VOLCOPPER$	$VOLCOTTON$	$VOLCRUDE$	$VOLGOLD$
$LRSENSEX_{t-1}$	**Co-efficient**	-0.14948	-0.00164	0.00002	0.00630	-0.00001
	S. E	0.05897	0.00072	0.00003	0.01393	0.00002
	t-statistic	-2.53487	-2.28167	0.82766	0.45227	-0.43402
$LRSENSEX_{t-2}$	**Co-efficient**	-0.01646	-0.00104	0.00003	-0.02128	-0.00002
	S. E	0.05829	0.00071	0.00003	0.01377	0.00002
	t-statistic	-0.28238	-1.46668	1.01214	-1.54536	-0.87913
$VOLCOPPER_{t-1}$	**Co-efficient**	-12.50617	0.00577	0.00062	1.64603	-0.00008
	S. E	4.97425	0.06050	0.00232	1.17494	0.00194
	t-statistic	-2.51418	0.09537	0.26874	1.40095	-0.04016
$VOLCOPPER_{t-2}$	**Co-efficient**	2.70720	-0.02623	-0.00003	0.70558	0.00017
	S. E	4.99992	0.06081	0.00233	1.18100	0.00195
	t-statistic	0.54145	-0.43134	-0.01332	0.59744	0.08612
$VOLCOTTON_{t-1}$	**Co-efficient**	154.23204	0.08805	-0.06221	-48.12965	-0.00064
	S. E	126.30773	1.53630	0.05890	29.83435	0.04916
	t-statistic	1.22108	0.05731	-1.05608	-1.61323	-0.01304
$VOLCOTTON_{t-2}$	**Co-efficient**	-443.34161	0.45762	-0.14067	-4.65620	0.00580
	S. E	127.26765	1.54798	0.05935	30.06109	0.04954
	t-statistic	-3.48354	0.29562	-2.37023	-0.15489	0.11700
$VOLCRUDE_{t-1}$	**Co-efficient**	-0.39157	0.00153	-0.00023	0.85325	0.00003
	S. E	0.25672	0.00312	0.00012	0.06064	0.00010
	t-statistic	-1.52525	0.49053	-1.88362	14.0709	0.27262
$VOLCRUDE_{t-2}$	**Co-efficient**	0.51395	-0.00212	0.00052	0.09480	-0.00001
	S. E	0.25875	0.00315	0.00012	0.06112	0.00010
	t-statistic	1.98627	-0.67502	4.31764	1.55102	-0.10047
$VOLGOLD_{t-1}$	**Co-efficient**	-25.78966	0.23331	0.00161	3.85683	0.86251
	S. E	155.66078	1.89333	0.07259	36.76765	0.06059
	t-statistic	-0.16568	0.12323	0.02216	0.10490	14.2355
$VOLGOLD_{t-2}$	**Co-efficient**	-160.6479516	-1.043820688	-0.004948003	10.13389461	-0.0141511
	S. E	145.5090908	1.769852296	0.067856993	34.3697856	0.056637419
	t-statistic	-1.10404	-0.58978	-0.07292	0.29485	-0.24985
C	**Co-efficient**	0.039391282	0.000271915	6.10E-05	0.000888765	1.70E-05
	S. E	0.012013822	0.000146126	5.60E-06	0.002837709	4.68E-06
	t-statistic	3.27883	1.86083	10.8916	0.31320	3.63534

Source: Author's Calculation

Table: 4b – Regression estimates (Covid period)

Regression estimates	$LRSENSEX$	$VOLCOPPER$	$VOLCOTTON$	$VOLCRUDE$	$VOLGOLD$
R^2	0.12242	0.02638	0.15381	0.87531	0.83125
Adjusted- R^2	0.09015	-0.00942	0.12270	0.87072	0.82505
Sum Squ, Resid	0.09693	0.00001	0.00000	0.00541	0.00000
S. E	0.01888	0.00023	0.00001	0.00446	0.00001
F- Statistic	3.79424	0.73685	4.94398	190.93845	133.98699

Source: Author's Calculation

Comparative analysis:

Here we will compare the values of table 3a vs 4a, i.e., the coefficients of regression in the pre covid period vs the coefficients of regression during the covid period. Like in the case of the correlation analysis we will be concerning ourselves only with the output of the first column of each of these tables as the purpose of this study is to explore the relation ship of the volatilities of prices of the commodities on the stock market returns and not anything else. In the case of the relationship of LRSENSEX with it's lagged variables, we can see that its coefficients in the pre covid period are positive whereas, its coefficients during the covid period are negative. This may be due to the increased volatile nation of stock market return during the covid period. The same happens in the case of the coefficients of the first lag of copper, this is due to the increased volatility of copper especially during the initial stages of the covid pandemic. The coefficients of the volatility of copper have greatly increased from the pre covid to the during covid periods. This may be due to the relative strength of the agricultural sector during the pandemic and the increase of cotton exports driven by rise in prices of cotton during this period. The significance of the volatility of crude oil has decreased during the covid period. The reduced volatility of crude oil during this period could be the main reason for this. During covid period crude oil prices have been more or less stable due to surplus supply in the global markets and hence volatility of crude oil does not exhibit a significant short run relationship with the stock returns. The most significant driver of stock market returns both in the long run and short run is shown to be gold. Due to its current run of high volatility, upward trending prices and investor preference it has turned into a major determinant of stock market returns during the covid period. Comparing the R^2 and adjusted R^2 of the two periods we see that the volatilities of commodities have a much greater influence on stock market return of SENSEX during the covid period than during the pre-covid period. This may be due a combination of factors such as an increased demand for commodities for manufacturing and allied industries, increased investor preference as commodities are perceived to be relatively safer investments and increased volatility of commodities presenting an attractive investment opportunity to investors.

3.5.3 Impulse responses of Stock Market return of SENSEX to the Price Volatility of Commodities:

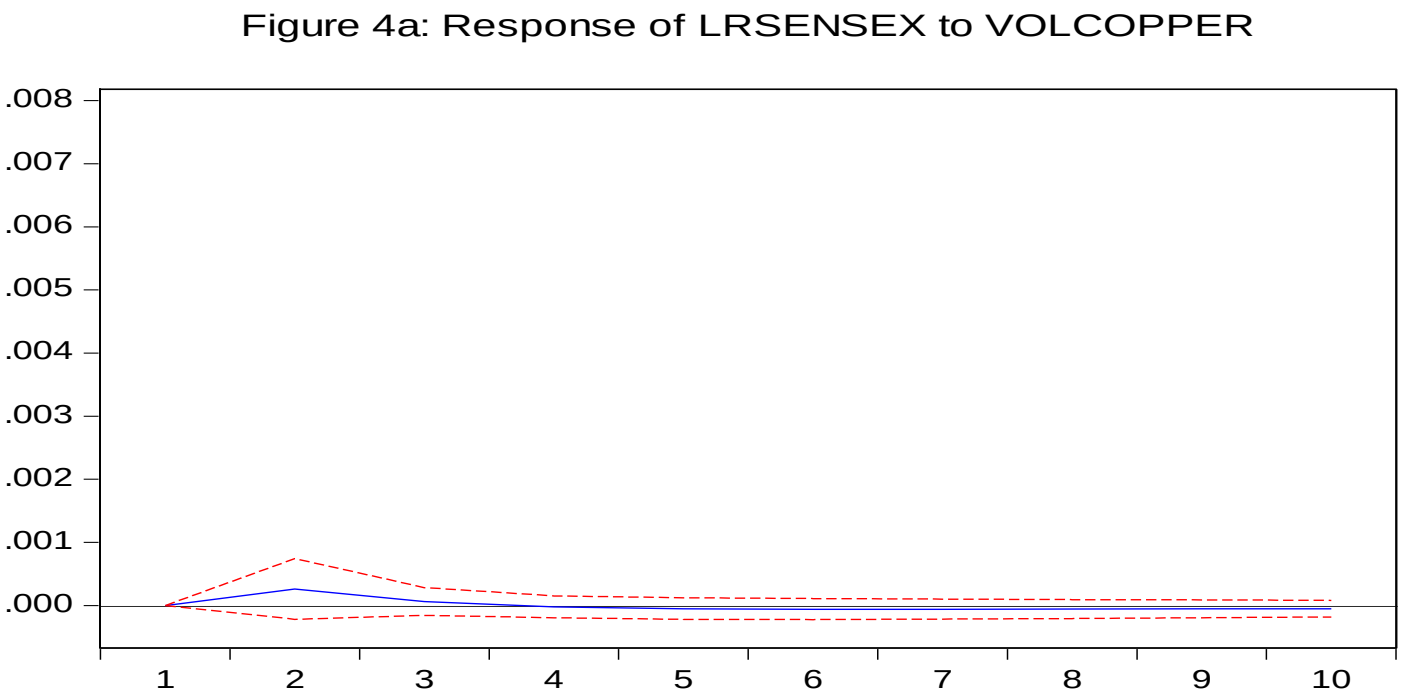
In signal processing, the impulse response, or impulse response function (IRF), of a dynamic system is its output when presented with a brief input signal, called an impulse. More generally, an impulse response refers to the reaction of any dynamic system in response to some external change. In both cases, the impulse response describes the reaction of the system as a function of time. In all these cases, the dynamic system and its impulse response may be actual physical objects, or may be mathematical systems of equations describing such objects. Since the impulse function contains all frequencies, the impulse response defines the response of a linear time-invariant (unescwa.com).

The impulse responses of LRSENSEX to the various price volatilities of commodities being considered (VOLCOPPER, VOLCOTTON, VOLCRUDE and VOLGOLD) are carried out using the above-described unrestricted VAR process. First be carry out and interpret the four impulse response functions of the pre-covid period before moving on to carry out the impulse response functions of the period during covid pandemic. Then finally we conduct a comparative analysis of the relevant IRF's between the pre-covid and during covid periods.

Pre-covid period:

Impulse response of SENSEX returns to Price Volatility of Copper:

Figure: 4a – IRF of SENSEX returns to price volatility of copper (Pre-covid)



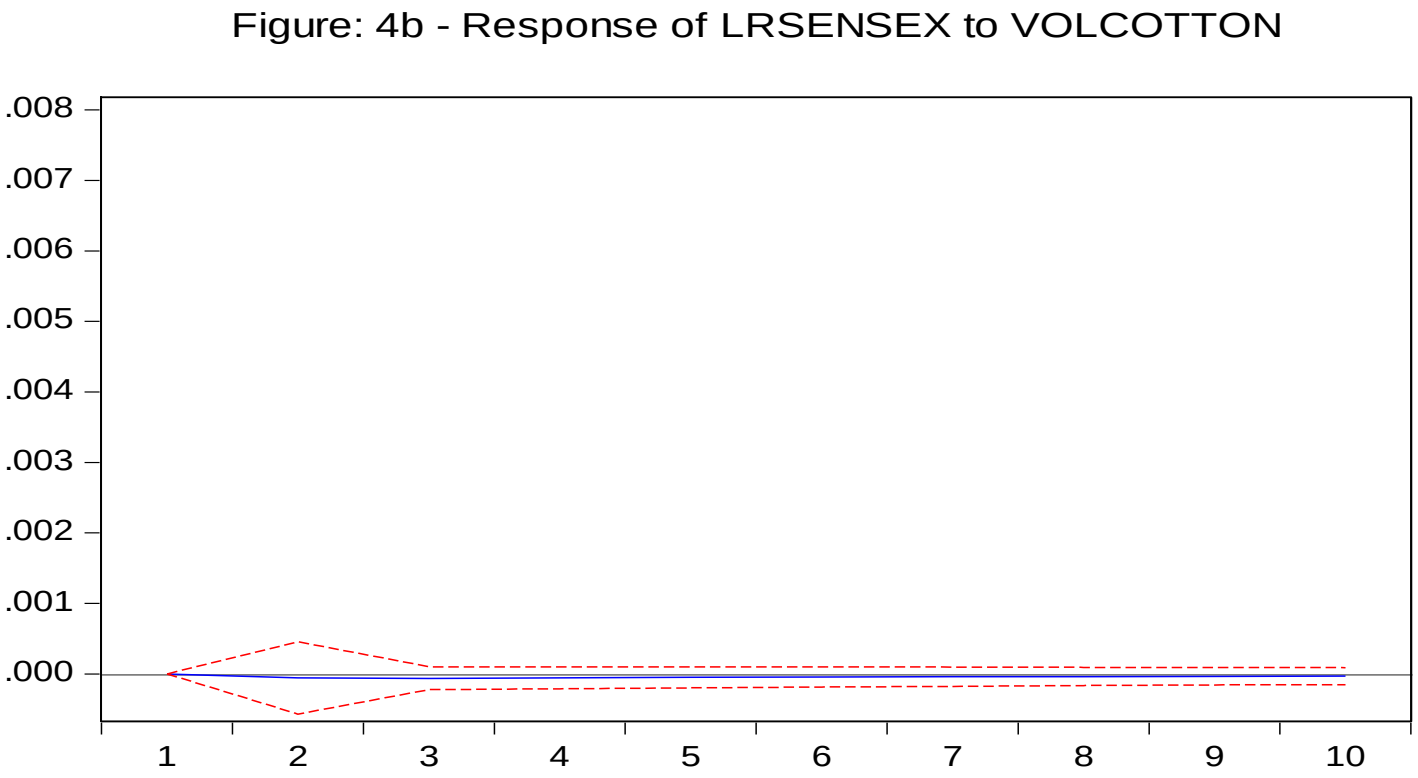
Source: Author's Calculation

Here, a one Standard Deviation shock (innovation) is given to the Price volatility of copper which causes an immediate response from SENSEX returns in period 1, as the SENSEX returns rises slightly and steady until it reaches its peak at period 2 before it begins to decay once again. At the end of period 3 it reaches its Steady State Value on the origin (0) line and continues on this line until it reaches period 5. Once it reaches period 5, the response gradually declines further very slightly into the negative region. It remains at this negative region till the end of the IRF region (period 10). This shows that shocks to volatility of copper have a slight positive impact in the short run but result in a small negative impact to the SENSEX returns in the long run.

This result is also reflected in the regression coefficient of volatility of copper on SENSEX returns (Refer Table: 3a). Prior research involving signaling effects found similar results when examining the correlation between stock returns of mining companies and changes in the metal prices they primarily produce (Zevallos and del Carpio, 2015).

Impulse response of SENSEX returns to Price Volatility of Cotton:

Figure: 4b – IRF of SENSEX returns to price volatility of cotton (Pre-covid)



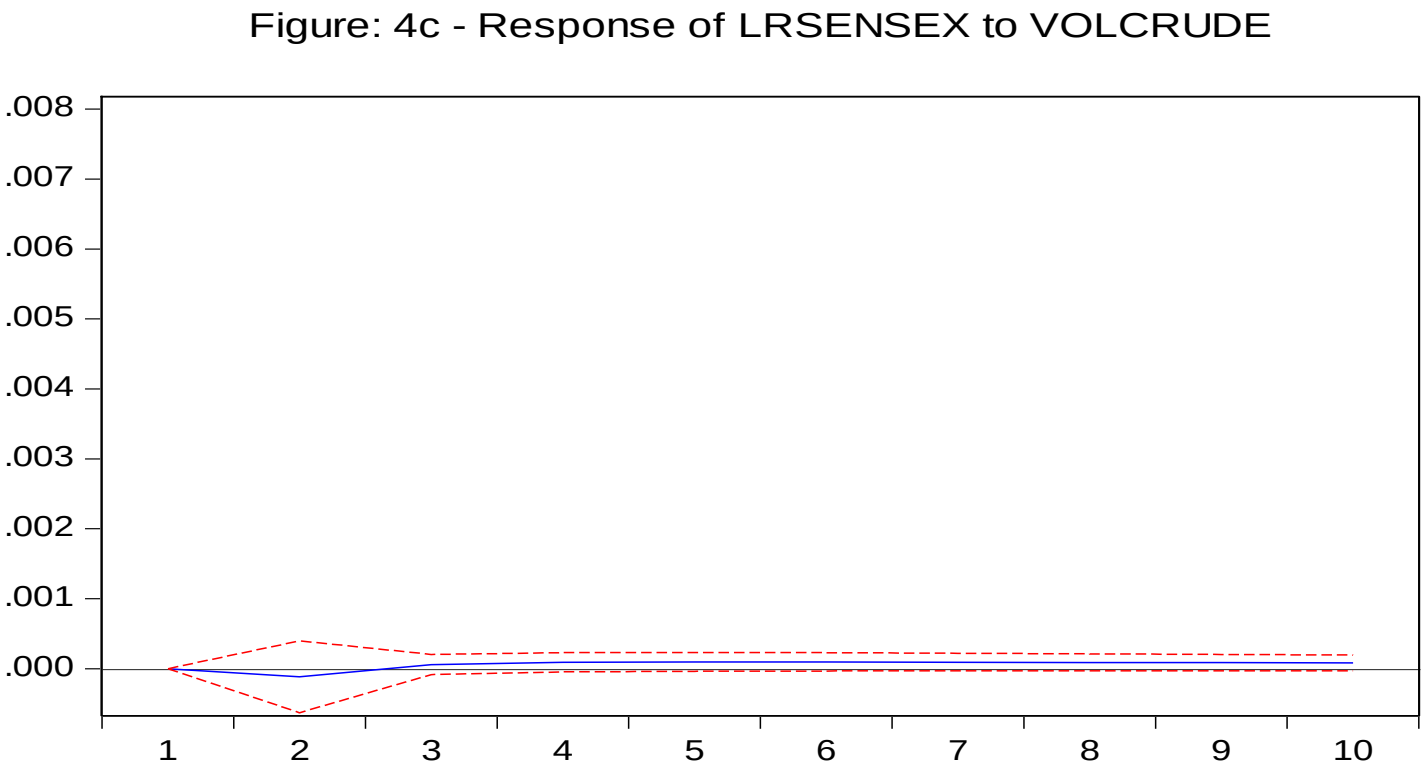
Source: Author's Calculation

Here, a one Standard Deviation shock (innovation) is given to the Price Volatility of cotton which causes a delayed and gradual negative impact on the SENSEX return after period 1. After the 1st period, the response dips into the negative region and enters its here it enters its Steady State Value and continues with one slight upward movement at the 5th period. The SENSEX impulse continues in the negative region till the end of the IRF (i.e., at the 10th period). This shows that shocks to volatility have a very slight negative impact in the short run as well as in the long run on the SENSEX returns.

This overall negative impact of the volatility of cotton on the SENSEX returns is mirrored in the values of the coefficient of cotton in the regression output (Refer Table:3a). These slight negative impacts could be due to the fact that the market for cotton is characterized by low elastic demand and strong inertial supply. Given that the returns of markets depend on evaluating the uncertainty, which due to the above-mentioned reasons, such evaluation depends on measuring predictability instead of volatility (Joëts M, Mignon V and Razafindrabe T, 2015)

Impulse response of SENSEX returns to Price Volatility of Crude Oil:

Figure: 4c – IRF of SENSEX returns to price volatility of crude oil (pre-covid)



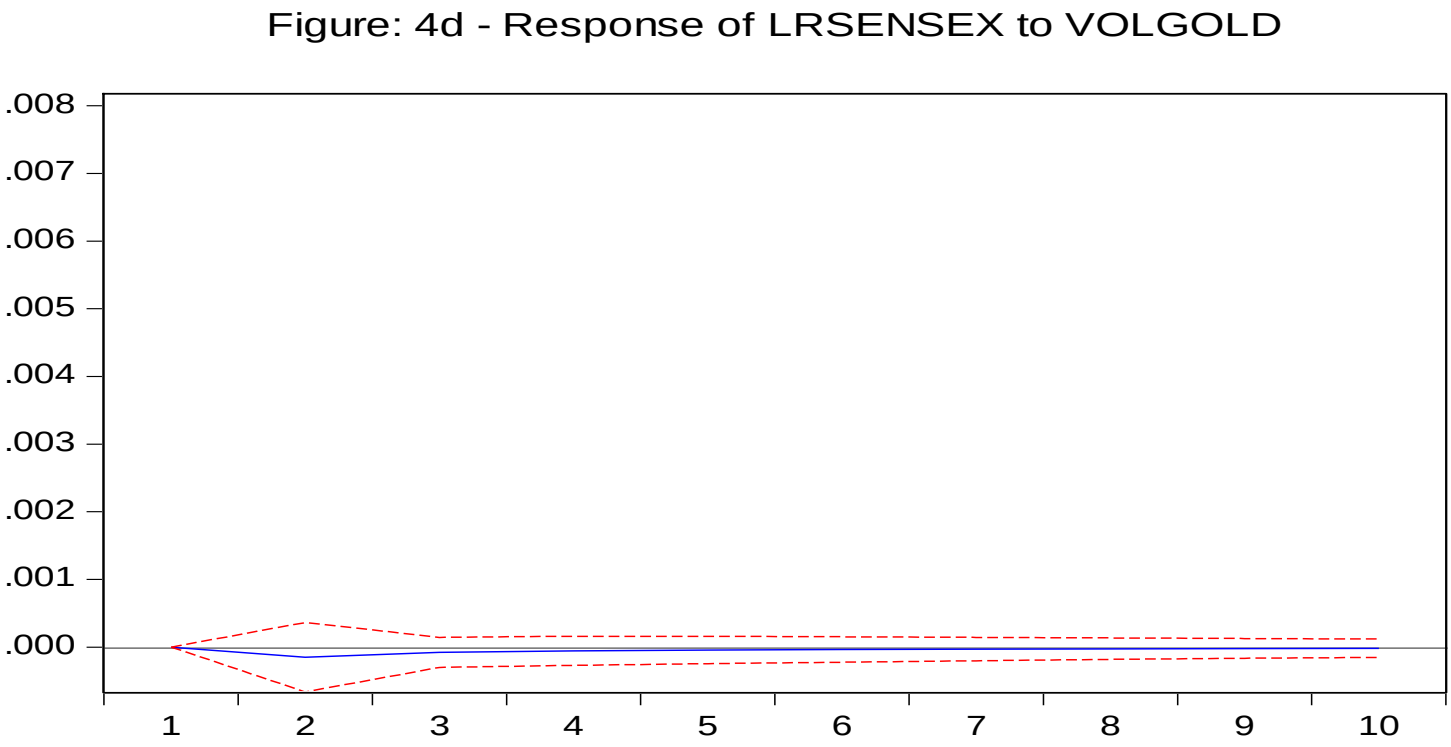
Source: Author's Calculation

Here, a one Standard Deviation shock (innovation) is given to the Price Volatility of crude oil which causes an almost immediate albeit, slow and small negative response from the SENSEX returns in the first period, such that the impulse enters the negative region. This slow decrease in the SENSEX returns impulse continues till the middle of the 2nd period, where it reaches its peak. After reaching its peak in the middle of the 2nd period the negative impact starts to decrease (tend towards the 0 line). This continues until it reaches the 3rd period. After reaching the 3rd period, the impulse response of the SENSEX returns enters the positive region and enters its Steady State Value. It continues along its Steady State Value in the positive region until the end of the IRF. This shows that shocks to Price Volatility of crude oil cause a slight negative impact on the SENSEX returns in the short run but causes a slight positive impact in the long run.

This effect is also seen in the value of the coefficient of the lags of crude oil in the VAR regression output (Refer Table: 3a). The increase in level of future oil prices uncertainty leads to downward movement on stock markets. Negative shocks seem to have greater effects on the current volatility of stock returns than the positive shocks. Generally, the volatility driven by abnormal information positively affects the volatility of return while the jump behavior has negative impact on return (Thanh Nam Vu, 2019).

Impulse response of SENSEX returns to Price Volatility of Gold:

Figure: 4d – IRF of SENSEX returns to price volatility of gold (pre-covid)



Source: Author's Calculation

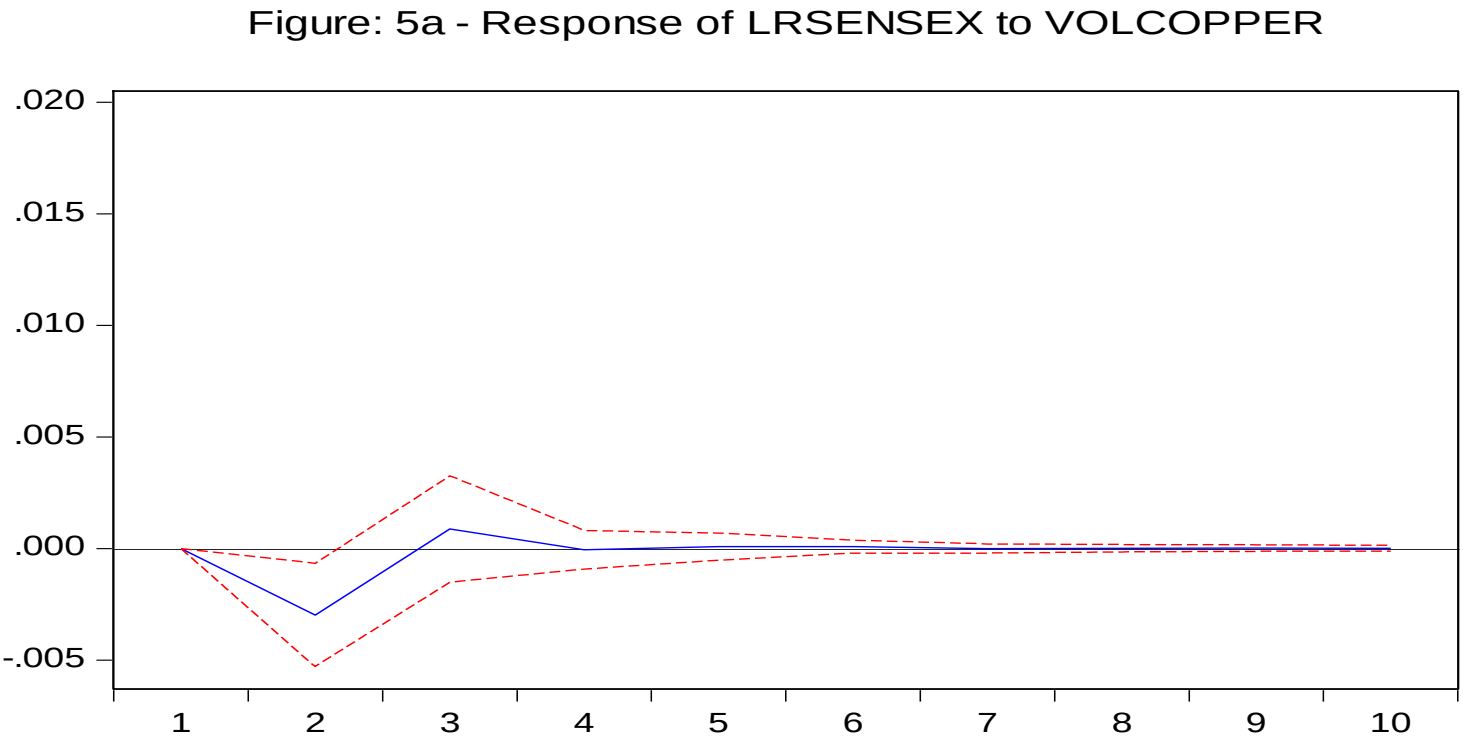
Here, a one Standard Deviation shock (innovation) is given to the Price Volatility of Gold, which causes an immediate negative response from the SENSEX returns in the 1st period. The response of the SENSEX returns decreases gradually in the negative region until it reaches mid-way through the 2nd period. From here there is a gradual positive impact as the response of the SENSEX returns tends towards the "0" line. It keeps increasing towards the zero line until it reaches the 4th period, where it enters its Steady State Value. From here it continues on its Steady State Value until it reaches the 7th period, when it increases to touch the zero line. The response of the SENSEX return then continues on the zero line until it reaches the 10th and last period. This shows that the Price Volatility of gold has a negative impact on the SENSEX returns in the short run but has a neutral impact in the long run.

The value of the coefficients of the lagged Price Volatility of gold shows a negative relation at first and then show a neutral relation in the long run. This maybe caused to the existence of a long run equilibrium between gold prices and stock returns in addition to their causal relationship. (Mishra, Das & Mishra, 2010)

Covid period:

Impulse response of SENSEX returns to Price Volatility of Copper:

Figure: 5a – IRF of SENSEX returns to price volatility of copper (covid)



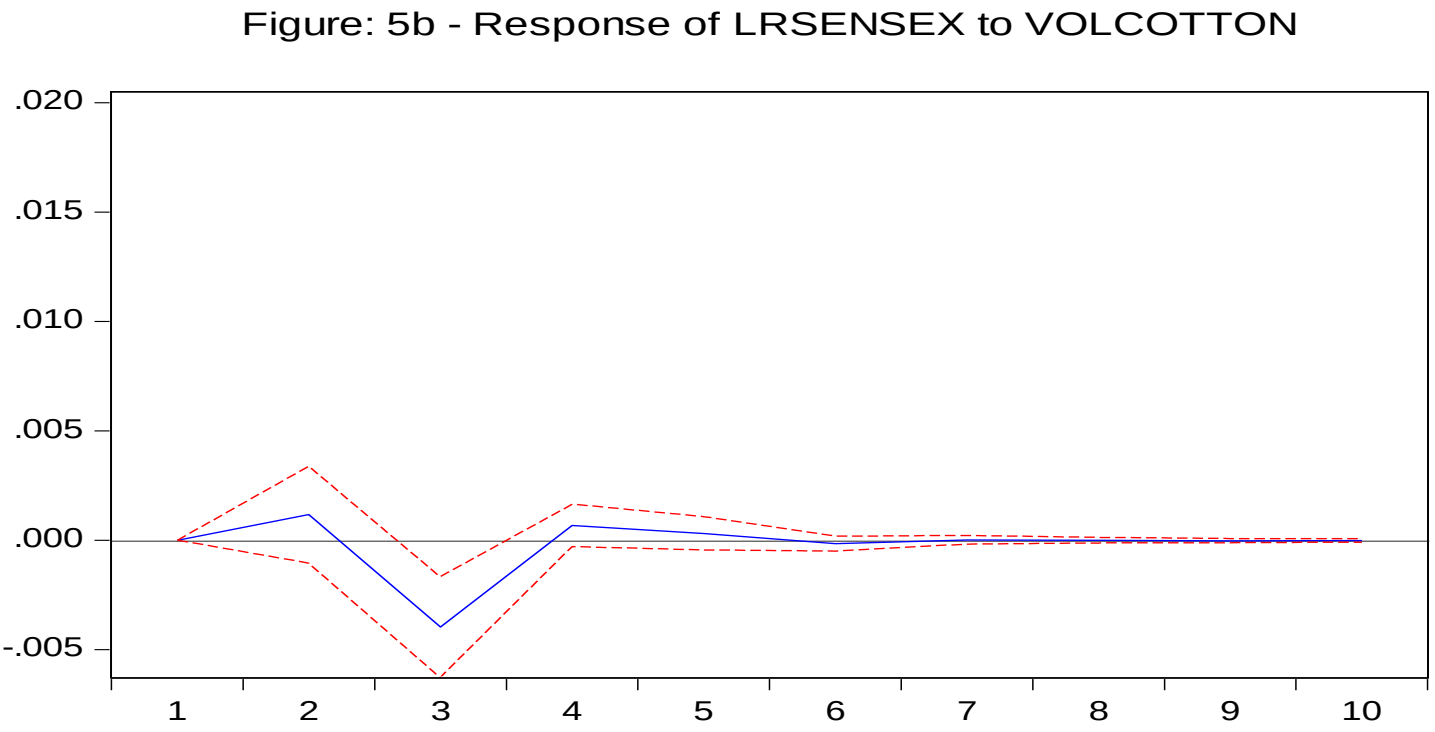
Source: Author's Calculation

Here, a one Standard Deviation of shock (innovation) is given to the Price Volatility of Copper which causes an immediate negative impulse response from SENSEX returns in the 1st period. The response of the SENSEX returns keeps decreasing in the negative region until it reaches mid-way through the 2nd period. From here there is a positive impact on the SENSEX returns such that its impulse response rises towards the zero line. The impulse response of the SENSEX returns reaches the zero line at the 3rd period, from here it keeps increasing as it goes into the positive region where it reaches its peak in the 3rd period itself. From here on in the SENSEX returns decreases and touches the zero line at the 4th period. From here the SENSEX returns fluctuates minutely between the negative region and the positive region in the 4th and 5th periods respectively before entering its Steady State Value on the zero line at the beginning of the 7th period. It continues along this line until the end of the IRF. This shows that a shock in the price volatility of copper causes a negative impact on the SENSEX returns in the immediate short run followed by a recovery into the positive region and finally exhibits a net neutral impact in the long run.

With the pandemic having a negative effect on the volatility of copper prices, the no relatively stable copper when shocked can cause heavy unpredictability over the short run, but the affects of which settle to a stable point in the long run.

Impulse response of SENSEX returns to Price Volatility of Cotton:

Figure: 5b – IRF of SENSEX returns to price volatility of cotton (covid)



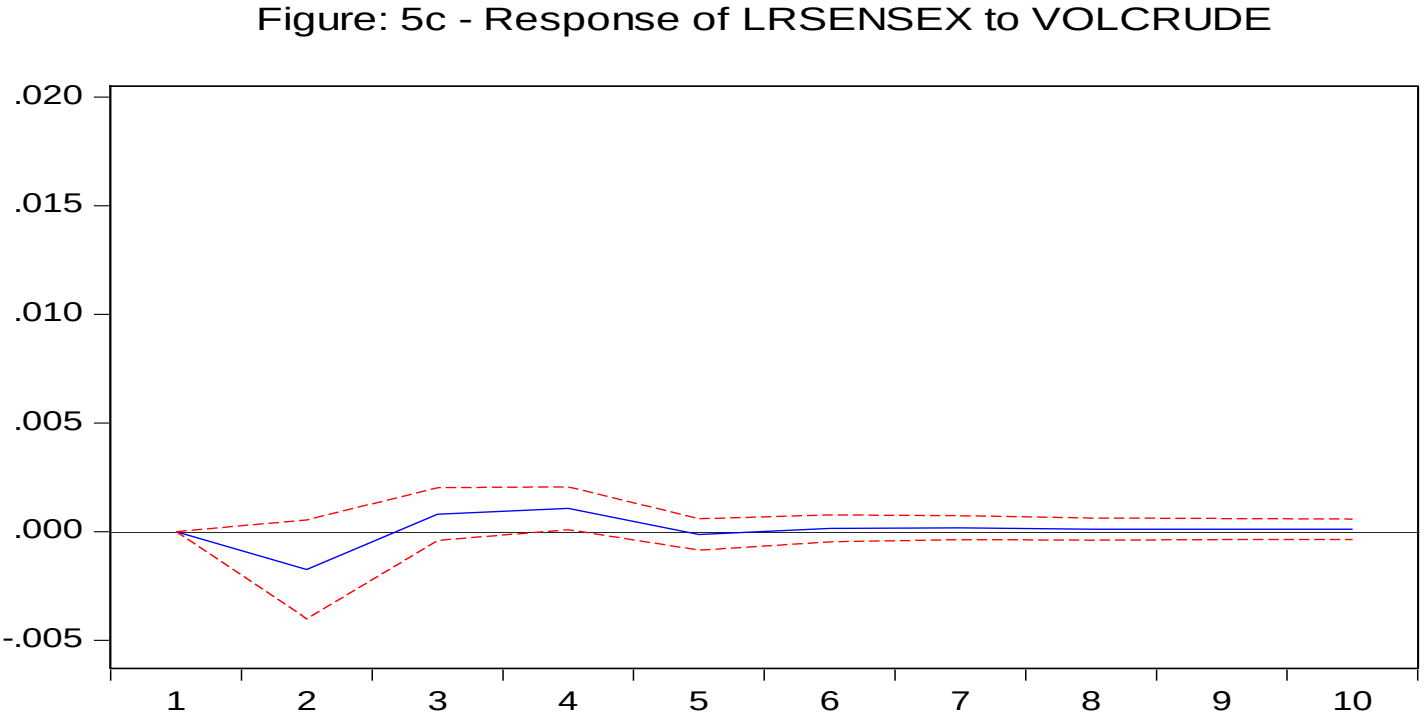
Source: Author's Calculation

Here, a one Standard Deviation of shock (innovation) is given to the Price Volatility of cotton which causes an immediate positive impact in the SENSEX returns in the 1st period. This upward positive impact continues until mid-way through the 2nd period, when the SENSEX returns reach its positive peak, from here there is a negative impact that gradually drives the SENSEX returns into the negative region by the end of the 2nd period. This negative impact continues until the SENSEX returns reaches its negative peak level in the middle of the 3rd period, from where there is a positive impact on the SENSEX returns once again such that it enters the positive region again at the 4th period. Shortly after the SENSEX returns begin to decline once again and reach the zero line and settle at its Steady State Value at the 6th period. From here the SENSEX returns continues along its Steady State Value until the end of the IRF. This shows that a shock in the Price Volatility of cotton causes an immediate positive impact in the near future followed by a negative impact which is closely followed by another positive impact in the short to medium run, and exhibits a net neutral impact in the long run.

Shocks to the price volatility of cotton have seemingly quite drastic short to medium term effects. This is because the cotton markets have a typically low elasticity of demand and are fairly predictable and their returns hinge on said predictability (Joëts M, Mignon V and Razafindrabe T, 2015). During the pandemic, the agricultural sector remained relatively resilient compared to other sectors. Hence it would be reasonable to assume that any shocks in the cotton markets would be wholly unpredictable and would have quite drastic effects on the stock returns before it eventually resets itself to a normal level in the long run

Impulse response of SENSEX returns to Price Volatility of Crude:

Figure: 5c – IRF of SENSEX returns to price volatility of crude oil (covid)



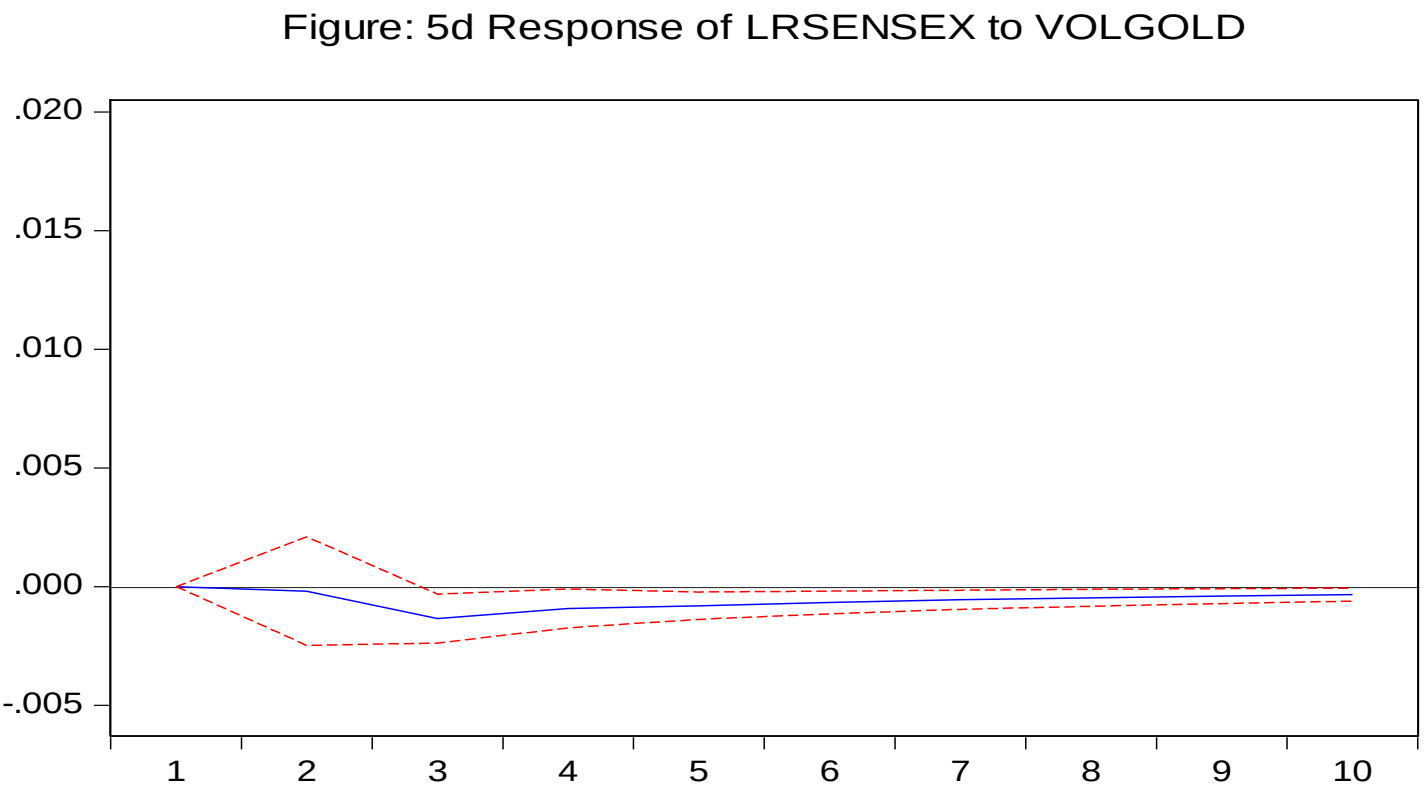
Source: Author's Calculation

Here, a one Standard Deviation shock (innovation) is given to the Price Volatility of crude oil which causes an immediate negative impact on the SENSEX returns during period 1. These negative impacts cause the SENSEX returns to decrease further into the negative region until it reaches its negative peak at the 2nd period, from here the SENSEX returns experience a positive impact such that they rise towards the positive region. Upon entering the 3rd period, they enter the positive region and reach a plateau point at which point they continue on that line till the end of the 4th period. At this point the SENSEX returns experience another negative impact when they begin to decrease again till they reach the zero line at the 5th period. Here the SENSEX returns experience a small positive impact and rise just above the base line and enter their Stable State Values, on which they continue till the end of the IRF. This shows that a shock in the Price Volatility of crude oil causes an immediate negative impact in the short run but a small positive impact in the long run.

During the Covid period, the volatility of crude oil has been more or less stable except for the period of high volatility during the initial lockdowns. The lack of volatility could be attributed to the leverage effects of the pandemic on the price volatility of crude oil (Meher, Hawaldar, Mohapatra & Sarea, 2020). An increase in price volatility of crude oil negatively impacts the stock returns (Aloui, Jammazi & Imen, 2008). From that we can infer that the low volatility provides a level of certainty and has a positive effect on stock returns.

Impulse response of SENSEX returns to Price Volatility of Gold:

Figure: 5d – IRF of SENSEX returns to price volatility of gold (covid)



Source: Author's Calculation

Here, a one Standard Deviation shock (innovation) is given to the Price Volatility of Gold which causes a delayed and slow negative impact on the SENSEX returns such that they decrease gradually till they reach their peak at the 3rd period. At this point they start to rise steadily towards the base line until the SENSEX returns response line gradually reaches the 8th period at which point it enters its Stable State Value, in which it continues till the end of the IRF. This shows that a shock in the Price Volatility of gold causes a delayed negative impact in the short run and in the long run as well.

Throughout the years, gold has been considered as a "safe-haven" good, and even during the pandemic has been the go-to for investors to hedge against market uncertainty (Thoss & Agnese, 2012). This high demand for gold throughout the globe has made the price volatility of gold quite high, although given the largely positive impacts of price volatility on gold prices, there is relatively low risk. Given the predictability of the price volatility of gold prices it is fair to say that there is limited uncertainty when it comes to gold prices. Hence any shocks to the price volatility of gold can only have a lasting negative impact on the returns of stock market as this introduces a degree of unpredictability in the prices of gold.

3.5.4 VAR Stability test:

The VAR model was checked for stability by ensuring that no roots lie outside the error circle.

The results of the AR Roots table and graphs of both the periods are given below:

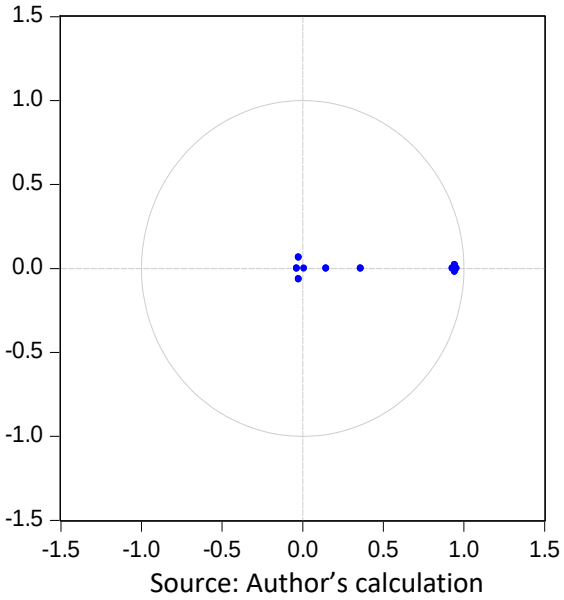
Table: 5a – AR Roots Table of both the periods

Pre-Covid period		Covid Period	
Root	**Modulus**	**Root**	**Modulus**
0.954175	0.954175	0.939107	0.939107
0.944447 - 0.020246i	0.944664	0.849410	0.849410
0.944447 + 0.020246i	0.944664	-0.200015 - 0.333027i	0.388475
0.930253	0.930253	-0.200015 + 0.333027i	0.388475
0.360021	0.360021	0.213597 - 0.250631i	0.329302
0.146267	0.146267	0.213597 + 0.250631i	0.329302
-0.023604 - 0.065081i	0.069229	-0.261163	0.261163
-0.023604 + 0.065081i	0.069229	-0.027044 - 0.258513i	0.259923
-0.036316	0.036316	-0.027044 + 0.258513i	0.259923
0.009484	0.009484	0.009415	0.009415

Source: Author's Calculation

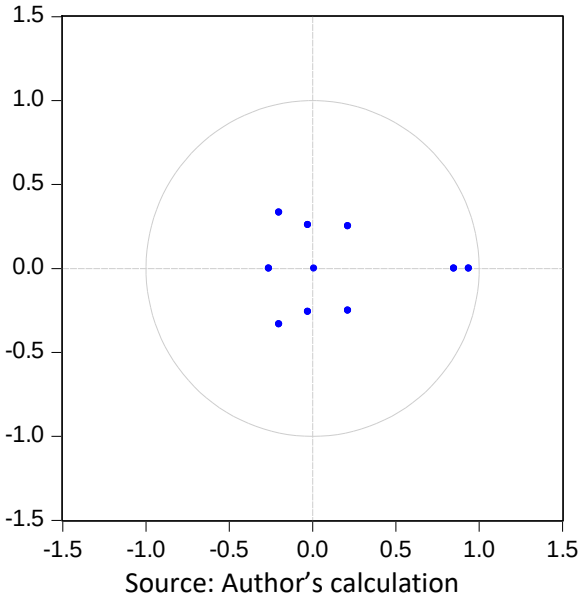
Figure: 6a – VAR Stability graph (Pre-covid) **Figure: 6b – VAR Stability graph (Covid)**

Figure: 6a - Inverse Roots of AR Characteristic Polynomial (Pre-Covid period)



Source: Author's calculation

Figure: 6b - Inverse Roots of AR Characteristic Polynomial (Covid period)



Source: Author's calculation

From Table:5a, Figure: 6a, and Figure: 6b, it is proven that the roots of the VAR model lie within the calculated circle and therefore, the VAR model is stable.

CHAPTER – 4

Conclusions

CHAPTER - 4

Conclusions:

To say that the Covid pandemic has been devastating and catastrophic would be an understatement. The full picture of the impacts of the Covid pandemic is just beginning to come into frame. Understanding the impacts and effects of this intangible force on the economy is of utmost importance as it may help us to mitigate disasters or even seize on new opportunities. The effect of the pandemic on the stock markets and commodity markets has been nothing short of tremendous. There doesn't seem to be anyone formula that fits the approach to tackle the effects of the pandemic on the stock and commodity markets of India. It has caused a combination of positive and negative impacts across all sectors of the economy. Here we have seen the drastic changes in the price volatility of commodities and how these price volatilities respond over time to various policy and economic changes. We have found that there is a significant positive impact of the covid pandemic on the price volatility of all commodities. We have also found that before the pandemic, gold and crude oil are the major drivers of stock returns among the commodities. This however changes after the onset of the pandemic as crude oil has a very diminished effect on the stock market returns, whereas gold transforms into one of the main drivers of stock returns.

Through the Impulse Response Function approach, we were able to map out the response of the stock returns of SENSEX to shocks in the price volatilities of the commodities both before and after the onset of the pandemic. We have found that before the pandemic, the SENSEX returns were quite resilient to shocks in the price volatilities of the commodities, showing very small short-run impact and even smaller long-run impact. This however changes after the onset of the pandemic. In the cases of shocks in the price volatilities of copper, cotton, and crude oil there is a significant impact on the SENSEX returns in the short to medium run although they more or less stabilized in the long run with a slight lasting effect in some cases. However, shocks in the price volatility of gold are shown to cause significant short-term and long-term impacts on the SENSEX returns, this may be because gold markets are very averse to unpredictability. And given the huge demand for gold currently and its current use as a hedge against market uncertainty, it is understandable that such shocks would have a significant negative impact on the SENSEX returns. This increased volatility of commodities after the onset of the COVID pandemic could provide investors with unique opportunities and alternatives to usual investment routes.

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