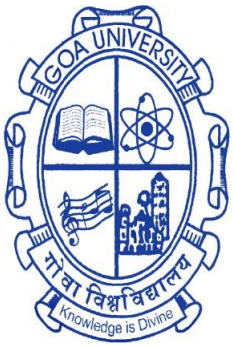
THE IMPACT OF CRUDE OIL PRICES ON ECONOMIES OF BRICS COUNTRIES- AN EMPIRICAL STUDY

A Thesis submitted in partial fulfillment for the Degree of

DOCTOR OF PHILOSOPHY

In the Goa Business School

Goa University



By

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DECLARATION

I, Shripad Ramchandra Marathe hereby declare that this thesis represents work which has been carried out by me and that it has not been submitted, either in part or full, to any other University or Institution for the award of any research degree.

Place: Taleigao Plateau.
Date : 14-11-2022 Shripad Ramchandra Marathe

CERTIFICATE

I hereby certify that the work was carried out under my supervision and may be placed for evaluation.

Prof. Guntur Anjana Raju
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Dedicated to

My Parents

Shri. Ramchandra Shripad Marathe

Smt. Manisha Ramchandra Marathe

&

My Guide

Prof. Guntur Anjana Raju

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List of Abbreviations

NSE	National Stock Exchange
CMIE	Centre for Monitoring Indian Economy
GOLD	Gold Prices
SILVER	Silver Prices
FER	Foreign Exchange Reserves
INFL	Inflation Rate
IR	Interest Rate
BRENT	Crude Oil Prices
M3	Broad Money
M1	Narrow Money
REER	Real Effective Exchange Rate
GDP	Gross Domestic Product
CA	Current Account
FDI	Foreign Direct Investment
FPI	Foreign Portfolio Investment
IM	Imports of Goods and Services
EX	Exports of Goods and Services
BSE	Bombay Stock Exchange
ARDL	Autoregressive Distributed Lag
US	United States
VAR	Vector Autoregression
BRICS	Brazil, Russia, India, China, and South Africa
CAPM	Capital Asset Pricing Model
NYSE	New York Stock Exchange
ADF	Augmented Dickey Fuller
FRED	Federal Reserve Economic Data
RBI	Reserve Bank of India
VOLATILITY	Market Volatility
IP	Industrial Production
FER	Foreign Exchange Reserve
CPI	Consumer Price Index
IR	Interest rate
OECD	The Organisation for Economic Co-operation and Development database

CHAPTER I

An Overview of the BRICS and Crude Oil Market

1.1 Introduction to BRICS and Crude Oil Market

The development of any country is depending upon the economic developments and the flow of income. And it is very important that country with the abundant resources must share the resources with developing countries. So that the developing countries will get the resources for the expansion of their economies in terms of technology and financial growth. As early as 2001, Jim O'Neill understood that it was time to concentrate on new nations. Brazil, Russia, China, and India were considered to be the four largest fast developing emerging economies. As a result, he created the acronym BRIC, which stands for a transfer of power from developed to emerging economies. In 2010, South Africa became the group's fifth and final member. The BRICS comprises both the most populous and the least densely populated countries, with a range of demographics, particularly in terms of population ageing, life expectancy, and the proportion of dependents. BRICS financial growth also varies considerably, with the percentage of adults with bank accounts used as a measure of financial inclusion with lot in common, including broadly similar stages of development, the aim of increasing sustainable growth, a focus on inclusivity and digitalisation, and investments in climate resilience. Because of these qualities BRICS have united in order to support the growth and prosperity of human communities around the world and thereby the common good for all.

In 2010, the year after the crisis their annual growth rate was approximately 8.2 percent compared to the sluggish 2.7 percent of industrialized nations. This is consistent with predictions that a rise in the capital, automobile, and energy markets will allow the BRICS to surpass the major industrialised nations.

The oil industry and the crude oil market in particular seem to be among those most significant. Crude oil accounts for 34% of world primary energy consumption and will likely remain the same for decades to come. BRICS countries are major petroleum consumers and have exceeded America's oil consumption since 2011 (IEA, 2019). A country's standing is justified by their considerable presence in the crude oil market. The crude oil price development was significantly linked to the financial collapse according to Hamilton (2009). Therefore, knowing the consequences of variations in the price of oil can lead to sustainable growth in the future. The main contribution of this study is to analyze the expanding theory of O'Neill by examining the market of crude oil for Brazil, Russia, India, China and South Africa. Moreover, the quantitative analysis of the effects of the change in oil prices on the financial market of each country completes the assumptions.

Brazil, Russia, India, China, and South Africa (BRICS) have grown rapidly and are becoming more integrated with the developed economies, particularly in terms of trade and investment. Furthermore, by 2030, these economies are expected to consume a significant portion of the world's oil and account for more than 45 percent of global stock market capitalization (the year when China is expected to overtake the United States). The BRICS stock markets appear to be a promising area for diversifying international portfolios.

The Table 1.1 describes the world growth rates from the year 2000 to 2020 it can be understood that the total world growth rates has declined from the 2006 to 2010 and got recovered from 3.6% to 4.7% in the year 2020.Similarly it can also be observed that the growth rate of developing countries are more then the word growth rate and OPEC countries which is increase from 4.4% to 6% in 2019.furthermore the OPEC countries depicts the growth rate is been constantly same over the year from 2010 to 2019. In 2020 the growth rates of all the regions and group of countries fall because of global pandemic.

Table 1.1: World Economic GDP Growth rates 2000–2020 (*% change over previous period)*

	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20
OECD	3.7	0.7	1.8	2.2	3.3	2.8	3.1	2.7	0.9	-3.4	2.8	1.7	1.3	1.3	1.8	2.0	1.7	2.5	2.3	2.8	-3.4
Other Europe	3.8	4.3	4.2	4.0	6.2	4.6	6.5	6.5	5.8	-5.5	-0.3	1.7	-0.3	1.4	1.5	2.9	3.7	4.8	3.8	-0.3	-5.5
Developing Countries	4.3	2.6	2.7	4.4	6.1	5.8	6.5	6.6	5.1	1.5	6.0	4.4	3.9	3.6	3.7	3.1	3.2	4.0	3.9	6.0	1.5
Africa	3.4	3.6	2.8	3.5	5.0	4.9	5.6	5.9	5.4	2.0	4.4	1.5	5.0	3.5	3.3	3.0	2.3	4.2	3.4	4.4	2.0
Latin America & Caribbean	3.4	1.2	-0.4	1.8	5.9	4.7	5.6	6.0	4.9	-0.8	5.4	4.0	2.6	3.1	0.7	-0.8	-1.4	1.1	0.6	5.4	-0.8
Asia &Oceania	4.8	3.0	4.0	5.7	6.5	6.5	7.1	7.0	5.1	2.3	6.7	5.3	4.1	3.9	4.9	4.4	4.8	4.7	4.9	6.7	2.3
Asia Pacific	5.8	1.5	3.9	4.4	6.1	5.1	5.5	6.0	3.6	-1.0	7.7	4.4	4.2	4.2	3.9	3.6	4.0	4.7	4.5	7.7	-1.0
OPEC	4.4	3.1	1.7	3.1	7.0	5.7	5.7	6.0	5.9	1.1	3.5	3.2	5.3	2.7	2.6	2.3	1.4	2.4	1.1	3.5	1.1
FSU	8.0	6.2	5.0	7.8	8.2	9.9	10.7	11.4	9.0	8.7	10.3	9.2	7.8	7.7	7.4	6.9	6.7	6.9	6.6	10.3	8.7
Total World	4.6	2.3	2.9	3.8	5.0	4.7	5.4	5.4	3.1	-0.9	4.7	3.6	3.0	2.9	3.3	2.9	3.0	3.8	3.6	4.7	-0.9

Source: compiled from OPEC Report 2000-2021

Table 1.2: Comparison: OPEC and non-OPEC Developing Countries

Table 1.2(a) OPEC (2004-2020)

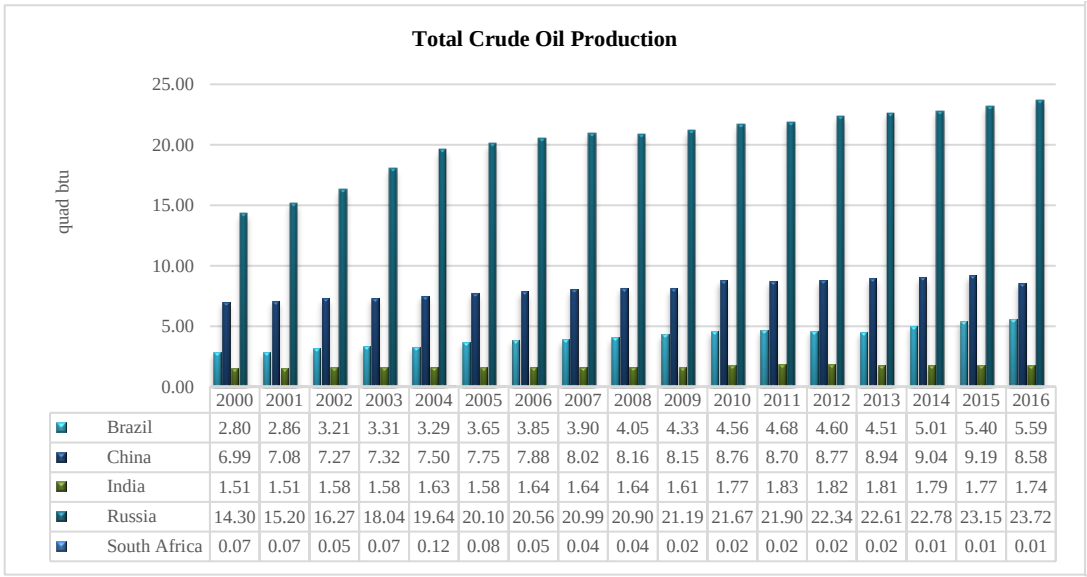
Year	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20
Real GDP Growth (Per Cent)	7	5.9	5.7	6	5.9	1.10	3.5	3.2	5.4	2.2	2.9	1.3	2.4	2.4	3.5	2.8	-3.7
Petroleum Export Value ($bn)	349	179	674.6	729.6	980	588.03	709	1038.9	1261.2	1112.1	956.2	515.6	443.1	579	1861	1614	939
Value of Non-petroleum exports ($bn)	145.4	1601	204.3	272.7	331.4	162.43	190.6	289.2	427	469.4	648.4	477.6	484.8	445	17115	16892	15437
Oil exports as percentage of total exports	70.6	10.1	76.8	72.8	74.7	78.36	78.8	78.2	74.7	70.3	59.6	51.9	47.7	56.5	9.8	8.7	5.7
Value of Imports ($bn)	289.3	1829	460.3	531.9	730.9	534.01	602.3	724	807	880	1062.7	830.4	804.9	803.2	19165	18629	16434
Current account balance ($bn)	136.4	70.4	258.1	329.5	402.8	63.50	186.9	398.9	503.2	417.7	238.1	-82.2	-102.5	59.6	364.2	402	202
Crude Oil production (b/d)	29.1	11.2	30.9	31	31.9	28.72	29.2	29.8	31.1	30.2	30.8	31.5	32.6	32.4	75.91	75.16	69.08
Reserves ($bn, excluding Gold)	231	1118	402.8	530.8	646.5	590.53	990.3	1148.3	1308	1446	1508.6	1216.4	1091.4	1040	11796	12199	13120

Source: compiled from OPEC Report 2004-2021

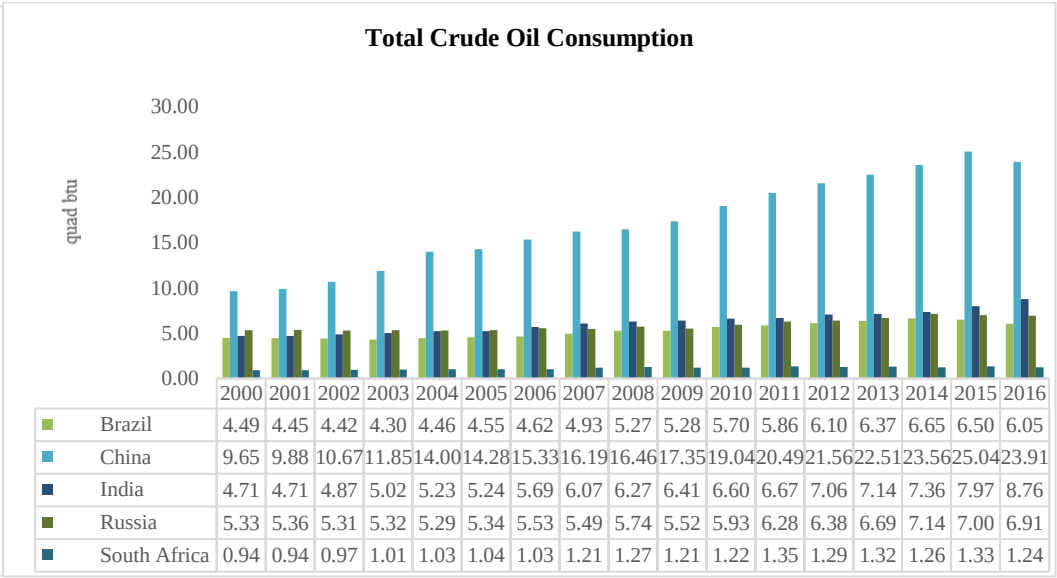
Table 1.2(b) Non-OPEC 2003-2020)

	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20
Real GDP Growth (Per Cent)	4.7	5.9	5.9	6.6	6.7	5	1.53	6	4.4	4.1	2.2	3.8	3.2	3.5	4	2.4	3.5	2.8
Petroleum Export Value ($bn)	99.3	135.8	179.8	215.5	222.4	295	192	265.3	215.7	1261	1112.1	380.9	250.1	189	244	579	1861.8	1614
Value of Non-petroleum exports ($bn)	1150	1385	1601.3	1867.2	2117	2346	2170	2681.2	3074.4	427	469.4	3011.2	2895.3	2890	3242	445	17115	16892
Oil exports as percentage of total exports	7.9	8.9	10.1	10.3	9.5	11	8.15	9	7.6	74	70.3	11.2	8	6.1	5.5	56	9.8	8.7
Value of Imports ($bn)	1275	1562	1829.2	2126.4	2430.1	2949	2506	3142.6	3565.4	807	880	3829.2	3526.7	3396	3790	803	19165	18629
Current account balance ($bn)	101	86.4	70.4	100.2	109.6	-81	58	-2.1	-66.4	503	417.7	-116.8	-78.8	-3.7	-49	59	364.2	402
Crude Oil production (b/d)	10.2	10.7	11.2	10	9.3	9	10	10.5	10.5	31	30.2	9.4	10.1	9.8	9	32.4	75.91	75.16
Reserves ($bn, excluding gold)	890	1042	1118.1	1322.7	1672.5	1789	2170	2457.3	2634.8	1308	1446	2716.3	2831	2935	3142	1040	11796	12199

Source: compiled from OPEC Report 2000-2021



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Brazil	2.80	2.86	3.21	3.31	3.29	3.65	3.85	3.90	4.05	4.33	4.56	4.68	4.60	4.51	5.01	5.40	5.59
China	6.99	7.08	7.27	7.32	7.50	7.75	7.88	8.02	8.16	8.15	8.76	8.70	8.77	8.94	9.04	9.19	8.58
India	1.51	1.51	1.58	1.58	1.63	1.58	1.64	1.64	1.64	1.61	1.77	1.83	1.82	1.81	1.79	1.77	1.74
Russia	14.30	15.20	16.27	18.04	19.64	20.10	20.56	20.99	20.90	21.19	21.67	21.90	22.34	22.61	22.78	23.15	23.72
South Africa	0.07	0.07	0.05	0.07	0.12	0.08	0.05	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Brazil	4.49	4.45	4.42	4.30	4.46	4.55	4.62	4.93	5.27	5.28	5.70	5.86	6.10	6.37	6.65	6.50	6.05
China	9.65	9.88	10.67	11.85	14.00	14.28	15.33	16.19	16.46	17.35	19.04	20.49	21.56	22.51	23.56	25.04	23.91
India	4.71	4.71	4.87	5.02	5.23	5.24	5.69	6.07	6.27	6.41	6.60	6.67	7.06	7.14	7.36	7.97	8.76
Russia	5.33	5.36	5.31	5.32	5.29	5.34	5.53	5.49	5.74	5.52	5.93	6.28	6.38	6.69	7.14	7.00	6.91
South Africa	0.94	0.94	0.97	1.01	1.03	1.04	1.03	1.21	1.27	1.21	1.22	1.35	1.29	1.32	1.26	1.33	1.24

Source: Compiled from EIA report 2019

Figure 1.1 Crude oil Consumption and Production in BRICS countries (2000-2016)

Table 1.2 (a) and Table 1.2 (b) explains the comparison between OPEC and Non-OPEC developing countries from 1999 to 2020. The parameters for comparisons are Real GDP Growth (Per Cent), Petroleum Export Value ($bn),Value of Non-petroleum exports ($bn), Oil exports as percentage of total exports, Value of Imports ($bn), Current account balance ($bn), Crude Oil production (b/d), Reserves ($bn, excluding Gold).It can be noticed that OPEC Real GDP growth is 3.38% and Non OPEC 4.25% which is highest compare to OPEC countries. Additionally, Petroleum Export Value ($bn) of Non-OPEC is 709 ($bn) on an average and OPEC is 436 ($bn) which is lessor then Non-OPEC countries. As per Value of Non-petroleum exports ($bn) for Non-OPEC 2549 ($bn) on an average compare to OPEC which is 3171 ($bn).

Similarly, Oil exports as percentage of total exports of Non-OPEC is 16.30% on an average compare to 57.55% of OPEC. On average, the value of non-OPEC imports ($bn) is substantially larger (i.e., 3666.540 $bn) than the average for OPEC ($3001.569 $bn). Additionally, OPEC's current account balance ($bn), which is 190.56 $bn, is greater than the average for non-OPEC nations, which is 88.268 $bn. In terms of daily crude oil output, OPEC has a 34.75 (b/d) edge over non-OPEC countries. Lastly, non-OPEC countries own 2596.032 reserves ($bn, excluding gold) as opposed to OPEC Nations.

As per the (EIA, 2019) and Figure 1.1 elaborates Russia, China and Brazil are in the top ten largest Oil producers in the world. Where Russia produces 11.49 mb/d or 23.72 quad; which is equivalent to 11 percent of world share. Similarly, China and Brazil produce 4.89 mb/d (8.58 quad) and 3.67mb/d (5.59 quad) respectively which contributes 9 percent of total world share in production of Crude Oil. Additionally; on the consumption side China, India, Russia and Brazil are the biggest consumers of the Crude Oil. Collectively, 25 percent of the total Crude Oil is consumed by the above countries.

Given the importance of Crude Oil in the economy, the changes in the price of Crude Oil would therefore have a major effect on economy and in specific macroeconomic variables as well as stock market. Investors and policymakers in the BRICS would like, in order to gain diversification advantages and reduce risks,

to understand how to compare Crude Oil with the BRICS macroeconomic variables.

1.2 Classification of Crude Oil

The fundamental classification of crude oil is based on the quality of the crude oil and the place of its production. If quality is a factor, crude oil that yields a high number of value products and can be processed in a greater number of refineries throughout the world will have an advantage over crude oil that yields a low number of valuable products and can only be processed by a limited number of refineries. Quality and location are the primary factors used to classify crude oil.

If the production location element is taken into account, oil produced close to the market is cheaper since transportation costs are minimal; however, markets further away from the site will be unappealing and hence will command a high transportation cost. According to OPEC report 2020, the price differentials of crude oil are explained by two primary features of crude oil, namely API gravity and Sulphur content. Crude oil qualities may change in terms of hydrocarbon proportion and Sulphur concentration when extracted from various geographical areas throughout the world.

West Texas Intermediate and Brent crude oils are either traded directly or have their pricing reflected in other forms of crude oil. In general, the price difference between crude oils is due to quality. West Texas Intermediate (WTI) crude oil is of high grade and is ideal for refining. It has an API gravity of 39.6 degrees (light) and only 0.24 percent Sulphur (sweet). WTI crude oil is refined in the Midwest and Gulf Coast regions of the United States. It is commonly used as a benchmark for oil pricing. The price of Brent crude, which is sourced from the North Sea, is used as a global benchmark for oil purchases. This substance has an API gravity of around 38.06. Brent is slightly heavier than West Texas Intermediate (WTI), which has a Sulphur content of 0.37 percent. Actually, Brent is suitable for the manufacture of gasoline.

Table 1.3 Brief History of Crude Oil Market

Crude oil has been considered as a major commodity and this commodity has gone through from some phases which has been mentioned below.

Year	Event
1850 To 1865	**Black Gold Rush** • The Industrial Revolution began in Europe and America after the Watt steam engine was developed in the late 18th century. • In 1861, the United States sells its first refined oil to London.
1880 To 1900	**Competition for Oil** • In 1880, the US produced 85% of global crude oil. The US dominance in Europe and Asia is hotly debated. • California, Oklahoma, and Texas large oil discoveries increased US oil production to 64 million barrels per year. • By 1900, over 200 oil by-products were used, including industrial lubricants. • A Texas oil boom nearly tripled US output in 1901.
1908	**The Model T** • Henry Ford's Model T, the world's first inexpensive mass-produced car, helped increase auto ownership significantly. • Petrol (gasoline) consumption surpasses kerosene in 1910
1911	• By the 1880s, Standard Oil controlled 90% of US oil refineries, pipelines, and tankers. • In 1906, the company was sued for breaking the Sherman Antitrust Act. • In May 1911, the US Supreme Court rules for the government. • Standard Oil splits into Chevron, Amoco, Mobil, Conoco, and Exxon. For the next six decades, these companies dominated the global oil market.
1914 To 1918	**World War I** • Beginning in World War I, oil is used to power ships, land vehicles, and planes. The attacks on Germany disrupt US oil exports to Britain and France, causing shortages.

	• In 1917, the Wilson administration intensifies efforts to supply oil to Britain and France. • Because domestic and war demand exceeds domestic supply, the US imports oil from Mexico to fill the gap.
1920	**Addressing Oil Insecurity** • The United States geological survey estimated in 1919 that US oil supplies would run out in ten years, causing the first oil security concerns. • Though the United States produces roughly one million barrels of oil per day, or 65 percent of global oil supplies, more than 90 percent is consumed domestically.
1928	**The Red Line Agreement** The 1928 Red Line agreement, with its self-denial clause, allows seven companies, five of which are American, to control most of the Middle East's oil production until the early 1930s.
1928 To 1933	**Oil Quotas** In 1931, the price of a barrel of oil was just a few cents. The US government-imposed tariffs on imported oil in 1933 to limit the supply of cheap oil on the market.
1932 To 1939	**Nationalization** • European governments impose import limits, regulate prices, require the use of ethanol blends, and invest in domestic oil infrastructure. • Mexico nationalises the oil business in 1938 and terminates US oil concessions.
1941	**Oil Embargo on Japan** • The United States places restrictions on oil exports to Japan, effectively cutting off oil supplies to Japan in the summer of 1941.
1942 To 1945	**Gas Rationing and Budding U.S.-Saudi Relations** • When the US enters the war, it implements a nationwide rationing plan that includes petrol coupons and a 35-mph speed limit.

	• In 1938, Saudi Arabia possessed a lot of oil. For his part, President Franklin Roosevelt backed Saudi oil in 1943. Saudi Arabia became the world's largest oil exporter after discovering the world's largest oil field
1948	**The Marshall Plan** The European Recovery Program, also known as the Marshall Plan, began in 1944. Over the course of the forty-five-month program, the U.S. supplies more than $11 billion in oil aid. The continent begins to become more dependent on oil for its energy needs as Europeans turn from coal.
1954	**U.S.-Iran Oil Consortium** In 1954, a consortium of mainly U.S. companies takes over management of Iran's oil sector. To avoid antitrust concerns, U. S. oil majors relinquish a small portion of their share to allow independent producers to buy in.
1959	**Cap on U.S. Oil Imports** In 1959, U.S. President Dwight Eisenhower imposes a quota system on oil imports. The quota lasts for fourteen years and oil prices remain stable.
1960	**Creation of OPEC** In August 1960, Western oil majors slash prices without consulting exporting countries. On September 14, the Organization of the Petroleum Exporting Nations (OPEC) is formed.
1973	**End of U.S. Import Quota** President Richard Nixon announces the termination of the Mandatory Import Program in April 1973. Nixon imposed oil price controls two years prior to the import mandate. Oil imports, which accounted for around 30% of U.S. consumption in 1973, increased to nearly 50% in just four years.
1980	**Iran-Iraq War** • In 1980, Iran and Iraq declare war on each other, which lasts for eight years. Officially neutral, the United States re-establishes diplomatic ties with Iraq, which had been broken

	since 1967. • Attacks on oil installations in Iraq and Iran reduced world oil production by four million barrels per day.
1981 To 1986	**U.S. Diversifies Energy Consumption** • In 1981, the Reagan government completely deregulations crude prices, allowing American producers to boost prices to market levels. Non-OPEC production begins to outpace OPEC's, limiting the cartel's ability to control oil prices.
1990 to 1991	**Iraq's Invasion of Kuwait** • Iraq invades Kuwait on August 2, 1990, as a result of a border dispute over the Rumaila oil field. • President George H.W. Bush stated in a speech on August 8, 1990 that Iraq's aggression poses an economic threat to the United States, which now imports half of its oil.
1993 To 2005	**A Nation of SUVs** • The Clinton government announces a collaboration in 1993 to develop and construct low-cost, fuel-efficient vehicles. • Between 1993 and 2005, the country's oil consumption increased by 3.6 million barrels per day, reaching 20.8 million barrels per day. • The Energy Policy Act, passed by the United States Congress in 2005, offers new incentives for alternate transportation fuels and flex-fuel vehicles, as well as increased subsidies for domestic oil exploration.
2006 To 2008	**Skyrocketing Oil Prices** Oil prices began to rise steadily in 2006, at a time when US oil consumption and imports were at record highs, reaching a high of $147 a barrel in the summer of 2008
2011	**Libya Rocks Oil Markets** As of February 2011, Libya is the first major oil-producing nation to join a regional wave of populist upheavals that toppled Egypt and Tunisia. Libya produces around 2% of the world's oil. Global oil prices rose 10% in one day.

2014	**U.S. Oil Imports Hit Two-Decade Low** According to the US Energy Information Administration, crude oil and petroleum product imports have dropped to less than 260,000 barrels per day, the lowest level in in two decades
2016	**Paris Agreement** • The Paris Agreement, which has been signed by over 190 countries, including the United States, comes into effect. • The US has committed to reducing emissions by more than 25% from 2005 levels by 2025, a goal that will need a shift away from fossil fuels, including oil.
2020	**COVID-19 Pandemic** Oil prices have dropped to historic lows; in April, a major benchmark price for U.S. crude oil fell below zero for the first time in history.

***Source**: Authors compilation from the literature (1920-2021)*

1.3 Chapter Plan of the Thesis

Chapter 1: Overview of the BRICS and Crude Oil Market

This chapter will introduce the concept of Crude Oil. Along with this it will also offer a brief historical background about the Crude oil market in BRICS. Here, the current trends and growth of Crude Oil market will be presented.

Chapter 2: Review of Literature

This chapter summarizes the literature review and describes the methodology adopted in conducting the research. The chapter also lists out the literature reviewed during the research process and presents a summary of the literature reviewed.

Chapter 3: Research Design and Methodology

This chapter begins with a discussion on the problem of the study and brought out the research gap, significance of the study, the scope of the study, research questions, set of research objectives, and methodology used to perform this research. In particular under methodology detailed out the data sources, data

periods, sample variables and step-by-step approach on how the framework of various methods applied to carry out the analysis of research objectives.

Chapter 4: The Relationship Between Crude Oil and Macroeconomic Variables of BRICS Countries.

This chapter will deal with relationship between Crude Oil Prices and Macro-economic variables in BRICS countries using Quarterly data from 01st April 1999 to 31st March 2021 and a Correlation, Regression analysis, Unit root test, Cointegration, Vector auto regression, Vector error correction model, Granger Causality test has been deployed to study the relationship between Crude Oil and Macro-economic variables of BRICS countries.

Chapter 5: The Relationship Between Crude Oil Prices and Sectoral Stock Market Indices of BRICS Countries.

This chapter deals with the study the relationship between the sectoral indices of BRICS countries and the relationship with the crude oil. The data set consists of monthly observations 01st April 1999 to 31st March 2021. The present objectives use Monthly data of BRICS sectoral indices from the respective stock exchanges of Countries i.e. Brazil (Bovespa Stock Exchange), Russia (Moscow Stock Exchange), India (National Stock Exchange), China (Shanghai Stock Exchange), South Africa (Johannesburg Stock Exchange). The data has been collected from respective Stock Exchanges, Bloomberg, Yahoo finance and Investing website. To study the sector wise linkages with Crude oil, ten equity sector indices across five markets are selected which includes Chemical, Const. & Material, Oil & Gas, Manufacturing, Real Estate, Pharmaceuticals, Textiles, Industrial Mining, Financial, Fast-Moving Consumer Goods sector. To study the relationship we have used Correlation, Unit root test and Granger Causality test.

Chapter 6: The Volatility Transmission Between Crude Oil Prices and BRICS Stock Market Returns.

This chapter deals with the interlinkages and weak form of efficiency of BRICS countries. Daily stock indices of BRICS countries including Brazil Stock Exchange, Moscow Stock Exchange, National Stock Exchange, Shanghai Stock

Exchange and Johannesburg Stock Exchange and Brent Crude oil prices starting from 01st April 1999 to 31st March 2021. All the data has been extracted from Bloomberg data base. Data has been filtered and considered only those days where all the five stock markets were open for trading. This has reduced data set to 5267 observations and to study the volatility transmission used Unit root test, Lo and MacKinlay variance ratio, Impulse Response Function (IRF), Granger Causality Test, Johansen Cointegration Test, ARCH- GARCH MODEL has been used and then we have drawn the conclusion.

Chapter 7: The Structural Events Impact on Crude Oil Prices and Stock Market Indices of BRICS Countries

This chapter deals with the structural events and its impact on crude oil prices and stock market indices of BRICS countries. Data has been considered from 01st April 1999 to 31st March 2021. The data set of BRICS countries has been obtained from Bloomberg, Fred Reserve database and Yahoo Finance. Data has been filtered and considered only those days where all the five stock markets were open for trading. This has reduced our data set to 5267 observations. For the analysis Correlation, Unit root analysis, regression analysis and granger causality test has been used. Study tried to find out the effect of certain events before and after its happening and tried to draw a conclusion out of it.

Chapter 8: Findings, Conclusion and Suggestions.

Finally, based on the entire research objective analysis displayed in standalone Chapter 4, 5, 6 and 7, the major findings are drawn from each objective, its conclusions, possible implications and suggestions figure out in chapter eight. It also briefs up the limitations of the study and highlighted the scope for future research.

Chapter 2

Review of Literature

2.1 Introduction

Oil is the largest traded commodity internationally and change in prices of commodity largely impact economy of the country. The main drivers of crude oil prices are demand- supply, growth of the world economy, change in OPEC policy, geo political events, fluctuation in US dollar with these there are many other factors which are impacting the crude oil prices. Crude oil prices are the single most driving factor of any world economy and its fluctuations always effect significantly on that respective economy and its growth.

The links between the evolution of crude oil prices and stock markets are investigated in several papers. Studies have documented the effect of oil price fluctuations on economy and it has been seen that importing developed economies have direct effect of oil prices fluctuations.in India it has been seen that volatility in stock prices has significant impact on oil prices but the change in oil prices does not have effect on stock market ***(Chittedi, 2012), (Makhija & Raghukumari, 2015)*** but contradictory to that it has been seen that may countries has opposite view that oil prices has change the pattern of stock market ***(Gupta, 2016), (Kang, Ratti, & Vespignani, 2016), (Liu, Chen, & su, 2011), (Sek, Teo, & Wong, 2015), (Kang, Ratti, & Yoon, 2015) , (Kang, Ratti, & Yoon,2015), (Li, Cheng, & Yang, 2015), (Benada, 2014), (Jain, 2013)*** but in some studies ***(Akgul, Bildirici, & Ozdemir, 2015)*** it has been seen that crude oil prices effect differs in different regimes. In some of the articles stated Oil Prices are not affecting the stock prices but it is vice versa ***(Chittedi, 2012),*** but in contradictory to that it is seen in various studies that oil prices positively effects the stock returns ***(Caporale, Ali, & Spagnolo, 2015), (Kang, Ratti, & Vespignani, 2016).***

In the present research the literature from the year 1921 - 2021 has been studied and in total 404 research papers were referred for the study. In order to collect the research papers for the review, detailed search was carried out using the following available databases were used: Emerald Full Text, Elsevier, JSTOR, Springer, Taylor and Francis, Oxford University Press, SSRN, Google Scholars, ProQuest. After a detail search of various journals, those research papers have been selected which were directly associated with the concept of Crude Oil and also included those papers where keywords such as impact of crude oil on economies, Crude Oil prices Etc.

2.2 Review of Literature

2.2.1 Relationship between Crude Oil and Macroeconomic Variables of BRICS Countries

A large number of studies looked at the examining the relationship between Crude oil and Macroeconomic variables of BRICS countries.

One of the first studies to examine the subject of whether or not there is a relationship between the price of oil and other macroeconomic factors was conducted by Hamilton. His work was considered a pioneering effort in 1983. During the period of 1948-1981, James Hamilton researched the effect that oil price shocks played in the business cycles of the United States. He discovered that fluctuations in the price of oil had an effect on both GDP and unemployment rates in the United States economy. **(*Burdbidge and Harrison, 1984)*** showed that oil price shocks have a significant negative impact on industrial production by leveraging VAR models for Canada, Germany, Japan, the United Kingdom, and the United States. They found that oil price shocks had a significant negative impact on industrial production.

(Mark,1989), following Hamilton, he puts up a non-linear definition of oil prices and differentiated between positive and negative fluctuations in oil prices. He came to the conclusion that an increase in the price of oil led to a considerable and strong negative link with fluctuations in real GDP, whereas a decrease in the price of oil had no meaningful consequences.

Using the example of the economy of the United States, **(*Lee, Ni, and Raati, 1995)*** looked at the correlation between oil price shocks and real GDP growth from 1944 to 1992. Using the GARCH model, they came to the conclusion that positive oil price shocks are considerably adversely

connected with real GDP growth, whereas negative oil price shocks are not significantly negatively correlated with real GDP growth.

According to the findings of **(*Hamilton, 2005)*** an increase in the price of oil is considerably more significant than a decrease in the price of oil. Similarly, **(Rodriguez and Sanchez, 2010)** demonstrate that there is a greater effect on macroeconomic variables caused by an increase in the price of oil than there is caused by a fall in price for the Euro area. Many authors used the VAR model to conduct an empirical investigation into the effects that oil price shocks have on the real economic activities of the most important industrialized nations. They discovered that the influence of oil prices on real GDP is non-linear. In particular, they indicate that an increase in the price of oil has a greater influence on GDP growth than a decrease in the price of oil does. **(*L'oeillet and Licheron ,2008)*** in this study, they explored the relationship between rising oil prices and rising inflation in the euro area. They demonstrated that the inflationary effect of the current setting does not approach to the high level it had during the seventies by constructing a reverse Phillips curve using data from Europe between 1970 and 2007. It would appear that the principal reason for this is that nations that are part of the euro area have been moving toward a lower energy intensity. Another explanation has to do with the volatile character of the current oil market.

(Nusair & Kisswani, 2016) investigate the long-run link between Asian real exchange rates and prices in Asia. The findings reveal evidence of bidirectional causation between Malaysia and Thailand, as well as unidirectional causality between exchange rates and prices. Korea, the Philippines, and Singapore, unidirectional causality from pricing to the exchange rate Indonesia, and proof causality Japan are all examples of causation that may be found.

(Samavati and Dits, 2007) broke down the impact that fluctuating oil prices have on many aspects of GDP in the United States. In their analysis, they looked at the years 1986 to 2006 to establish how changes in oil prices affect a variety of economic factors, including consumption, government spending, investment, and net exports. According to them, the price of oil was positively correlated with three different types of spending: consumption, investment, and government expenditure. Similarly, **(*Francois and Mignon, 2008)*** conducted an analysis of short run and long run interaction and demonstrated the existence of a wide range of interactions between oil prices and

macroeconomic variables. They placed a particular emphasis on the linkages between oil prices and share prices in the short run for three groups of countries: OECD members, oil importing countries, and oil exporting countries. They found that these relationships exist for all three groups of countries.

2.2.2 Relationship between Crude Oil Prices and Sectorial Stock Market Indices of BRICS Countries

Many of the results from earlier studies suggest almost no connection with Oil prices ***(Chen, Roll, & Ross, 1986), (Hamao, 1989). (Ferson & Harvey, 1995)*** concluded that the price of Oil has a huge effect on the return on investment of 18 financial markets. ***(Huang et al. 1996)*** analyzed the relationship between Oil and equity in the U.S. context with the use of Vector Autoregression Technique (VAR) and concluded that the wide market index such as S&P500 has little impact. ***(Cong, Wei, Jiao, & Fan 2008)*** conducted a report on the Chinese equity market about Oil price shocks and found no major impact on real stock returns except for Oil-related industries. In the presence of Oil and exchange rate sensitivities for 15 countries in the Asia Pacific region between 1994-2004, ***(Nandha & Hammoudeh, 2007)*** check the relationship between market risk (beta) and realized stock index return.

They concluded with Oil which affects none of the sample countries. ***(Jones and Kaul, 1996)*** concluded that the reaction of the United States and the Canadian Stock market to Oil price shocks can be fully explained by changes in the expected value of future real cash flows. By comparison, ***(Sadorsky, 1999)*** discussed the Oil-equity relationship based on VAR in his paper. He finds that a negative relationship exists, both in terms of return and volatility. ***(Faff and Brailsford, 1999)*** and ***(Sadorsky, 2003)*** published research on the relationship between Oil price and returns for the manufacturing sector.

Nevertheless, the effect of Oil on various industries differed, both studies found clear linkages between Oil and Equity returns. ***(Maghyereh, Aktham, 2004)*** analyzed the complex relations in 22 emerging economies between Oil price shocks and stock market returns. For 1998 to 2004, they used VAR model on daily data, and found poor evidence of a relationship between Oil price shocks

and stock market returns in these emerging economies. His findings show that high energy consumption findings in a high shock to the Oil price. In a multivariate VAR system, ***(Papapetrou, 2001)*** analyzed the Oil-equity relationship with respect to the Greek economy and concluded high influence of Oil prices in explaining the returns on equities. ***(Basher and Sadorsky, 2006)*** used a pricing model of Multi-Factor Arbitrage and found good evidence that Oil price instability has an effect on the returns of emerging stock markets.

(Sadorsky, 2008) shows that rises in firm size or Oil prices decrease stock market price returns, and increases in Oil prices impact stock market returns more than decreases in Oil prices do. Many of the recent research claims that the correlation between Oil and economic activity is not entirely linear and that negative price shocks (price increases) appear to have a greater effect on growth than positive shocks do for example see ***(Hamilton, 2003), (Zhang, 2008) and (Cologni & Manera, 2009)*.**

The relationship between the Crude Oil Prices and Sectorial Stock Market Indices has been studied thoroughly in the past years which includes to understand the long term and short-term phenomenon as well as the effect of each variable on each other the studies includes**: *(Chittedi, 2012), (Benada, 2014), (Hamma, Jarboui, & Ghorbel, 2014), (Creti, Ftiti, & Guesmi, 2014), (Caporale, Ali, & Spagnolo, 2015), (Gokmenoglu & Fazlollahi, 2015), (Rahmanto, Riga, & Indriana, 2016)***.

(Wattanatorn & Kanchanapoom, 2012) Investigated the relationship between the crude oil and profitability performance of sectors in Thailand and they found that oil prices have significant impact on profit of energy and food sectors. Similarly, ***(Chittedi, 2012)*** Studied the relationship between the oil prices and stock market i.e., Sensex and Nifty by using ARDL model and found that volatility of stock prices in India have a significant impact on the volatility of oil prices. But a change in the oil prices does not have impact on stock prices. ***(Benada, 2014), (Hamma, Jarboui, & Ghorbel, 2014)*** Studied the impact of development of crude oil prices on Prague stock exchange by using two factor models on discovered that there is a significant influence of crude oil returns on stock market. ***(Caporale, Ali, & Spagnolo, 2015)*** Explained the relationship between the oil price uncertainty and effect on sectorial indices returns in China by using bivariate VAR GARCH in mean model and result shows that oil price volatility affects stock returns positively during periods characterized by demand-side shocks in all cases except the Consumer Services, Financials, and Oil and Gas sectors.

Studies has also conducted to understand the impact of crude oil prices on sectorial stock market indices which includes: ***(Setyawan, 2014), (Wattanatorn & Kanchanapoom, 2012), (Grabowska, Otola, & Wlodarczyk, 2015), (Hamma, Jarboui, & Ghorbel, 2014). (Akomolafe & Danladi, 2014), (Sonenshine & Cauvel, 2017), (Jafarian & Safari, 2015), (Arouri, Foulquier, & Fouquau, 2011), (Yun & Yoon, 2015), (Broadstock & Filis, 2014), (Olsen & Henriz, 2014), (Liu & Ma, 2016).***

2.2.3 Volatility Transmission between Crude Oil prices and BRICS Stock Market returns

Many researchers have tried to examined the market linkages on time to time using various econometric methods and period of study. Many of the studies shows that there is a strong linkage between various stock markets in the world. As (Fama,1965) reported an efficient stock market where security prices fully reflect all the information. Future prices cannot be calculated by evaluating past prices and volume results, in the presence of weak form of efficiency. Abnormal returns cannot however be obtained in the long run based on investing techniques that use past share prices or other historical data.

Many researcher including ***(Zhanna, 2010), (Bu, 2011), (Liu, Chen, & Su, 2011), (Selmi, Bouoiyour, & Ayachi, 2012), (Yang, Han, Cai, & Wang, 2012), (Chittedi, 2012), (Lee & Huang, 2014), (Yildirim & Ozturk, 2014), (Hamma, Jarboui, & Ghorbel, 2014), (Caporale, Ali, & Spagnolo, 2015), (Gokmenoglu & Fazlollahi, 2015), (Mustapha & Sulaiman, 2015), (Kang, Ratti, & Yoon, 2015), (Grabowska, Otola, & Wlodarczyk, 2015), (Al-Maadid, Caporale, Spagnolo, & Spagnolo, 2016), (Mikhaylov, 2018)*** found the strong relationship and linkages among the markets and Crude Oil. Several studies are conducted in Indian context to examine the weak form of efficiency including ***(Verma, 2005), (Mishra & Pradhan, 2009), (Singh & S.Suri, 2010)*** *and* ***(Aggarwal, 2012)*** and found stock prices follows a random walk and markets were having weak form of efficiency. Interestingly many researchers including ***(Gupta & Basu, 2007)*** *and* ***(Srinivasan, 2010)*** rejected the above claim of weak form of efficiency hypothesis.

Recent Studies ***(Khan, 2010), (Hammoudeh, Kang, Hoon, & Mensi, 2014); (Singh & Singh, 2016), (Bagchi, 2017), (Kelikume & Muritala, 2019)*** has studied the interlinkages between stock markets of various regions and found a strong evidence of relationship. The initial weak form of efficiency was mainly focused on developed market which is mainly USA. These studies includes ***(Chan & Gup, 1992), (Lee, 1992), (Choudhry, 1994)*** and ***(Bos, 1994)*** found the weak form of

efficiency while other including ***(Lo & MacKinlay, 1988), (Atkins & Dyl, 1993)*** **and** ***(Jarret, 2008)*** found there is no weak form of efficiency in US markets. Likewise ***(Lake & Katrakilidis, 2009), (Jain, 2013), (Zakaria S. Abdalla, 2014), (Balcilar, Gupta, & Miller, 2014), (Sood, Bapna, Totala, & Saluja, 2014), (Fatima & Bashir, 2014), (Kumar, 2014), (Leng, Cheong, & Hooi, 2015), (Makhija & Raghukumari, 2015), (Valdes, Fraire, & Vazquez, 2015), (salma, 2015)*** and ***(Yun & Yoon, 2015)*** tries to study the weak efficiency of the market and interlinkages and found that there exist the interlinkages of the market and weak form of efficiency.

The research on integration and connections between the market is started after the Grubel's work in 1968.Where he was concerns about the international diversification of investors in USA. Later, many researchers around the world became interested in the topic. The globalization process has been identified as one of the main engines of market integration. Among these writers, ***(Agmon, 1972), (Hilliard, 1979), (Becker, Finnerty, & Gupta, 1990), (Hamao, Masulis, & Ng, 1990)*** also tried to establish correlation between the developed markets such as the United States , the United Kingdom and Germany.

2.2.4 Structural Events Impact on Crude Oil Prices and Stock Market Indices of BRICS Countries

From many years' researchers are trying to understand the impact of certain events on crude oil prices and stock market. Researchers tried to understand the complexity of one event and its effect on certain variables representing stock market indices. These researches include: **(*Kang, Ratti, & Yoon, 2015)*** where they have investigated impact of structural oil price shocks on U.S. stock market return and found that coefficients and the nature of shocks have changed over time. In the real stock return equation, the posterior coefficients of global real economic activity and of oil price driven by oil-market specific demand are smaller. Similarly by analysing oil price shocks many stududied has concluded the positive impact on the former variable ***(Arouri, Foulquier, & Fouquau, 2011), (Bjornland, 2008), (Le & Chang, 2011), (Jones, Leiby, & Paik, 2004), (Mendoza & Vera, 2010), (Boubaker & Raza, 2017).***

Similarly, ***(Li, Cheng, & Yang, 2015)*** investigated global crude oil shocks and its impact on stock returns of chines oil exploitation industry for 5 years using impulse response function and found that returns are influenced by crude oil shocks. In similar studies ***(Jones, Leiby, & Paik, 2004),***

(Mendoza & Vera, 2010), (Boubaker & Raza, 2017), (Maconachiea, Tanko, & Zakariya, 2009), (Gupta & P.Modise, 2013).

(Kang, Ratti, & Yoon, 2015) The influence of structural oil price shocks on US stock returns is studied using VAR. The coefficients and variance-covariance matrices show time variation. During the global financial crisis, demand-side structural shocks reached forty-year highs and have remained high since. The coefficient of global real economic activity has fallen since the late 1990s, while the coefficient of oil-market specific demand shock has fallen since the early 1990s. In ***(Li, Cheng, & Yang, 2015)*** classifies global crude oil price shock into four categories: oil supply shock, global demand shock, domestic demand shock, and precautionary demand shock. The findings reveal that all three industries return respond positively to each of the four oil price shocks, with the impacts of the three demand shocks being the most substantial. Furthermore, the returns of different businesses respond to distinct oil price shocks in a variety of ways. It has been noticed that Precautionary demand shock is the most important factor in determining the returns of the oil exploitation business, whereas domestic demand shock is the most important factor in determining the returns of the oil exploitation and oil sales sectors. Specifically, the return of the oil sales business is the most significant response to all oil price shocks, followed by the response of the oil refinery sector.

Similarly, ***(Bjornland, 2008)*** investigated the effects of oil price shocks on stock returns. A structural VAR model is used to describe the interaction between the different variables. Stock returns are integrated into the model since stock prices are an important transmission route of wealth in a country with large oil reserves. It has been found that all indicators, on the other hand, imply that the Norwegian economy responds to higher oil prices by raising aggregate wealth as well as aggregate demand. The findings also highlight the importance of other shocks, in particular monetary policy shocks, which are key drivers of short-term stock price volatility on the stock exchange.

(Le & Chang, 2011) analysed the response of Japanese stock markets to fluctuations in oil prices. By utilising the generalised impulse response and variance, Singapore, Korea, and Malaysia were able to decomposition analysis. According to the findings that the reaction of stock markets to

changes in the price of oil differs dramatically across different countries. The study stated that there were a number of factors that appeared to have hindered the stock market's response to aggregate shocks. *(Mendoza & Vera, 2010)* examines the consequences of unanticipated fluctuations in oil prices on the Venezuelan economy. Using the methods developed by **(*Hamilton ,2003), Lee et al. (1995),* and (*Mork, 1989)***. The study found that oil shocks had a positive and statistically significant impact on output growth in Venezuela.

(Boubaker & Raza, 2017) analysed the spillover effects of volatility and shocks between oil prices and the BRICS stock markets over a range of time periods. As a result, in order to investigate this phenomenon, we combine a multivariate ARMA-GARCH model with wavelet multiresolution analysis. All the markets under investigation show significant evidence of time-varying volatility. In contrast, study demonstrates that the oil price and the stock market prices are directly influenced by their own news and volatilities, and that they are indirectly influenced by the volatilities of other prices and the wavelet scale.

(Gupta & Modise, 2013) explore the dynamic link between several oil price shocks and the South African stock market. The study found that an oil-importing nation like South Africa, stock returns increase only when global economic activity increases, not when oil prices rise. Similarly, variance decomposition reveals that the oil supply shock is responsible for a greater proportion of the variability in real stock prices also found that different types of oil price shocks have varying effects on stock returns. In ***(Zhang, Li, & Yu, 2013)*** financial crisis has resulted in long-term linkages between BRICS developed countries and stock markets. The findings provide compelling evidence that decreasing diversification advantages is a long-term global phenomenon, particularly in the wake of previous financial crises. ***(Kang, Ratti, & Yoon, 2015)*** Examined the influence of structural oil price shocks on the covariance of the return on the U.S. stock market as well as the volatility of the stock market. Positive shocks to aggregate demand, as well as to oil-market specific demand, are related with negative impacts on the covariance of return and volatility of the stock market index.

(Adeniyi, Oyinlola, & Omisakin, 2011) investigates alternative measures of oil price shocks. The major findings of this study are that oil price shocks do not explain for a significant share of

observed fluctuations in macroeconomic aggregates (e.g., inflation). Despite the inclusion of threshold effects, this pattern continues to exist. This implied the enclave nature of Nigeria's oil sector with weak linkages. As a result, if a positive impact on real production growth is anticipated, it is critical that oil revenues be used effectively. ***(Ewing & Malik, 2010)*** Oil shocks diminish rapidly but have a significant initial impact, which is in contrast to earlier findings.

Studies conducted on BRICS Countries

(Mensi, Hkiri, Al-Yahyaee, & Kang, 2017) examined the co movements of stock market and its effect on crude oil and gold prices; interestingly they found that no impact of co movements on gold prices but with the wavelet approach found a significant impact on crude oil prices. Similarly, ***(Ono, 2011)*** investigated the inverse relationship with the help of VAR models for ten years and resulted that stock returns has positively affected because of oil price shocks and volatility in real stock returns is significantly large for china and Russia. In addition; ***(Raza, Shahzad, Tiwari, & Shahbaz, 2016), (Singh Tomar & Singh, 2016), (Ratti & Vespignani, 2012), (Bouoiyour & Selmi, 2016), (Boubaker & Raza, 2017) , (Ma, Wei, Huang, & Zhao, 2013), (Mensi, Hammoudeh, Reboredo, & Nguyen, 2014), (B. Zhang, Li, & Yu, 2013), (Ramaprasad Bhar & Nikolova, 2009)***.

2.3 Evolution of Crude Oil Fluctuation and Its Impact on World Oil Market

Crude oil prices fluctuate differently in different time horizons and in different economies. So, there is always having some impact on the economies and the Macroeconomic variables. There are many studies conducted to test the impact of crude oil prices on economies.

Table 2.1 Evolution of Crude Oil Fluctuation and Its Impact on World Oil Market

Year	Evolution of Crude Oil Studies
1921-1970	**Focus was on how** • Oil stocks Impact on Stock Prices *(Pogue, 1921)* • Public Policy impacts on Crude Oil Industry *(Davidson, 1963)*
1970-1980	• Focus shifted towards impact of production of Crude Oil on Crude Oil prices *(Uri, 1982)*
1981-2000	**Focus of studies shifted towards** • World Crude oil Market *(Gately, Adelman, & Griffin, 1986)* • How Oil prices are determined *(Mabro, 1992)*

	• Integration properties and Stock Market *(Chou, 1994)* • Crude Oil prices and GDP *(Mork, Olsen, & Mysen, 1994)* • Impact of Oil market Event on Macroeconomic Consequences *(Mork, , 1994)* • Crude Oil prices and Stock Returns *(Stijn Claessens & Glen, 1995)* • Crude Oil Prices and Employment *(Uri & Bom, 1996)*
2000-2010	**Nexus Shifted Towards** • World Crude Oil market and Impact on European Equity Market *(Fratzscher, 2001)* • Crude Oil and Macroeconomic Variables *(Eltony & Al-Awadi, 2001)* • Crude Oil prices and Market Integration *(Bekaert, Harvey, & Ng, 2002)* • Impact Crude Oil prices and War and Crises *(Kang, 2002)* • Short term and Long-term Linkages between Crude Oil and economies *(Fan, 2003)* • Impact of Crude Oil on Saving and Investment Strategies *(Devlin & Titman, 2004)* • Crude oil price Shocks and its Impact on Macroeconomic variables *(Ayadi, 2005)* • Crude Oil prices and Demand Supply relationship *(Akcelik & ogunc,2016)* • Crude Oil prices and Stock returns *(Kilian & Park, 2009), (Bjornland, 2008) (Constantinos, Ektor, & Dimitrios, 2010), (Masih, Peters, & De Mello, 2011)* • Forecasting and Crude Oil prices *(MacAskie & Jablonowski, 2008)* • OPEC and other economies impact Crude Oil prices *(Kisswani,2009)* • Crude Oil prices and Financial Crises *(Alsahlawi, 2010)*
2010-2021	**Focus Shifted Towards** • Crude Oil prices and Welfare effect (Sa*nchez*, 2011) • Response of Stock market Volatilities and Crude Oil price *(Le & Chang, 2011)* • Crude Oil prices and Trade *(Chuku, Akpan, Sam, & Effiong, 2011)* • Impact of Crude Oil prices and food price shocks *(Khan & Ahmed, 2011)* • Relationship between Future and Spot Crude Oil prices *(Liu, Chen, & su, 2011)* • Macroeconomic news and Crude Oil prices *(Chatrath, Miao, & Ramchander, 2012)* • Liquidity and Crude Oil Prices • Correlation between Assets pricing and Crude Oil *(Broadstock, Cao, & Zhang, 2012)* • Consumption and Hedging Strategies on Crude Oil *(Aloui, Nguyen, & Njeh, 2012)* • Relationship between Oil Importing and Exporting Countries *(Oskooe, 2012)* • Impact of Crude Oil on Profitability of sectors *(Wattanatorn &*

	Kanchanapoom, 2012) • Impact of Government policies on Crude Oil prices (Natal, 2012) • Crude oil shocks and Crude Oil prices *(Barragan, Ramos, & Veiga, 2013)* • Crude Oil prices and Global Activity *(Ratti & vespignani,2013)* • Financial Speculation and Crude Oil prices • Volatility Spillovers between stock market and Crude Oil prices *(Guesmi & Fattoum, 2014)* • Time Varying Impact on Crude Oil prices *(Broadstock & Filis, 2014)* • Impact of Crude Oil on Sovereign Ratings *(Breunig & Chia, 2015)* • Intertemporal Interaction between Crude Oil prices *(Le, 2017)*

Source: Authors compilation

2.4 Major Observations derived from the Literature Review

- The sufficient large number of studies has been conducted on the area of crude oil prices, but all the studies has been focusing on the fluctuation of crude oil and its Impact on the economies ***(Eltony & Awadi, 2001)***. But there are very few studies which focuses on Market integrations. So, there is a scope for researchers to conduct the studies in this area.
- Many researchers has studied the impact of Crude oil on the macro economic variables ***(Mork, 1994), (Jones & Kaul, 1996), (Bjornland, 2000), (Eltony & Awadi, 2001)*** but many macroeconomic variables has been excluded under study which have significant impact on Crude Oil.
- The study has also revealed that most of the researchers have been focusing on USA around 31% of articles collected ***(Wang & Chueh, 2013), (Uri, 1982), (Davidson, 1963), (Hsu, Lin, & Chen, 2014), (Schubert & Turnovsky, 2011)***. Therefore, the research can be conducted in other developing and emerging markets.
- There are many researches has been done on impact of crude oil on Stock indices but there are very few studies which are focusing on industry or sector specific. So, researcher can also focus on this aspect.
- Several articles has developed a different models ***(Devlin & Titman, 2004), (Chuku, Akpan, Sam, & Effiong, 2011), (Aloui, Nguyen, & Njeh, 2012), (Le, 2017).***The future research can be done on the validation and testing of the models which are developed in different studies.
- It can be said that there is a sufficient contribution has been made in the area of crude oil and its impact but there is always a scope of study that the researcher has to identified. There are

various techniques which can be used to generalize these results and to solve the research problem. The Scope of the study is not limited to further research but there are many other issues which are unaddressed which are relevant and unidentified which the researcher can find out for the further study.

After reviewing the literature, it can be observed that the studies on crude oil prices and its impact witnessed an increasing number globally on the most important reason behind this is technological advancement and increasing demand of crude oil in developing and emerging economies. It has been noted that crude oil is considered as a primary commodity but after certain point of time crude oil got the substitute as alternate energy. Further there are many studies were conducted on focusing crude oil on major regions or cluster of countries. But during the research many factors has been omitted during the research.

Over a period of time the studies related to crude oil got shifted towards finding the relationship with macroeconomics variables and stock market. Also, the focus has been shifted towards regional studies such has NAFTA, G7, G20, SAARC, ASIAN and so forth. So present study tries to fill the gap in literature by examining the macro-economic impact of crude oil.

Chapter 3

Research Design and Methodology

This chapter outlines the complete research methodology to carry out this study. Section 3.1 presents the problem of the study, the derived research gap (section 3.2), Research questions (Section 3.3), Significance of the study (section 3.4), objectives of the study and hypothesis to be tested in the section 3.5 and 3.6 respectively. In the section 3.7 the detailed research methodology which includes Data period, Data sources, Tools and techniques (section 3.8) which is employed to each objective are defined. In the section 3.9 the overview of macroeconomic variables under study is defined as well as in the section 3.10 the structural event taken under study are outlined.

3.1 Problem of the study

Crude Oil prices are essential to the BRICS economy, and it is well known that oil is the most traded commodity in terms of volume and value. The picture of global views concerning our economic future is largely painted by oil prices. Growing economies require more oil, then underdeveloped economies. In the end, its movement is thought to signal whether the economy is going for good or bad times.

The movement that has appeared from the literature indicates that studies on the crude oil is on growing path. The increase in demand of crude and globalization are the most important factor which has attracted the researchers a lot. Primarily the studies were more focused on impact of crude oil on the economies but as the years goes study became more empirical in nature which were focused on underdeveloped and developed countries and specifically towards diversified areas like welfare, Government policies.

Researchers has studied the impact of Crude oil on the Macro economic variables (Mork, 1994), (Jones & Kaul, 1996), (Bjornland, 2000), (Eltony & Awadi, 2001) but many variables has been excluded under study which have significant impact on Crude Oil. There are many researches has been done on impact of Crude oil on

Stock indices but there are very few studies which are focusing on industry or sector specific.

Many researchers have previously concentrated their attention on the commodity market in general and crude oil in particular. In recent years, a large number of studies have been carried out in the field of crude oil, specifically in the United States of America but there have only been a few studies undertaken in the BRICS countries that have been specifically focused on crude oil. Furthermore, there are studies that are predominately focused on the relationship between crude oil and the financial markets, while macroeconomic variables have received less attention in the literature. It has been discovered that no prior study exists that examines macroeconomic factors, financial market conditions, and structural changes all at the same time across the BRICS economies.

3.2 Research Gap

The current study will address the gap in the literature in the following ways:

- The study will be more focused on macroeconomic variables than the earlier studies. The study will concentrate on significant macroeconomic indicators that are influenced by changes in crude oil prices.
- In this framework of the study the BRICS sectoral indices are studied and will tries to find out the relationship between the sectorial indices and crude oil.
- The present study tries to examine the volatility transmission between stock market indices and crude oil of BRICS countries which was not studied earlier in the BRICS countries as per the literature review.
- The study will try to find out various structural events which has impact stock market and crude oil prices and tries to find out the relationship between the stock market indices and crude oil price before and after the happening of the event.

3.3 Research Questions

The current study will address the gap in the literature in the following ways:

- Does Crude Oil Prices Co-integrate with macroeconomic variables of BRICS Countries?
- Does the Crude Oil Price influence the BRICS macroeconomic variables?

- How long does it take for the variables to return to normal when the long-run equilibrium experiences a shock?
- Is there any relationship between BRICS sectoral indices and crude oil?
- Is there any volatility transmitted between stock market indices and crude oil prices of BRICS countries?
- Do structural events have any impact on stock market indices and crude oil?

3.4 Significance of the Study

Crude oil is considered as essential commodity for any developing or emerging countries and it has direct or indirect relationship with the development of economies. The study aims to make a substantial contribution to the field of finance literature and help market participants and research analysts to assess the BRICS economy. The study looks at a wide range of macroeconomic variables, which will assist the government in understanding the crucial function that each macroeconomic indicator currently plays. Additionally, investors will learn whether conventional performance measures

Also, in terms of increasing attention towards Emerging Markets the study becomes all the more important because Emerging Market are interrelated in terms of trade, Investment and capital inflows and outflows.

3.5 Objectives of the Study

1. To Examine the relationship between Crude Oil and Macroeconomic Variables of BRICS Countries.
2. To Study the relationship between Crude Oil Prices and Sectorial Stock Market Indices of BRICS Countries.
3. To Study the volatility Transmission between Crude Oil prices and BRICS Stock Market returns.
4. To analyse the Structural Events Impact on Crude Oil Prices and Stock Market Indices of BRICS Countries.

3.6 Research Hypothesis

The formulated null hypotheses of the objectives are:

1. To Examine the Relationship Between Crude Oil and Macroeconomic Variables of BRICS Countries

H_{01}: No significant relationship between Macroeconomic variables and Crude Oil.

2. To Study the Relationship Between Crude Oil Prices and Sectorial Stock Market Indices of BRICS Countries

H_{02}: No statistically significant relationship between Crude oil prices and Stock market Indices of BRICS Countries.

3. To Study the Volatility Transmission Between Crude Oil Prices and BRICS Stock Market Returns

H_{03}: Non-existence of volatility transmission between Crude oil and BRICS stock market returns.

4. To analyse the Structural Events Impact on Crude Oil Prices and Stock Market Indices of BRICS Countries

1. **H_{04}**: There exists no significant impact of **Dot Com Bubble** on stock market Indices of BRICS countries
2. **H_{05}**: There exists no significant impact of 9**-11 attacks (2001)** on stock market Indices of BRICS countries
3. **H_{06}**: There exists no significant impact of **Energy Crisis (2003)** on stock market Indices of BRICS countries
4. **H_{07}**: There exists no significant impact of **Low spare capacity (2005)** on stock market Indices of BRICS countries
5. **H_{08}**: There exists no significant impact of **Chinese stock bubble (2007)** on stock market Indices of BRICS countries
6. **H_{09}**: There exists no significant impact of **Global financial Collapse (2008)** on stock market Indices of BRICS countries
7. **H_{10}**: There exists no significant impact of **OPEC cuts production targets 4.2 mbpd (2009)** on stock market Indices of BRICS countries
8. **H_{11}**: There exists no significant impact of **Brazil Economic Crisis (2014)** on stock market Indices of BRICS countries

9. **H_{12}**: There exists no significant impact of **Russian Economic Crisis (2014)** on stock market Indices of BRICS countries
10. **H_{13}**: There exists no significant impact of **OPEC production quota unchanged (2015)** on stock market Indices of BRICS countries
11. **H_{14}**: There exists no significant impact of **Chinese Stock Market Crash (2015)** on stock market Indices of BRICS countries
12. **H_{15}**: There exists no significant impact of **Global pandemic reduces oil demand (2019)** on stock market Indices of BRICS countries

3.7 Research Methodology

3.7.1 To Examine the Relationship Between Crude Oil and Macroeconomic Variables of BRICS Countries.

Data period: The data set consists of quarterly observations from 01st April 1999 to 31st March 2021 for Brazil, Russia, India, China, and South Africa as five developing and Emerging economies of the world.

Data Sources and variables: To Examine the relationship between Crude Oil and Macroeconomic Variables of BRICS Countries the data set of BRICS countries has been obtained from Bloomberg, Fred Reserve database, OECD (The Organisation for Economic Co-operation and Development database), World Bank, and Central and Reserve bank of respective countries. Based on the available literature as a set of potential variables, which includes Industrial Production (IP), Export (EX), Import (IM), Gross Domestic Product (GDP), Foreign Direct Investment (FDI), Exchange Rate (ER), Money Supply (MS), Gold Prices, Silver prices, Foreign Exchange Reserve (FOREX), Current Account (CA), Interest Rates and Inflation. We have used M3 as a proxy of Money Supply, Consumer Price Index (CPI) as a proxy of Inflation, Study has used Brent Crude oil prices as a proxy of Crude Oil has been considered.

3.7.2 To Study the Relationship Between Crude Oil Prices and Sectorial Stock Market Indices of BRICS Countries

Data period: The data set consists of daily observations from 01st April 1999 to 31st March 2021.

Data Sources and variables: To Study the relationship between Crude Oil Prices and Sectorial Stock Market Indices of BRICS Countries the daily data of BRICS sectoral indices from the respective stock exchanges of Countries i.e. Brazil (Bovespa Stock Exchange), Russia (Moscow Stock Exchange), India (National Stock Exchange), China (Shanghai Stock Exchange), South Africa (Johannesburg Stock Exchange) has been collected from respective Stock Exchanges, Bloomberg, Yahoo finance and Investing website. To study the sector wise linkages with Crude oil, ten equity sector indices across five markets are selected which includes Chemical, Construction & Material, Oil & Gas, Manufacturing, Real Estate, Pharmaceuticals, Textiles, Industrial Mining, Financial, Fast-Moving Consumer Goods sector.

3.7.3 To Study the Volatility Transmission Between Crude Oil Prices and BRICS Stock Market Returns

Data Period: The daily data used from the period 01st April 1999 to 31st March 2021. Data has been filtered and considered only those days where all the five stock markets were open for trading. This has reduced our data set to 5267 observations.

Data Sources and variables: to study the interlinkages and weak form of efficiency of BRICS countries have used daily stock indices of BRICS countries including Brazil Stock Exchange, Moscow Stock Exchange, National Stock Exchange, Shanghai Stock Exchange and Johannesburg Stock Exchange and Brent Crude oil prices. All the data has been extracted from Bloomberg data base.

3.7.4 To Analyse the Structural Events Impact on Crude Oil Prices and Stock Market Indices of BRICS Countries

Data period: we have used data from 01st April 1999 to 31st March 2021. We have filtered the data and considered only those days where all the five stock markets were open for trading. This has reduced our data set to 5267 observations.

Data Sources and variables: To analyse the structural events and its impact on crude oil prices and stock market indices of BRICS countries the data set of has been obtained from Bloomberg, Fred Reserve database and Yahoo Finance of

Brazil Stock Exchange, Moscow Stock Exchange, National Stock Exchange, Shanghai Stock Exchange and Johannesburg Stock Exchange and Brent Crude oil prices.

Detail of the event are as follows:

	Events	Pre-Period	Day of the event	Post- Period
1.	Dot Com Bubble	01 April 1999 to 09 March 2000	10 March 2000	11 March 2000 to 31 March 2021
2.	9-11 attacks (2001)	01 April 1999 to 10 September 2001	11 September 2001	12 September 2001 to 31 March 2021
3.	Energy Crisis (2003)	01 April 1999 to 04 August 2003	05 August 2003	06 August 2003 to 31 March 2021
4.	Low spare capacity (2005)	01 April 1999 to 29 April 2005	30th April 2005	01 May 2005 to 31 March 2021
5.	Chinese stock bubble (2007)	01 April 1999 to 26 February 2007	27 February 2007	28 February 2007 to 31 March 2021
6.	Global financial Collapse (2008)	01 April 1999 to 14 September 2008	15 September 2008	16 September 2008 to 31 March 2021
7.	OPEC cuts production targets 4.2 mbpd (2009)	01 April 1999 to 02 February 2009	03 February 2009	04 February 2009 to 31 March 2021
8.	Brazil Economic Crisis (2014)	01 April 1999 to 15 May 2014	16 May 2014	17 May 2014 to 31 March 2021
9.	Russian Economic Crisis (2014)	01 April 1999 to 15 December 2014	16 December 2014	17 December 2014 to 31 March 2021
10.	OPEC production quota unchanged (2015)	01 April 1999 to 15 March 2015	16 March 2015	17 March 2015 to 31 March 2021
11.	Chinese Stock Market Crash (2015)	01 April 1999 to 11 June 2015	12 June 2015	13 June 2015 to 31 March 2021
12.	Global pandemic reduces oil demand (2019)	01 April 1999 to 30 December 2019	31 December 2019	01 January 2020 To 31 March 2021

3.8 Tools and Techniques

1. Correlation

One way to determine how closely two variables move in respect to each other is to look at the correlation coefficient (R). The values range from a negative one to a positive one. A correlation measurement inaccuracy is indicated by a number greater than or less than 1.0. There is a perfect negative correlation when the correlation coefficient is -1.0, and a perfect positive correlation when the correlation coefficient

is 1. There is no linear relationship between the two variables when the correlation is zero.

The correlation coefficient is determined by dividing the covariance by the product of the two variables' standard deviations.

$$\rho xy = \frac{Cov\ xy}{\sigma x\ \sigma y}$$

where:

$\rho xy = \text{Pearson product} - \text{moment correlation coefficient}$

Cov xy = Covariance of variable x and y

$\sigma x = \text{Standard deviation of x}$

$\sigma y = \text{Standard deviation of y}$

As an investment tool, correlation coefficients are frequently employed. Portfolio composition, quantitative trading and performance evaluation all rely on them. When it comes to managing portfolios, some managers keep an eye on the correlation coefficients of particular assets so that total volatility is kept to a reasonable level.

2. Regression Analysis

An MLR methodology, also known as multiple regression, is a statistical method for predicting the result of a response variable by using many explanatory variables. Modeling a linear relationship between explanatory (independent) and response (independent) variables is the purpose of multiple linear regression. As the name implies, multiple regression is a generalisation of the ordinary least-squares (OLS) regression method.

$Yi=\beta_0+\beta_1 x_{i1}+\beta_2 x_{i2}+...+\beta_p x_{ip}+\epsilon$……Eq. (1)

where, for $i=n$ observations:

Yi = Dependent variable

Xi = Explanatory variables

β_0 = y-intercept (constant term)

β_p=Slope of the coefficients for each explanatory variable

E = Error term

3. Unit root test

Most of the techniques applied in modelling the time series data are majorly concerned with Stationary properties of the data. If a time series has a unit root than series is considered as a non-stationary, while the absence of it entails stationarity. The non-stationary series can result in spurious regression. The statistical procedure applied to determine the stationarity of the time series is called “Unit root test”. The present study uses the Augmented Dickey-Fuller (ADF) test to examine the properties of time series data and to study the stationary properties.

- **Augmented Dickey-Fuller (ADF) test**

It is the most common method of Unit root test. Suppose consider the series ‘Y’ for testing unit root. With this series, the following ADF model can be developed as in Equation (2):

$\Delta Y_t=\mu+\delta Y_{t-1}+\sum_{i=0}^{n} \beta_I \Delta Y_{t-i}+e_t$…….…….…….Eq.(2)

Where,

$\delta= \alpha-1$

α = Coefficient of Yt-1

ΔYt= First difference of Yt

$\delta= 0$ is the null hypothesis of ADF test and alternative is $\delta<0$. If we do not reject the null hypothesis, then the series is said to be non-stationary and vice versa.

4. Johansen Cointegration Test

To examine the long-term relationship Johansen's co-integration test was used. The Johansen's test approaches the co-integration test by testing the number of independent linear combinations for variables in the time series that yield stationarity. If two or more variables of the same order are combined, and if their linear combination is found to be stationary, then these variables are said to be co-integrated. Since Johansen's Co-integration test is responsive to the option of lag length a suitable lag structure was selected using the Akaie Knowledge Criterion (AIC), the Schwarz Criterion (SC) and the Likelihood Ratio (LR) test.

5. Vector Error correction Model

In order to determine the stationarity of the variables, first perform augmented Dickey-Fuller (ADF) unit root test. Johansen co-integration test is used to evaluate the long-term equilibrium between variables that are found to be non-stationary at levels but stationary at First Difference. Through the use of the Vector Error Correction Mechanism, it is possible to analyse the short-run nature of the relationship between cointegrated pairs of variables. Because all of the variables are integrated in the order I (1), study utilised Johansen Co-integration to model the long-term relationship between the variables.

If there are two variables in the with one cointegrating equation with no lagged differenced term. The cointegrating equation is:

$Y_{2,}\, t = \beta y_1, t$…….Eq. (3)

From the above equation the VEC model developed is:

$$\Delta Y_1 = \alpha_1(Y_{2,\, t-1} - \beta Y_{1,\, t-1}) + E_1, t$$

$$\Delta Y_1 = \alpha_2(Y_{2,\, t-1} - \beta Y_{1,\, t-1}) + E_2, t$$

In the above model, the right hand side variables is error correction term and in the long term this equation becomes zero. If, on the other hand, y1 and y2 vary from the long-run equilibrium, the error correction term will be non zero, and each variable will adjust in order to partially restore the equilibrium relation to its original value. The coefficient measures the rate at which the i-th endogenous variable adjusts in the direction of the equilibrium value.

6. Granger Causality test

Granger causality is a method for determining the relationship between two variables in a time series. The technique is a probabilistic view of causality; it finds patterns of association using empirical data sets. It is common to apply the Granger causality test to empirically test the causality relationship. In a bivariate framework, it is said that the variable y_1 in the Granger sense causes the variable y_2 if the y_2 forecast improves considering lagged variables y_1.

7. Lo and MacKinlay variance ratio

Lo and MacKinlay variance ratio are used to check the weak form of efficiency of Stock markets of BRICS countries. The test is based on the assumption that if a time series follows a Random Walk, in a finite sample the increments in the variance are

linear in the observation interval, i.e., the variance estimated from the q period returns should be q times as large as the variance estimated from one period returns. That means, the variance of (X_t -X_{t-q}) is q times the variance of (X - X_t). It can be described as below equation:

$$VR(q) = \frac{\sigma^2(q)}{\sigma^2(1)} \quad \text{..... Eq. (4)}$$

8. Impulse Response Function (IRF)

A stable VAR order model can be represented as an infinite order Vector Moving Average (VMA) process as a univariate AR model. This representation serves as the key to the study of the IRF. An IRF enables one to trace the time path of the impact of a shock on all the variables included in the VAR model in one variable. Impulse Response Analysis is performed to check, using graphs, the response of one country's stock market indicators to the shocks created in another country's stock market.

9. ARCH- GARCH MODEL

Auto Regressive Conditional Heteroskedasticity (ARCH) models are used to characterize and model observed time series with time-varying volatility. ARCH models assume that the variance of the current error term is related to the size of the previous periods squared error terms, giving rise to volatility clustering. This phenomenon is widely observable in financial markets, where periods of high variance or volatility tend to group together.

Bollerslev (1986) proposed a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model,

$$\sigma^2_t = \omega + \beta(L)\sigma^2_{t-1} + \alpha(L)\eta^2_t \quad \text{..... Eq. (5)}$$

It is quite obvious the similar structure of Autoregressive Moving Average (ARMA) and GARCH processes: a GARCH (p, q) has a polynomial β(L) of order “p” - the autoregressive term, and a polynomial α(L) of order “q”- the moving average term.

3.9 Overview of Macroeconomic Variables

1. Exchange rate:

Exchange Rate is the rate at which the currency of one country is changed into the currency of another. The exchange rates are set by the foreign exchange market. On

the foreign exchange market, there are many different kinds of buyers and sellers, and currencies are always being bought and sold. The spot exchange rate is another name for the exchange rate. Forward exchange rate is the rate of exchange that is quoted and traded today, but payment and delivery are made at a certain date in the future. The Effective Exchange Rate is an index that shows how strong a currency is in relation to a basket of other currencies. Most of the time, currency pairs are involved in bilateral exchange rates, and the effective exchange rate is based on the weighted average of a basket of foreign currencies. The Nominal Effective Exchange Rate (NEER) gets heavier as the asymptotic trade weights go up. And NEER is called Real Effective Exchange Rate when it is adjusted by foreign price level and deflated by home country price level.

2. Gold Prices

Gold is a transferable financial asset and the foundation of the global monetary system. It has a high position among precious metals since, in addition to being used for jewellery, it is also a reserve instrument and means of exchange. When the value of fiat currencies falls, gold becomes a safe haven. Gold is a strategic asset because it is resistant to inflation and serves as a safe haven in times of global political and economic instability. When their economies struggle to meet their international debt obligations, both developing and industrialised nations turn to gold as collateral for loans. Gold's appeal to investors arises from its usage as a safe haven and store of value, which comes in handy during times of crisis and when distributing risk across many assets. Gold has been considered as a leading indicator of inflation by some researchers due to its reputation as a safe haven in times of economic turmoil. Because of its liquidity and countertrend movement to stock prices, gold plays an important role in times of economic, financial, and political crisis. Gold might be a suitable option when the stock market is depressed or turbulent. Gold and stock prices are complementary, and historically, the two have moved in different directions. Several governments use gold as collateral for loans when their balance of payments is endangered.

Gold has remained the de facto worldwide money standard to this day. Many European nations adopted gold-based currencies in the nineteenth century, only to relinquish them momentarily during World War One. The Bretton Woods System,

which linked the value of the dollar to gold after WWII, was later abandoned after the Nixon shock of 1971. Gold trading takes place 24 hours a day, seven days a week, and is based on intraday spot pricing. These prices are obtained from over-the-counter gold trading platforms.

3. Inflation

Price increases for products and services are referred to as inflation. Fewer goods and services can be purchased as prices rise since the buyer's purchasing power is decreased. The real worth of the currency is further diminished by the rising inflation, which therefore hinders investment returns. The term "inflation rate" refers to the measure of price inflation, which is typically expressed by the Consumer Price Index (CPI) or the Wholesale Price Index (WPI). Inflation may make it difficult to save money for the future or invest it, raise the opportunity cost of holding money, or cause a shortage of products and services because people may hoard them in anticipation of future price increases. Medium to low inflation may be brought on by changes in consumer demand for goods and services, while high inflation is typically caused by an excessive expansion of the money supply.

The two types of inflation are as follows: 1) Cost-Push Inflation is defined as an increase in both the cost of inputs and the prices of goods and services. Demand Pull (ii) According to the definition of inflation, prices for goods and services rise as a result of supply and demand. There are two widely used inflation indicators: the WPI (wholesale price index) and the CPI (consumer price index) (CPI). While CPI evaluates the retail price of goods and services, WPI estimates the wholesale price of manufactured goods, basic goods, fuel, and electricity, among other goods and services. The most common and popular inflation proxy is the CPI. Expected inflation occurs when supply is insufficient compared to demand, which raises prices and boosts corporate profits. Instead, unexpected inflation raises prices and causes a slow transition from investment to consumption.

4. Industrial Production

OECD (2020) defines, “Industrial production refers to the output of industrial establishments and covers sectors such as mining, manufacturing, electricity, gas, and steam and air-conditioning. This indicator is measured in an index based on a reference period that expresses the change in the volume of production output”.

The Index of Industrial Production is a commonly used indicator of manufacturing activity across many economic sectors, making it a useful tool for monitoring production activity in the industry. The core sector, which includes eight major industries with a combined weightage of 40% in IIP, includes the production of electricity, crude oil, cement, steel, coal, natural gas, refinery products, and fertilizer.

5. Money Supply

The term "money supply" refers to the entire amount of money in the economy at a given time and includes both demand deposits and currency that is in circulation. It is essential to the monetary policy. It is important to talk about the nature of the link between the money supply and stock prices because monetary policy is generally one of the central bank's most effective tools. The present value of future cash values, which is derived by applying discount rates to the future cash flows, is used to determine stock prices. The money supply and discount rates have a substantial relationship.

There are two types of money: broad money and narrow money. All coins and banknotes, short-term bank deposits, money market securities, and debt securities are all considered to be part of broad money. Broad money is represented by the symbol M3. Narrow money, on the other hand, refers to the most liquid kinds of money, such as coins and banknotes, quickly convertible bank account balances, or the money utilised for cashless transactions. Narrow money is a subset of broad money and is represented by the symbol M1.

6. Silver Prices

Like gold, silver is a valuable metal that is widely traded worldwide. Since the collapse of the silver standard, silver is no longer recognised as legal tender in developed nations. Silver is increasingly in demand for commercial uses, bullion coins, jewellery, and things that are exchanged on exchanges. Similar to other commodities, the price of silver is determined by supply, demand, and speculation. Silver's market is less than that of gold, hence it is more volatile. Additionally, compared to gold, silver has less market liquidity.

7. Current Account Balance

Balance of payments is made up of three parts. The current account is one of them. The capital account and the foreign account are the other two parts. Balance of trade, net current affairs, and net income from abroad are all parts of the current account balance. It shows how well the economy of a country is doing. A positive current account balance means that the country is a net lender to the world. A negative current account balance, on the other hand, means that the country is borrowing money from the rest of the world. The country's net foreign assets go up when it has a current account surplus and go down when it has a current account deficit.

8. Export

Export of Goods and Services refers to the process of sending goods and services from one country to another. Exporters are people who are involved in the sale of such goods and services. Exporting had many benefits. Companies are exposed to a wider market, enabling them to produce goods that meet worldwide standards. The business has access to global customers. The fundamental competencies of the businesses are strengthened by exporting.

9. Import

Imports of products and services refer to the process of bringing in commodities and services from another nation. Importers are people who are involved in purchasing such goods and services. Two different sorts of imports are imports of intermediary (goods and services) and industrial and consumer goods. Companies import the products and services in order to provide the domestic market with products and services that are more affordable and of higher quality.

10. Foreign Exchange Reserve

The term "foreign exchange reserves" refers to the possession of assets or funds by a nation's central bank for the purpose of meeting any potential liabilities. It goes by the names FX reserves and forex reserves or FOREX. To hold such reserves, one or more reserve currencies are employed. US dollars are the most commonly utilised reserve money. Foreign bank deposits, foreign bank notes, short- and long-term foreign government securities, foreign treasury bills, gold reserves, positions in the international monetary fund's reserve accounts, and Special Drawing Rights are all

included in the foreign exchange reserves. The capital account in a balance of payments includes the foreign exchange reserves, which are referred to as "Reserve Assets."

11. Foreign Direct Investment

Investments made outside of a country's borders, either in the form of acquiring a majority stake in an existing business or by starting a new one, are known as "foreign direct investment" (FDI). Joint ventures, management stakes, knowledge and technology transfers, and other similar mechanisms are all acceptable forms of foreign direct investment. By bringing in its cutting-edge technology, the corporation investing abroad can tap into the country's untapped resources. The economy as a whole benefit from the presence of the target enterprise, which in turn creates jobs and helps revitalise the surrounding neighbourhood.

12. Interest Rates

Interest rates relate to the annual percentage yield of a deposit, loan, or borrowing, or the amount of interest due per period. The overall cost of borrowing or lending money varies on several variables, including the interest rate, the size of the loan, the length of time for which it is borrowed, and the frequency with which interest is compounded. The percentage of a loan's principal that the lender collects as interest from the borrower. It's the cost the borrower incurs to use the bank's funds. Demand and supply in the market, the currency of the principle sum, government directions to the central bank in accomplishing government goals, the term to maturity of the investment, the possibility of default by the borrower, and so on can all affect the interest rate in the country.

13. Gross Domestic Product

Gross domestic product (GDP) is the market worth of all final products and services produced in a country during a certain time period and expressed in monetary terms (GDP). Estimates of Nominal GDP are frequently employed as a means of communicating the economic performance of any nation or region. In order to compare the level of living in different nations or areas, per capita GDP at purchasing power parity is used instead of per capita Nominal GDP since it accounts

for differences in inflation and cost of living. As per the definition of OECD, the GDP is "an aggregate measure of production equal to the sum of the gross values added of all resident and institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs).” Total GDP can be broken down into its component parts according to the relative importance of the various economic sectors. Standard of living, or GDP divided by the entire population, is measured in terms of the ratio between the two. According to the International Monetary Fund, "GDP quantifies the monetary value of final products and services produced in a country over a specific period of time (say a quarter or a year)."

3.10 Economic events related to Crude oil

Over the past four decades, oil prices have fluctuated in response to political and other developments. When oil supply is interrupted or future supplies are unknown, prices tend to rise.

1. Dot Com Bubble

The dotcom bubble is a stock market bubble that occurred between 1995 and 2000 as a result of speculation in dotcom, or internet-based, enterprises. The majority of the businesses have ".com" domains as part of their web addresses. The price of crude oil kept fluctuating in this period. Oil prices were under pressure due to rising Russian output, OPEC members exceeding limits, and a faltering US economy. OPEC agreed to reduce output over the time period in response; a quota cut of 3.5 million barrels was made up until September 2000. Up to the middle of November 2001, the price of crude oil had already decreased by 35%. However, OPEC did not start reducing its quota until January 2002. the ongoing 4,62,500-barrel reduction in output by Russia, OPEC, and non-OPEC nations.

2. 9-11 attacks

The 11 September 2001 terrorist attack on US economic and military facilities, which temporarily sent oil prices surging to above $31 per barrel, reaffirmed the link between the oil market and political instability. The New York Mercantile Exchange (NYMEX), which is nearby the World Trade Centre, is at the centre of US oil trade, and while the attack caused stock markets to crash, it also had an effect on the oil

market, especially after it was revealed that several of the hijackers involved in the attacks were from West Asia. Many people were worried that the US's fight against terrorism would extend to nations suspected of harbouring terrorists (viz., Iran, Iraq and Libya). The fact that all of these nations are significant oil producers increased the market's anxiety. The oil market has also become more unstable, despite the fact that prices have now dropped to $18–20 per barrel as the West Asia Peace Process is currently going through one of its most violent and tumultuous phases.

3. Energy Crisis (2003)

Many things changed around the beginning of the century. Many countries transitioned from rural to modern industrialised economies. Industrialization and urbanisation are both closely related to oil consumption. The newly industrialised countries were responsible for 69% of the increase in world consumption. Because of improving living standards, more people can afford cars and have a tendency to use more energy to power their homes. Particularly considerably increasing their use of oil was China and India. When adjusted for inflation, oil prices during the 2000s energy crisis, which lasted from 2003 to 2008, reached all-time highs. In 2000, a barrel of oil cost $30 on average. From 2003 to 2008, there was a definite upward tendency, but it was more irregular than usual.

From the middle of the 1980s until September 2003, the average price of a barrel of crude oil on the NYMEX was less than $25 in 2008 dollars. The price grew by more than $30 in 2003, reached $60 on August 11, 2005, and reached its highest point of $147.30 in July 2008. Commentators have linked these price increases to a number of factors, including Middle East unrest, soaring Chinese demand, the declining value of the dollar, signs of dwindling petroleum reserves, worries about peak oil, and financial speculation.

4. Low spare capacity (2005)

The price of crude oil then shot up to USD 42.33 a barrel, reaching a record high in the 21 years it had been traded on the New York Mercantile Exchange. The second Persian Gulf War, increased Chinese demand for crude oil, and a shortage in US capacity for refining crude oil were a few of the factors contributing to the spike. The Venezuelan Crisis, often known as the "Oil Strike" or oil lockout in late 2002, was, however, the event that the increase was most strongly associated with.

Venezuelan oil production fell by 2.1 million barrels per day between December 2002 and January 2003 as a result of the strike. In addition, from April to July 2003, US attacks on Iraq removed an extra 2.2 million barrels per day.

Over the past 20 years or so, OPEC's spare production capacity has occasionally indicated pressure. Initially, in the early 1990s, and most recently, in 2004, this was brought on by unanticipatedly high demand and/or unforeseen production losses. However, since 2004, the levels of spare capacity have significantly increased despite some persistent geopolitical problems in nations like Nigeria and Iraq. Between 2003 and 2008, while OPEC's spare capacity levels were comparatively low, oil prices rose. High spare capacity suggests a withholding of output, perhaps for price management objectives, while low spare capacity restricts OPEC's ability to respond to demand and price hikes.

5. Chinese stock bubble (2007)

The Chinese stock bubble was the primary factor in both the February 27 and November 2007 global stock market crashes, which destroyed hundreds of billions of dollars' worth of market value. Following claims that Chinese economic officials planned to raise interest rates in an effort to lower inflation and crack down on speculative trading using borrowed money, the SSE Composite Index of the Shanghai Stock Exchange dropped by 9%, the most in ten years.

The benchmark Shanghai Composite index spiked in the fourth quarter of 2006, exploded in 2007, tripling in size in just one year, and then abruptly started to decline at the beginning of 2008. These all describe a classic price and speculative bubble. Early in 2007, several financial analysts and economists identified it as a bubble, and in the middle of 2007, the government also started taking action to stop it.

6. Global financial Collapse (2008)

The oil and gas industry were significantly harmed by the 2008 financial crisis and the Great Recession that followed, which resulted in a sharp decrease in oil and gas prices and a contraction in credit. Oil and gas firms saw a reduction in revenues as a result of the price decline. Due to the restrictive credit circumstances brought on by the financial crisis, many producers and explorers were forced to raise cash at high interest rates, which will have an adverse effect on future profits.

From a peak of $133.88 in June 2008 to a low of $39.09 in February 2009, oil prices declined. The cost of natural gas decreased from $12.69 to $4.52 within the same time period. The financial crisis's primary effect on the sector was the drop in oil and gas prices. Thus, energy prices decreased as a result of declining demand, a reduction in available credit for purchases, and fewer corporate earnings, which resulted in job losses and more unemployment.

7. OPEC cuts production targets 4.2 mbpd (2009)

Oil exporting nations cut their production in 2008 by more than three million barrels per day in order to stabilise oil prices, which had fallen by roughly $100 per barrel since May 2008. That amounts to around 75% of the production cuts that cartel participants have committed to enacting since September 2008.

Saudi Arabia, the top exporter in the world, has taken the initiative to cut production, dropping it from about 10 million barrels per day in 2008 to eight million barrels per day. In February 2009, OPEC producers agreed to reduce their daily output by 4.2 million barrels, or around 5% of the world's supply.Oil lost 70% of its value in 2008–2009 as the global economy collapsed and oil consumption fell. The greatest consumer in the world, the United States, has seen a decline in demand of about 8%, or 1.6 million barrels per day, from 2008 to 2009.

8. Brazil Economic Crisis (2014)

Brazil went through a serious economic crisis starting in the middle of 2014. The Gross Domestic Product (GDP) of the nation decreased by 3.5% in 2015 and 3.3% in 2016, following which a modest economic recovery started. Up until 2020, when the COVID-19 epidemic started to affect the economy once more, the recovery was ongoing. The political crisis that led to President Dilma Rousseff's impeachment coincided with the economic catastrophe. Together, these incidents led to widespread public discontent with the political system.

The aforementioned political crisis as well as the 2014 commodity price shock, which adversely damaged Brazil's exports and decreased the inflow of foreign capital into the economy, were the root causes of the crisis. The internal factors that were related to economic measures that didn't produce the desired effects were, however, the most significant factor. The nova matriz econômica, which was adopted in 2011, is the name of these policies ("new economic matrix").

Brazil experienced high unemployment rates during the economic crisis, and a slew of political scandals contributed to a generalised lack of confidence in the country's economic prospects. The GDP of Brazil increased by 1% in the first quarter of 2017. This was the first GDP growth in eight straight quarters. Henrique Meirelles, Brazil's finance minister, declared that the country had "emerged from the largest crisis of the century." However, the increase in GDP did not signal the end of the crisis; it only signalled the end of a technical recession. The second-worst recession in the nation's history was followed by the slowest recovery.

9. Russian Economic Crisis (2014)

The low interest rates set by the U.S. Federal Reserve after the Great Recession began in 2007 had a huge impact on emerging markets. As investors searched for higher rates, capital shifted away from the United States and other wealthy countries and towards frontier and emerging economies. Companies seeking to profit from these developments quickly accrued debt in US dollars, particularly Russia, whose debt increased from 6.5 percent of GDP in 2008 to 13.5 percent of GDP in 2017.

The Russian economy depends heavily on crude oil and natural gas, particularly when it comes to state-owned behemoths like Gazprom. Between mid-2014 and early-2016, the price of crude oil dropped from a high of $107.95 per barrel to a low of $29.16 per barrel, drastically lowering the country's main source of income. 2 Investors have responded by selling oil-related stocks, and concerns about the government's ability to weather the storm are widespread.

The end effect for Russia is that the price of crude oil is under pressure to rise since OPEC has committed to enforcing supply cuts and the global economy is still showing signs of revival.

10. OPEC production quota unchanged (2015)

In spite of calls from members like Venezuela to reduce production so that crude oil prices may rise in 2015, OPEC maintained its 30 million barrels per day production cap at its 166th meeting in 2014. Venezuela and Nigeria, for example, are pushing for a reduction in production. For its economy to be supported, Venezuela needs a price of $120 per barrel. Even though OPEC holds 80% of the world's known reserves, it only delivers 33% of the world's total demand.

In the past, OPEC could decrease output to raise prices and increase production to lower prices. In the event that OPEC reduces production, nations like Russia might continue to produce at record rates and erode OPEC's market share. By doing this, OPEC seeks to eliminate the weaker players from the market, particularly the US Shale Oil producers.

11. Chinese Stock Market Crash (2015)

On June 12th, 2015, the Chinese depreciated more than 30% of the value of Class-A shares in just three weeks. When compared to the entire UK in 2013 and more than seven times the size of Greek debt, which at the time was a significant source of danger in the global financial markets, the provided a damning picture of the sheer enormity of this collapse.

The market dropped by about 8.5% on July 27, 2015, the most since 2007. On August 24, 2015, also known as "Black Monday," there was a further 8.5% decline. On August 25, 2015, often known as "Black Tuesday," the market experienced a further decline of almost 7.6%. The year came to a close with some relative stability, but the new year would bring on more aftershocks.

12. Global pandemic reduces oil demand (2019)

The timing of COVID-19 for the oil and gas sector could not have been worse. Oil consumption decreased by 10% in March 2020 and 30% in April 2020 as a result of lockdowns, with the International Energy Agency (IEA) predicting a 6–10% decline in demand year 2020, or a loss of 9.3 million barrels per day (bpd).Also, The pricing war between Saudi Arabia and Russia led to the collapse of crude oil prices as COVID-19 triggered unheard-of drops in demand. Beginning in March 2020, as the pandemic reached its height in Asia, OPEC opened their taps, dumping cheap oil on the world. This persisted into April as OPEC boosted output by 2.3 million bpd despite a 28 million bpd decline in world demand.

Crude oil prices fell from $64 to $18.47 between January and April 2020 as a result of the combination of decreasing demand and increased OPEC production. A lot of businesses were also juggling high inventory levels, with storage terminals filling up, incoming cargoes being delayed, and floating storage and pipelines being exploited to make up for onshore inventory restrictions.

Chapter 4

Examining the relationship between Crude Oil and Macroeconomic Variables of BRICS Countries

4.1 Introduction

This chapter will deal with relationship between Crude Oil Prices and Macro-economic variables in BRICS countries using quarterly data from 01st April 1999 to 31st March 2021 and a Correlation, Regression analysis, Unit root test, Cointegration, Vector auto regression, Vector error correction model, Granger Causality test has been deployed to study the relationship between Crude Oil and Macro-economic variables of BRICS countries. In this chapter, the research addresses the first three formulated questions (Chapter 3, section 3.3. Subsequently, the detailed empirical analysis of stock markets is presented in sections 4.2 to 4.4)

4.2 Result and Discussion

Table 4.1 elaborates the results summary statistics of macro-economic variables of BRICS countries. Table 4.1 presents a synopsis of the descriptive statistics of stock market returns and 13 macroeconomic factors for the BRICS nations. The mean is a measure of performance that is utilised in this context not for the purpose of comparing all of the variables together but rather to reflect the average performance of each individual variable. The standard deviation is a measure of the amount of variation in the data collected over a given time period. The study found mixed skewness in BRICS countries. To understand the data, summary statistics are offered before advanced analyses.

Table 4.1 Correlation Between Macroeconomic variable and Brent Crude Oil from 01st April 1999 to 31st March 2021

Brent	ER	EXPORT	GDP	INF	IR	MS	CA	FDI	FOREX	GOLD	Silver	IMPORT	IP
Brazil	-0.21	-0.07	-0.10	-0.10	-0.67	0.72	-0.08	0.03	0.81	0.63	0.02	-0.10	0.95
Russia	0.09	0.95	0.06	0.72	-0.87	0.78	0.26	-0.10	0.89	0.67	0.79	0.93	0.81
India	0.28	0.84	0.68	0.63	0.15	0.71	0.86	-0.54	0.81	0.77	0.60	0.79	0.77
China	-0.79	0.83	0.71	0.67	0.36	0.68	0.73	-0.14	0.84	0.84	0.75	0.85	-0.04
South Africa	-0.13	0.20	0.21	-0.09	-0.01	-0.05	0.01	-0.12	0.33	-0.29	0.16	0.30	0.23

Source: Authors Computation

Table 4.2: Descriptive Statistics of Macro economic variables of BRICS countries from 01st April 1999 to 31st March 2021

Table 4.2 (a): Descriptive Statistics of Macro economic variables of Brazil

	CA	ER	EXPORT	FOREX	GDP	GOLD	IMPORT	INF	IP	IR	MS	BRENT	SILVER	FDI
Mean	0.02	0.88	25.35	12.01	27.41	7.34	25.36	4.23	4.59	2.53	28.30	4.01	5.82	19.76
Median	0.01	0.83	25.30	12.39	27.44	7.56	25.37	4.23	4.59	2.55	28.35	4.08	5.85	22.42
Maximum	0.30	1.42	26.42	12.83	28.19	8.51	26.36	4.80	4.74	3.28	29.50	4.81	6.69	23.98
Minimum	-0.34	0.45	23.98	10.44	26.33	0.00	24.17	3.58	4.36	1.44	26.79	2.73	4.65	9.15
Std. Dev.	0.11	0.27	0.61	0.89	0.59	1.35	0.61	0.35	0.10	0.37	0.84	0.55	0.64	5.56
Skewness	0.02	0.32	-0.44	-0.58	-0.29	-3.99	-0.15	-0.13	-0.32	-0.37	-0.19	-0.34	-0.40	-1.28
Kurtosis	4.29	1.90	2.55	1.62	1.72	22.22	1.76	1.99	2.07	2.84	1.67	2.06	1.86	2.70
Jarque-Bera	5.57	5.43	3.30	10.81	6.56	1443.34	5.42	3.61	4.25	1.92	6.36	4.49	6.50	22.06

Source: Authors Computation

Table 4.2 (b): Descriptive Statistics of Macro economic variables of Russia from 01st April 1999 to 31st March 2021

	CA	ER	EXPORT	FDI	FOREX	GDP	GOLD	IMPORT	Inflation	IP	IR	MS	SILVER
Mean	9.42	3.53	24.90	18.26	12.07	17.60	10.10	24.36	3.94	4.43	2.47	30.09	6.67
Median	9.53	3.41	25.08	21.21	12.68	14.51	10.00	24.60	4.04	4.49	2.40	30.39	8.43
Maximum	10.58	4.31	25.66	23.82	13.23	30.93	11.39	25.20	4.74	4.68	4.01	31.70	9.63
Minimum	4.93	3.16	23.50	4.42	8.86	13.90	8.77	22.93	2.72	4.01	1.66	27.38	0.00
Std. Dev.	0.85	0.32	0.64	6.33	1.22	6.57	0.84	0.72	0.57	0.19	0.57	1.29	3.79
Skewness	-2.37	1.25	-0.67	-0.96	-1.18	1.52	-0.01	-0.68	-0.39	-0.7	0.75	-0.52	-1.16
Kurtosis	12.24	3.04	2.09	2.14	3.16	3.31	1.55	2.07	2.08	2.22	3.32	1.99	2.45
Jarque-Bera	341.0	19.65	8.26	13.95	17.63	29.47	6.66	8.66	4.59	8.09	7.49	6.58	17.94

Source: Authors Computation

Table 4.2 (c): Descriptive Statistics of Macro economic variables of India from 01st April 1999 to 31st March 2021

	CA	ER	EXPORT	FDI	FOREX	GDP	GOLD	IMPORT	Inflation	IP	IR	MS	SILVER
Mean	24.64	3.94	24.33	17.36	12.00	30.34	10.52	28.81	4.12	4.28	1.92	31.41	1.43
Median	25.05	3.87	24.56	23.63	12.45	30.30	10.64	29.03	4.05	4.38	1.85	31.51	1.48
Maximum	25.61	4.28	25.23	27.06	12.90	31.51	11.44	30.12	4.77	4.76	2.29	32.62	1.56
Minimum	23.03	3.67	22.86	8.35	10.29	29.19	9.33	27.11	3.55	3.67	1.79	29.94	0.00
Std. Dev.	0.89	0.17	0.77	8.20	0.81	0.74	0.75	0.95	0.40	0.34	0.15	0.84	0.18
Skewness	-0.53	0.57	-0.55	-0.03	-0.92	-0.01	-0.22	-0.41	0.15	-0.38	0.86	-0.18	-6.33
Kurtosis	1.67	1.87	1.78	1.03	2.42	1.61	1.43	1.70	1.51	1.67	2.26	1.64	50.74
Jarque-Bera	9.60	8.53	8.98	12.93	12.35	6.41	8.91	7.91	7.76	7.82	11.74	6.54	8131.72

Source: Authors Computation

Table 4.2 (d): Descriptive Statistics of Macro economic variables of China from 01st April 1999 to 31st March 2021

	CA	ER	EXPORT	FDI	FOREX	GDP	GOLD	IMPORT	Inflation	IP	IR	MS	SILVER
Mean	24.32	1.97	26.30	20.19	13.99	29.69	8.57	26.14	4.44	4.66	1.13	31.53	6.66
Median	24.41	1.93	26.56	23.33	14.48	29.78	8.74	26.40	4.44	4.71	1.18	31.54	7.07
Maximum	25.63	2.11	27.20	25.14	15.20	30.86	9.30	27.06	4.68	4.78	1.42	32.87	8.01
Minimum	22.65	1.81	24.55	9.96	11.90	28.39	7.67	24.45	4.24	0.00	0.99	30.04	0.00
Std. Dev.	0.94	0.12	0.83	6.00	1.16	0.75	0.54	0.80	0.15	0.53	0.10	0.88	1.43
Skewness	-0.20	0.10	-0.71	-0.91	-0.65	-0.20	-0.42	-0.72	0.05	-8.71	0.55	-0.10	-3.75
Kurtosis	1.67	1.36	2.07	1.88	1.87	1.66	1.67	2.16	1.49	77.28	3.88	1.65	17.97
Jarque-Bera	6.38	9.10	9.66	15.15	9.94	6.55	8.19	9.19	7.59	19404.98	6.67	6.23	934.18

Source: Authors Computation

Table 4.2 (e): Descriptive Statistics of Macro economic variables of South Africa from 01st April 1999 to 31st March 2021

	ER	EXPORT	GDP	INFLATION	IR	MS	CA	FDI	FOREX	GOLD	SILVER	IMPORT	IP
Mean	0.01	0.03	0.02	0.01	-0.01	0.03	-0.02	-0.25	0.03	0.03	0.00	0.03	0.00
Median	0.01	0.03	0.02	0.01	0.00	0.02	-0.13	0.19	0.01	0.02	0.00	0.02	0.02
Maximum	0.24	0.20	0.06	0.03	0.19	0.09	6.91	20.61	0.25	0.27	5.53	0.22	0.07
Minimum	-0.18	-0.16	-0.01	-0.02	-0.24	-0.01	-4.85	-20.96	-0.06	-0.15	-7.40	-0.21	-0.17
Std. Dev.	0.07	0.07	0.01	0.01	0.07	0.02	1.88	8.16	0.06	0.07	1.05	0.07	0.06
Skewness	0.27	-0.05	0.15	-0.07	-0.85	0.94	0.68	-0.07	1.66	0.62	-2.62	-0.05	-1.08
Kurtosis	4.52	3.23	4.04	4.32	5.07	4.05	4.80	5.35	6.10	3.80	42.01	4.24	3.19
Jarque-Bera	8.65	0.21	3.88	5.90	23.93	15.58	17.01	18.42	68.70	7.31	5163.47	5.11	15.76

Source: Authors Computation

In order to gain a better understanding of the relationship between macroeconomic variables and crude oil prices, we used a total of thirteen macroeconomic variables. These variables include the following: the exchange rate; import; export; gross domestic product; inflation rate; money supply; current account; foreign direct investment; gold prices; silver prices; industrial production; foreign exchange reserve; and interest rates; and we used Brent crude as a proxy for crude oil prices.

The relationship between Crude oil and other macroeconomic indicators is laid down in Table 4.1. From the table it is clearly understood that some of the variables are negatively correlated with crude oil and vice versa. Additionally, it provides an explanation for the connection between Brent crude oil and many macroeconomic factors. According to the data presented in the table above, a negative relationship exists in Brazil between ER, Export, GDP, INF, IR, and MS imports and exports. In Russia, an inverse relationship can be shown between interest rates and FDI levels. In a manner that is analogous to this, a negative association can be found in South Africa between ER, INF, IR, MS, and FDI and gold. In China, there is a negative correlation between ER and IP. Every country has been found to have a negative association for the macroeconomic indicator, with the exception of FDI.

Table 4.2 (a) to 4.2 (e) elaborates the results summary statistics of Brent crude oil and 13 macroeconomic factors for the BRICS nations. The mean is a measure of performance that is utilised in this context not for the purpose of comparing all of the variables together but rather to reflect the average performance of each individual variable. The standard deviation is a measure of the amount of variation in the data collected over a given time period. The study shows a mixed response of skewness in BRICS countries. Before proceeding with advanced analyses, the results of the summary statistics are presented so that the nature of the data may be understood.

In order to acquire a deeper comprehension of the connection that exists between the state of macroeconomic factors and the price of crude oil regression model has been used. In addition to this, the characteristics of the countries, as well as their classification, according to the International Energy Agency. The BRICS countries have been broken up into three categories: oil exporting countries, oil importing countries, and both oil exporting and importing countries. With the use of a regression model. The sign of a regression coefficient will tell whether there is

a positive or negative relationship between each independent variable and the one that is being analysed (the dependent variable). A positive coefficient shows that there is a tendency for the mean of the dependent variable to increase in conjunction with an increase in the value of the independent variable. When the coefficient is negative, it shows that when the independent variable increases, there is a tendency for the dependent variable to decline.

Table 4.3 provides an explanation of the impact that changes in brent have on macroeconomic variables. Both India and South Africa are included in the category of countries that import crude. Except for the current account, all of the variables have a negative relationship with crude oil. The above model is reliable because it explains 95% of the data. Inflation, money supply, foreign direct investment, gold prices, industrial production, and the current account are all statistically significant at 5%.

In a similar manner, there is no autocorrelation present in this model due to the fact that DW statistics is lower than 4. At the 5% level of statistical significance, the following variables in South Africa are statistically significant: gold prices; exchange rate; export; inflation; money supply; foreign direct investment; and foreign exchange reserve. And as the aforementioned model suggests, all of the variables that are statistically significant are having a negative impact on the price of crude oil, with the exception of foreign direct investment and foreign exchange reserve.

Table 4.3: Oil Importing Countries impact of Brent on Macroeconomic Variables (India and South Africa) from 01st April 1999 to 31st March 2021

India					South Africa				
	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**	**Variable**	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-22.55	13.55	-1.66	0.04*	C	0.02	0.04	0.54	0.04*
ER	0.72	0.51	1.41	0.16	ER	-0.56	0.25	-2.21	0.0306*
EXPORT	0.69	0.24	2.91	0.00*	EXPORT	-0.56	0.25	-2.21	0.0306*
GDP	0.68	0.48	1.41	0.16	GDP	1.14	1.63	0.70	0.49
INF	-1.22	1.06	-1.15	0.02*	INF	-0.36	0.32	-1.13	0.02609*
IR	0.25	0.20	1.25	0.03*	IR	0.34	0.28	1.20	0.23
MS	-1.10	0.45	-2.44	0.0173*	MS	-1.02	0.93	-1.10	0.0275*
CA	1.08	0.19	5.85	0.005*	CA	0.00	0.01	0.09	0.93
FDI	-0.003	0.01	-0.49	0.02*	FDI	0.00	0.00	-1.08	0.02829*
FOREX	0.11	0.14	0.78	0.44	FOREX	0.63	0.29	2.19	0.0323*
GOLD	-0.16	0.20	-0.79	0.43	GOLD	-0.66	0.22	-2.92	0.0047*
Silver	0.52	0.12	4.43	0.00	Silver	0.02	0.01	1.18	0.24
IMPORT	0.10	0.25	0.40	0.69	IMPORT	0.40	0.32	1.22	0.22
IP	-1.11	0.82	-1.35	0.18	IP	0.41	0.29	1.40	0.17
R-squared	0.950078				R-squared	0.686778		Durbin-Watson stat	2.105851
Adjusted R-squared	0.940391		Durbin-Watson stat	1.562882	Adjusted R-squared	0.567794			

Source: Authors Computation

Table 4.4: Oil Importing and Exporting Countries impact of Brent on Macroeconomic Variables (China and Brazil) from 01st April 1999 to 31st March 2021

China					Brazil				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**Variable**	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-4.35	4.67	-0.93	0.0355*	C	18.15	14.33	1.27	0.0120*
ER	-2.74	0.69	-3.95	0.0002*	ER	-0.19	0.19	-1.00	0.0318*
EXPORT	-0.36	0.37	-0.98	0.33	EXPORT	-0.07	0.30	-0.24	0.81
GDP	0.08	0.18	0.45	0.66	GDP	-3.08	0.99	-3.11	0.0027*
INF	-3.46	1.27	-2.73	0.0081*	INF	2.06	1.12	1.85	0.07
IR	1.26	0.24	5.25	0.00*	IR	-0.04	0.09	-0.44	0.0188*
MS	-0.12	0.07	-1.70	0.09	MS	1.03	0.63	1.64	0.11
CA	0.46	0.36	1.27	0.21	CA	-0.33	0.16	-2.12	0.0375*
FDI	0.02	0.01	2.11	0.04	FDI	0.03	0.01	2.80	0.0067*
FOREX	-0.19	0.19	-1.00	0.32	FOREX	0.08	0.07	1.11	0.27
GOLD	-0.26	0.26	-1.02	0.31	GOLD	0.01	0.02	0.42	0.67
Silver	0.07	0.03	2.53	0.0136*	Silver	0.14	0.13	1.10	0.28
IMPORT	1.20	0.24	5.07	0.00*	IMPORT	0.56	0.27	2.09	0.0407*
IP	0.00	0.04	-0.07	0.94	IP	3.92	0.65	6.05	0.000*
R-squared	0.937036				R-squared	0.954107	Durbin-Watson stat		1.131838
Adjusted R-squared	0.924819		Durbin-Watson stat	1.858126	Adjusted R-squared	0.945203			

Source: Authors Computation

.

Table 4.5: Oil Exporting Country impact of Brent on Macroeconomic Variables (Russia) from 01st April 1999 to 31st March 2021

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-29.35	5.28	-5.56	0.00*
ER	0.08	0.29	0.26	0.80
EXPORT	1.15	0.16	7.38	0.00*
GDP	-0.03	0.01	-4.23	0.0001*
INF	-0.47	0.46	-1.02	0.31
IR	0.02	0.08	0.28	0.78
MS	0.47	0.30	1.56	0.12
CA	0.02	0.02	1.20	0.23
FDI	0.01	0.01	1.37	0.18
FOREX	-0.10	0.10	-1.01	0.31
GOLD	-0.09	0.16	-0.60	0.55
Silver	-0.05	0.01	-4.48	0.00*
IMPORT	-0.48	0.23	-2.11	0.0386*
IP	1.45	0.71	2.04	0.0451*
R-squared	0.970566	Durbin-Watson stat		1.523241
Adjusted R-squared	0.964587			

Source: Authors Computation

The relationship between crude oil and the various macroeconomic variables of countries that import and export crude oil is broken down in greater detail in Table 4.4. Both China and Brazil are included in the category of countries that export as well as import oil. There it can be shown quite clearly that the Exchange rate, the Inflation rate, the Interest rate, the foreign exchange reserve, gold prices, and silver prices are statistically significant at the 5% level. In addition to that, every single macroeconomic variable, with the exception of silver prices, is having a negative impact. There is no autocorrelation in the model, and the model explains 93% of the association that was found using the data. The relationship between brent crude oil and the various macroeconomic factors of oil exporting countries is broken down in Table 4.5. Russia is considered as oil exporting country. As can be seen in the table below, export, gross domestic product, inflation, silver prices, and industrial production all feature prominently. The above regression model reveals that all of the macroeconomic factors that are significant statistically have a negative connection with crude oil, with the exception of export. The model explains 97% of the relationship with no autocorrelation.

Table 4.6: Unit Root Test (Augmented Dickey-Fuller Test) of Macro economic variables of BRICS countries from 01st April 1999 to 31st March 2021

Variables	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference
	BRAZIL		RUSSIA		INDIA		CHINA		SOUTH AFRICA	
Exchange Rate	-1.72492	-7.16996	-0.13614	-7.98716	-0.34223	-8.48035	-1.14542	-6.06563	-0.84088	-6.73934
	[0.4149]	[0.00]	[0.9411]	[0.00]	[0.9128]	[0.00]	[0.6939]	[0.00]	[0.8016]	[0.00]
Export	-1.46145	-7.6007	-1.92457	-5.02314	-1.78339	-7.31295	-3.57833	-	-1.65237	-7.5547
	[0.5479]	[0.00]	[0.3196]	[0.00]	[0.3861]	[0.00]	[0.008]		[0.4512]	[0.00]
Foreign Direct Investment	-0.75404	-9.17625	-1.63591	-14.5632	-1.0082	-9.06961	-0.70663	-8.9821	-4.68916	-
	[0.826112]	[0.00]	[0.4596]	[0.00]	[0.7469]	[0.00]	[0.838]	[0.00]	[0.00]	
Foreign Exchange Reserve	-0.72061	-12.0718	-4.14724	-	-2.5472	-5.20907	-2.62015	-3.19761	-0.97193	-3.3028
	[0.8.4836]	[0.00]	[0.00]		[0.1085]	[0.00]	[0.09]	[0.023]	[0.75]	[0.0181]
Gross Domestic Product	-3.85937	-	-0.45429	-8.84229	-1.06712	-3.04692	-2.07172	-8.2649	-5.05074	-
	[0.00]		[0.8935]	[0.00]	[0.7251]	[0.035]	[0.2566]	[0.00]	[0.00]	
Import	-1.05238	-6.95399	-1.78969	-4.86363	-1.39952	-8.62212	-3.0294	-6.20809	-1.76112	-9.00535
	[0.7307]	[0.00]	[0.383]	[0.00]	[0.5785]	[0.00]	[0.0365]	[0.00]	[0.397]	[0.00]
Inflation Rate(CPI)	-1.39816	-3.48063	-2.41596	-10.6207	-2.18396	-15.3609	-1.95788	-6.4186	-0.53181	-4.17921
	[0.579]	[0.011]	[0.1409]	[0.00]	[0.2138]	[0.00]	[0.304]	[0.00]	[0.8784]	[0.00]
Interest Rate	-2.4276	-4.44386	-2.87093	-8.49685	-2.08944	-10.6466	-3.0103	-8.7221	-1.85085	-5.42327
	[0.1376]	[0.00]	[0.0534]	[0.00]	[0.2495]	[0.00]	[0.0382]	[0.00]	[0.3537]	[0.00]
Money Supply(M3)	-3.72075	-	-4.34273	-	1.21135	-5.95293	-6.42394	-	-3.94576	-
	[0.00]		[0.00]		[0.998]	[0.00]	[0.00]		[0.00]	
Exchange Rate	-0.75404	-9.17625	-1.63591	-14.5632	-1.0082	-9.06961	-0.70663	-8.9821	-4.68916	-
	[0.826112]	[0.00]	[0.4596]	[0.00]	[0.7469]	[0.00]	[0.838]	[0.00]	[0.00]	
Current Account	-0.72061	-12.0718	-4.14724	-	-2.5472	-5.20907	-2.62015	-3.19761	-0.97193	-3.3028
	[0.8.4836]	[0.00]	[0.00]		[0.1085]	[0.00]	[0.09]	[0.023]	[0.75]	[0.0181]
Gold Prices	-3.85937	-	-0.45429	-8.84229	-1.06712	-3.04692	-2.07172	-8.2649	-5.05074	-
	[0.00]		[0.8935]	[0.00]	[0.7251]	[0.035]	[0.2566]	[0.00]	[0.00]	
Industrial Production	-1.05238	-6.95399	-1.78969	-4.86363	-1.39952	-6.95399	-3.0294	-6.20809	-1.76112	-9.00535
	[0.7307]	[0.00]	[0.383]	[0.00]	[0.5785]	[0.00]	[0.0365]	[0.00]	[0.397]	[0.00]
BRENT Crude	-1.05238	-6.95399	-1.78969	-4.86363	-1.39952	-8.62212	-3.0294	-6.20809	-1.76112	-10.6466
	[0.7307]	[0.00]	[0.383]	[0.00]	[0.5785]	[0.00]	[0.0365]	[0.00]	[0.397]	[0.00]
Silver Prices	-1.39816	-3.48063	-2.41596	-10.6207	-2.18396	-15.3609	-1.95788	-6.4186	-0.53181	-4.17921
	[0.579]	[0.011]	[0.1409]	[0.00]	[0.2138]	[0.00]	[0.304]	[0.00]	[0.8784]	[0.00]

Source: Author's Computation

Table 4.7: Johansen Co-Integration Results of Macro economic variables of BRICS countries.

Table 4.7(a): Johansen Co-Integration Results (Brazil)

Variables	Trace						Max-Eigen					
	None			At most 1			None			At most 1		
	Trace Statistics	Critical Value (5%)	Prob.	Trace Statistics	Critical Value (5%)	Prob.	Max-Eigen Statistics	Critical Value (5%)	Prob.	Max-Eigen Statistics	Critical Value (5%)	Prob.
Export	7.19	15.49	0.55	0.90	3.84	0.34	6.28	14.26	0.57	0.90	3.84	0.34
Foreign Direct Investment	6.14	15.49	0.67	0.55	3.84	0.45	5.58	14.26	0.66	0.55	3.84	0.45
Foreign Exchange Reserve	20.72	25.87	0.19	2.10	12.51	0.96	18.62	19.38	0.06	2.10	12.51	0.96
Gross Domestic Product	20.42	15.49	0.00*	4.08	3.84	0.04*	16.33	14.26	0.02*	4.08	3.84	0.04*
Import	21.55	25.87	0.15	5.90	12.51	0.47	15.65	19.38	0.16	5.90	12.51	0.47
Inflation Rate(CPI)	9.23	15.49	0.34	0.82	3.84	0.36	8.40	14.26	0.33	0.82	3.84	0.36
Interest Rate	16.31	25.87	0.46	3.59	12.51	0.79	12.72	19.38	0.35	3.59	12.51	0.79
Money Supply(M3)	18.70	15.49	0.01*	6.05	3.84	0.01*	12.64	14.26	0.08	6.05	3.84	0.01*
Exchange Rate/USD	10.36	15.49	0.25	2.43	3.84	0.11	7.92	14.26	0.38	2.43	3.84	0.11
Current Account	41.77	15.49	0.00*	4.21	3.84	0.04*	37.55	14.26	0.00*	4.21	3.84	0.04*
Gold Prices	56.43	25.87	0.00*	4.83	12.51	0.61	51.59	19.38	0.00*	4.83	12.51	0.61
Industrial Production	16.82	15.49	0.03*	12.32	4.50	3.84	0.03	14.26	0.09	4.50	3.84	0.03*
Silver Prices	15.61	25.87	0.52	4.50	12.51	0.66	11.10	19.38	0.50	4.50	12.51	0.66

Source: Authors Computation

The outcomes of the Unit root test, as explained by the Augmented Dickey-Fuller Test, are presented in Table 4.6. The results of running the ADF model both at level and at first difference for each of the thirteen macroeconomic variables and for Brent Crude oil are presented in the table. In Brazil, all of the variables may be seen to be stationary at first difference, with the exception of Gross domestic product, money supply, and gold prices. In addition, in Russia, all of the variables are stationary at first difference, with the exception of the country's foreign currency reserve, its money supply, and its current account. Additionally, at the point of difference one, all of the variables are considered stationary in India. In a similar manner, China's exports and money supply have remained constant at the same level, while all other variables have moved to the first difference. In reference to the country of South Africa. It would appear that a number of significant macroeconomic variables, such as gold prices, foreign direct investment, gross domestic product, money supply, and exchange rate, are not changing. This is in stark contrast to the situation in the other BRICS countries.

Whereas all the macroeconomic variables are stationary at first difference and further stated that we can run Cointegration test to know the relationship between the variables. Table 4.7 displays the result of Johansen's Co-integration test. The following test has been performed by taking lag interval as 1 to 2, which has been selected as per the optimum lag length suggested by different tests like Akaie Information Criterion (AIC), Schwarz Criterion (SC) and the Likelihood Ratio (LR) test. The result of Johansen's Co-integration test indicates presence of at least one co-integrating vectors for Brazil and Russia at the 5% level of significance. This result has been supported by Trace test as well as Max Eigen values. Whereas for India, China and South Africa null hypothesis of no Co-integration can be rejected at 5% level of significance as P-value is less than 0.05. Thus, on the basis of above observation, it can be concluded that there exists a long-term relationship among all the variables pertaining to BRICS Countries. Therefore, the Vector Error Correction framework is being used to model the joint dynamics and causal relations among macroeconomic variable and crude oil from BRICS Countries.

Table 4.7(a) to 4.7(e) explains Johansen Co-Integration Results of Macro economic variables of BRICS countries. The Johansen Cointegration Test requires the presence of a level unit root. In the above data study found the presence of level unit root. As the number of lags in the VECM and Johansen test must be the same, the chosen optimal number of lags is then modified to account for autocorrelation in the VECM residuals.

Table 4.7(b): Johansen Co-Integration Results (Russia)

Variables	Trace						Max-Eigen					
	None			At most 1			None			At most 1		
	Trace Statistics	Critical Value (5%)	Prob.	Trace Statistics	Critical Value (5%)	Prob.	Max-Eigen Statistics	Critical Value (5%)	Prob.	Max-Eigen Statistics	Critical Value (5%)	Prob.
Export	16.42	25.87	0.45	4.39	12.51	0.68	12.09	19.38	0.41	4.39	12.51	0.68
Foreign Direct Investment	17.54	25.87	0.37	3.88	12.51	0.75	13.65	19.38	0.27	3.88	12.51	0.75
Foreign Exchange Reserve	43.17	25.87	0.00*	9.62	12.51	0.14	33.55	19.38	0.00*	9.62	12.51	0.14
Gross Domestic Product	5.15	15.49	0.79	0.50	3.38	0.47	4.61	14.25	0.78	0.50	3.84	0.47
Import	20.78	25.87	0.18	5.61	12.51	0.51	15.16	19.38	0.18	5.61	12.51	0.51
Inflation Rate (CPI)	26.27	15.49	0.00*	4.27	3.84	0.03*	21.99	14.26	0.00*	4.27	3.84	0.03*
Interest Rate	23.74	15.49	0.00*	9.37	3.84	0.00*	14.37	14.26	0.04*	9.37	3.84	0.00*
Money Supply(M3)	25.67	15.49	0.00*	6.32	3.84	0.01*	19.34	14.26	0.00*	6.32	3.84	0.01*
Exchange Rate/USD	30.81	25.87	0.01*	3.25	12.51	0.84	27.55	19.38	0.00*	3.25	12.51	0.84
Current Account	7.33	25.87	0.99	3.40	12.51	0.82	3.92	19.38	0.99	3.40	12.51	0.82
Gold Prices	8.96	15.49	0.36	2.44	3.84	0.11	6.52	14.26	0.54	2.44	3.84	0.11
Industrial Production	13.54	25.87	0.69	4.36	12.51	0.68	9.18	19.38	0.70	4.36	12.51	0.68
Silver Prices	13.96	15.49	0.08	3.06	3.84	0.07	10.89	14.26	0.15	3.06	3.84	0.07

Source: Authors Computation; * Indicates significant at 5% level

Table 4.7 (c): Johansen Co-Integration Results (India)

Variables	Trace						Max-Eigen					
	None			At most 1			None			At most 1		
	Trace Statistics	Critical Value (5%)	Prob.	Trace Statistics	Critical Value (5%)	Prob.	Max-Eigen Statistics	Critical Value (5%)	Prob.	Max-Eigen Statistics	Critical Value (5%)	Prob.
Export	18.71	25.87	0.29	3.17	12.51	0.85	15.53	19.38	0.16	3.17	12.51	0.85
Foreign Direct Investment	9.67	15.49	0.30	2.84	3.84	0.09	6.82	14.26	0.51	2.84	3.84	0.09
Foreign Exchange Reserve	14.66	15.49	0.06	3.66	3.84	0.055	10.99	14.26	0.15	3.66	3.84	0.055
Gross Domestic Product	14.36	15.49	0.07	4.10	3.84	0.04	10.25	14.26	0.19	4.10	3.84	0.04*
Import	18.71	25.87	0.29	2.02	12.51	0.96	16.68	19.38	0.11	2.02	12.51	0.96
Inflation Rate (CPI)	17.38	15.49	0.02*	0.22	3.84	0.63	17.15	14.26	0.01*	0.22	3.84	0.63
Interest Rate	18.02	15.49	0.02*	5.63	3.84	0.01*	12.39	14.26	0.09	5.63	3.84	0.01*
Money Supply(M3)	33.16	15.49	0.00*	5.50	3.84	0.01*	27.65	14.26	0.00*	5.50	3.84	0.01*
Exchange Rate/USD	10.16	15.49	0.26	1.29	3.84	0.25	8.87	14.26	0.29	1.29	3.84	0.25
Current Account	14.92	25.87	0.58	1.63	12.51	0.98	13.29	19.38	0.30	1.63	12.51	0.98
Gold Prices	16.76	25.87	0.43	2.96	12.51	0.88	13.80	19.38	0.26	2.96	12.51	0.88
Industrial Production	7.57	15.49	0.51	0.62	3.84	0.42	6.95	14.26	0.49	0.62	3.84	0.42
Silver Prices	8.49	15.49	0.41	1.84	3.84	0.17	6.64	14.26	0.53	1.84	3.84	0.17

Source: Authors Computation; * Indicates significant at 5% level

Table 4.7 (d): Johansen Co-Integration Results (China)

Variables	Trace						Max-Eigen					
	None			At most 1			None			At most 1		
	Trace Statistics	Critical Value (5%)	Prob.	Trace Statistics	Critical Value (5%)	Prob.	Max-Eigen Statistics	Critical Value (5%)	Prob.	Max-Eigen Statistics	Critical Value (5%)	Prob.
Export	78.88	25.87	0.00*	32.41	12.52	0.00*	46.46	19.39	0.00*	32.41	12.52	0.00*
Foreign Direct Investment	89.74	15.49	0.00*	32.68	3.84	0.00*	57.06	14.26	0.00*	32.68	3.84	0.00*
Foreign Exchange Reserve	40.60	15.49	0.00*	9.12	3.84	0.00*	31.48	14.26	0.00*	9.12	3.84	0.00*
Gross Domestic Product	66.90	25.87	0.00*	29.12	12.52	0.00*	37.79	19.39	0.00*	29.12	12.52	0.00*
Import	75.09	25.87	0.00*	26.71	12.52	0.00*	48.38	19.39	0.00*	26.71	12.52	0.00*
Inflation Rate(CPI)	53.07	15.49	0.00*	19.96	3.84	0.00*	33.11	14.26	0.00*	19.96	3.84	0.00*
Interest Rate	56.14	25.87	0.00*	19.68	12.52	0.00*	36.46	19.39	0.00*	19.68	12.52	0.00*
Money Supply(M3)	54.69	25.87	0.00*	18.07	12.52	0.01	36.62	19.39	0.00*	18.07	12.52	0.01*
Exchange Rate/USD	57.34	25.87	0.00*	24.88	12.52	0.00*	32.46	19.39	0.00*	24.88	12.52	0.00*
Current Account	75.47	15.49	0.00*	19.05	3.84	0.00*	56.42	14.26	0.00*	19.05	3.84	0.00*
Gold Prices	63.37	25.87	0.00*	24.46	12.52	0.00*	38.91	19.39	0.00*	24.46	12.52	0.00*
Industrial Production	36.43	25.87	0.00*	13.19	12.52	0.04*	23.24	19.39	0.01*	13.19	12.52	0.04*
Silver Prices	60.19	15.49	0.00*	22.87	3.84	0.00*	37.32	14.26	0.00*	22.87	3.84	0.00*

Source: Authors Computation; ** Indicates Significance level at 5%

Table 4.7(e): Johansen Cointegration Results (South Africa)

Variables	Trace						Max-Eigen					
	None			At most 1			None			At most 1		
	Trace Statistics	Critical Value (5%)	Prob.	Trace Statistics	Critical Value (5%)	Prob.	Max-Eigen Statistics	Critical Value (5%)	Prob.	Max-Eigen Statistics	Critical Value (5%)	Prob.
Export	13.55	15.49	0.09	5.72	3.84	0.01	7.83	14.26	0.39	5.72	3.84	0.01
Foreign Direct Investment	9.17	15.49	0.34	1.40	3.84	0.23	7.76	14.26	0.40	1.40	3.84	0.23
Foreign Exchange Reserve	19.06	15.49	0.01	6.24	3.84	0.01	12.82	14.26	0.08	6.24	3.84	0.01
Gross Domestic Product	22.05	25.87	0.14	8.09	12.52	0.24	13.96	19.39	0.26	8.09	12.52	0.24
Import	20.93	25.87	0.18	7.06	12.52	0.34	13.88	19.39	0.26	7.06	12.52	0.34
Inflation Rate(CPI)	8.41	15.49	0.42	0.03	3.84	0.85	8.37	14.26	0.34	0.03	3.84	0.85
Interest Rate	23.44	25.87	0.10	6.52	12.52	0.40	16.92	19.39	0.11	6.52	12.52	0.40
Money Supply(M3)	11.88	15.49	0.16	4.30	3.84	0.04	7.58	14.26	0.42	4.30	3.84	0.04
Exchange Rate/USD	22.02	15.49	0.00	3.26	3.84	0.07	18.76	14.26	0.00	3.26	3.84	0.07
Current Account	14.10	25.87	0.64	4.28	12.51	0.70	9.81	19.38	0.63	4.28	12.51	0.70
Gold Prices	18.98	25.87	0.28	2.46	12.52	0.93	16.52	19.39	0.12	2.46	12.52	0.93
Industrial Production	36.87	15.49	0.00	5.58	3.84	0.02	31.29	14.26	0.00	5.58	3.84	0.02
Silver Prices	9.72	25.87	0.94	4.11	12.52	0.73	5.61	19.39	0.97	4.11	12.52	0.73

Source: Authors Computation, ** Indicates significant at 5% level

The maximum eigenvalue and trace statistics indicate that there are one or two cointegrating relations between crude oil and macroeconomic variables at the 5% significance level. The variables must have at least one cointegrating relationship in order to use the VECM. These findings offer compelling proof that the variables do indeed have a long-term relationship. Additionally, VECM implementation could be done using the selected variables.

Table 4.8 explains VECM model for macroeconomic variables has been drawn and the model has been confirmed with Serial Correlation LM test, Normality and Heteroscedasticity test. Estimation reveals an ongoing, long-term connection between the macroeconomic environment and the crude oil. At a confidence level of 5%, the slope coefficient of the error correction term is negative and significant.

Table 4.8: Results of Vector error correction Model (VECM) of Macroeconomic variables of BRICS countries.

Variables	Co-integrating Equation and Long run model	Result of Serial Correlation LM test, Normality and Heteroscedasticity
	Brazil	
Current Account	ECT_{t-1}={1.00 CA_{t-1} -122.17 $BRENT_{t-1}$ -6.803} Current Account as a target variable: ⌂Consumption i_t= -0.0027 ECT_{t-1}+ 0.1820 $BRENT_{t-1}$ -0.076 CA_{t-1} + 0.0126	Serial Correlation LM test 0.05<0.42 Normality 0.05<0.82 Heteroscedasticity 0.05<0.56
GDP	ECT_{t-1}={1.00 GDP_{t-1} -1.3476 $BRENT_{t-1}$ +32.92} GDP as a target variable: ⌂$GDPi_t$= -0.080 ECT_{t-1}+ 0.1307$BRENT_{t-1}$ -0.11224 $BRENT_{t-2}$ + 4.59 GDP_{t-1}+0.872 GDP_{t-2} -0.1118	Serial Correlation LM test Lag 1 0.05<0.0002 Lag 2 0.05<0.1064 Normality 0.05<0.83 Heteroscedasticity 0.05<0.20
Gold Prices	ECT_{t-1}={1.00 $Gold_{t-1}$ -1.583$BRENT_{t-1}$ +7.59} Gold Price as a target variable: ⌂$Gold\ i_t$= - 0.0091ECT_{t-1}+ 0.19580$BRENT_{t-1}$ +0.0071$Gold_{t-1}$ + 0.014	Serial Correlation LM test 0.05<0.62 Normality 0.05<0.25 Heteroscedasticity 0.05<0.10
Industrial Production	ECT_{t-1}={1.00 IP_{t-1} -4.813$BRENT_{t-1}$ +18.09} IP as a target variable: ⌂IPi_t= -0.2978 ECT_{t-1}+ 0.2788 $BRENT_{t-1}$ +0.266 IP_{t-1} + 0.012	Serial Correlation LM test 0.05<0.399 Normality 0.05<0.53 Heteroscedasticity 0.05<0.411
Money Supply	ECT_{t-1}={1.00 MS_{t-1} -1.0062$BRENT_{t-1}$ +24.45}	Serial Correlation LM test 0.05<0.06

	MS as a target variable: $\Delta MS\ i_t = -0.033\ ECT_{t-1} + 0.23712 BRENT_{t-1} + 1.084\ MS_{t-1} - 0.0236$	Normality 0.05<0.0.23 Heteroscedasticity 0.05<0.08
	Russia	
Exchange Rate	ECT_{t-1}={1.00 ER_{t-1} +0.192 $BRENT_{t-1}$ +-4.70}	Serial Correlation LM test 0.05<0.06
	ER as a target variable: $\Delta ER\ i_t = -0.0416\ ECT_{t-1} + 0.101 BRENT_{t-1} - 0.073\ BRENT_{t-2} + 1.280\ ER_{t-1} + 0.104\ ERT_{t-1} + 0.303$	Normality 0.05<0.0.23 Heteroscedasticity 0.05<0.08
Foreign Exchange Reserve	ECT_{t-1}={1.00 $Forex_{t-1}$ +2.7671 $BRENT_{t-1}$ -37.71}	Serial Correlation LM test Lag 1 0.05<0.0002
	Forex as a target variable: $\Delta Forex\ i_t = -0.00464\ ECT_{t-1} + 0.1215\ BRENT_{t-1} - 0.1282\ BRENT_{t-2} + 0.580\ Forex_{t-1} + 0.048\ Forex_{t-2} - 0.01538$	Lag 2 0.05<0.1064 Normality 0.05<0.0.32 Heteroscedasticity 0.05<0.09
Inflation	ECT_{t-1}={1.00 INF_{t-1} + 3.767 $BRENT_{t-1}$ -19.1095)	Serial Correlation LM test Lag 1 0.05<0.09
	Inflation as a target variable: $\Delta Inflation\ i_t = -0.03135\ ECT_{t-1} + 0.02065\ BRENT_{t-1} - 0.099 BRENT_{t-2} - 0.158 BRENT_{t-3} + 1.94\ INF_{t-1} - 3.784\ INF_{t-2} - 2.56\ INF_{t-3} + 0.0150$	Lag 2 0.05<0.10 Lag 3 0.05<0.14 Normality 0.05<0.0.32 Heteroscedasticity 0.05<0.0.28
Money Supply	ECT_{t-1}={1.00 MS_{t-1} -1.52 $BRENT_{t-1}$ + 42.02}	Serial Correlation LM test Lag 1 0.05<0.0002
	Money Supply as a target variable: $\Delta MS\ i_t = -0.00762\ ECT_{t-1} + 0.207\ BRENT_{t-1} + 0.836 MS_{t-1} - 0.03$	Lag 2 0.05<0.1064 Normality 0.05<0.32 Heteroscedasticity 0.05<0.09
	INDIA	
Inflation	ECT_{t-1}={1.00 $Inflation_{t-1}$ +0.531 $BRENT_{t-1}$ -5.4728}	Serial Correlation LM test Lag 1 0.05<0.8
	Inflation as a target variable: $\Delta Inflation\ i_t = -0.109\ ECT_{t-1} + 0.225\ BRENT_{t-1} + 1.14 Inflation_{t-1} - 0.00411$	Normality 0.05<0.93 Heteroscedasticity 0.05<0.94
Interest Rate	ECT_{t-1}={1.00 IR_{t-1} -0.8134 $BRENT_{t-1}$ -2.4428}	Serial Correlation LM test Lag 1 0.05<0.4
	Interest rate as a target variable: $\Delta IR\ i_t = -0.0729\ ECT_{t-1} + 0.235\ BRENT_{t-1} + 0.4132\ IR_{t-1} + 0.014$	Normality 0.05<0.36 Heteroscedasticity 0.05<0.12
Money Supply	ECT_{t-1}={1.00 MS_{t-1} -0.76 $BRENT_{t-1}$ -3.42}	Serial Correlation LM test Lag 1 0.05<0.26
	Money Supply as a target variable: $\Delta MS\ i_t = -0.00035\ ECT_{t-1} + 0.2414\ BRENT_{t-1} + 0.0629 MS_{t-1} + 0.138$	Normality 0.05<0.49 Heteroscedasticity 0.05<0.89
	CHINA	
Exchange Rate	ECT_{t-1}={1.00 ER_{t-1} +3.930 $BRENT_{t-1}$ -11.7534}	Serial Correlation LM test Lag 1 0.05<0.12
	Exchange Rate as a target variable:	Normality 0.05<0.40

	⌂ER i_t= -0.127 ECT_{t-1}+ 0.285 BRENT $_{t-1}$ + 1.74272 ER_{t-1} +0.0078	Heteroscedasticity 0.05<0.35
Foreign Exchange Reserve	ECT_{t-1}={1.00 Forex $_{t-1}$ -0.5753 BRENT $_{t-1}$ +4.054}	Serial Correlation LM test Lag 1 0.05<0.41
	Foreign Exchange Reserveas a target variable:	Lag 2 0.05 <0.17
	⌂Forex i_t= -0.161 ECT_{t-1}+ 0.2447 BRENT $_{t-1}$ -0.103BRENT $_{t-2}$ +0.8562 $FOREX_{t-1}$+0.600$FOREXt_{-2}$ -0.044	Normality 0.05<0.17 Heteroscedasticity 0.05<0.0.09
Industrial Production	ECT_{t-1}={1.00 IP $_{t-1}$ +20.62 BRENT $_{t-1}$ -100.028}	Serial Correlation LM test Lag 1 0.05<0.39
	Industrial Production as a target variable:	Normality 0.05<0.23
	⌂IP i_t= -0.0007ECT_{t-1}+ 0.239 BRENT $_{t-1}$ -0.00268IP_{t-1} +0.0131	Heteroscedasticity 0.05<0.82
	SOUTH AFRICA	
Exchange Rate	ECT_{t-1}={1.00 ER $_{t-1}$ +0.86 BRENT $_{t-1}$ -0.033}	Serial Correlation LM test Lag 1 0.05<0.12
	Exchange Rate as a target variable:	Normality 0.05<0.40
	⌂ER i_t= -0.79 ECT_{t-1}+ 0.044BRENT $_{t-1}$ -0.386 ER_{t-1} +0.0054	Heteroscedasticity 0.05<0.35
		Serial Correlation LM test
Export	ECT_{t-1}={1.00 EXPORT $_{t-1}$ -2.214 BRENT $_{t-1}$ +0.0359}	Lag 1 0.05<0.25 Normality 0.05<0.36
	Export as a target variable:	Heteroscedasticity
	⌂EXPORT i_t= -0.060 ECT_{t-1}+ 0.053 BRENT $_{t-1}$ + 0.3564$EXPORT_{t-1}$ -0.0055	0.05<0.082
GDP	ECT_{t-1}={1.00 GDP $_{t-1}$ -3.33 BRENT $_{t-1}$ +0.052}	Serial Correlation LM test Lag 1 0.05<0.231
	GDP as a target variable:	Normality 0.05<0.23
	⌂GDP i_t= -0.946 ECT_{t-1}+ 0.194 BRENT $_{t-1}$ +0.04GDP_{t-1} -0.0055	Heteroscedasticity 0.05<0.48
Inflation	ECT_{t-1}={1.00 INF $_{t-1}$ +3.20 BRENT $_{t-1}$ -0.0658}	Serial Correlation LM test Lag 1 0.05<0.56
	Inflation as a target variable:	Normality 0.05<0.52
	⌂Inflation i_t= -0.78 ECT_{t-1}+ 0.140 BRENT $_{t-1}$ + 7.346 INF_{t-1} - 0.0062	Heteroscedasticity 0.05<0.32
Interest rates	ECT_{t-1}={1.00 IR $_{t-1}$ +0.47BRENT $_{t-1}$ -0.01972}	Serial Correlation LM test Lag 1 0.05<0.25
	Interest Rate as a target variable:	Normality 0.05<0.26
	⌂IR i_t= -0.0844 ECT_{t-1}+ 0.131 BRENT $_{t-1}$ + 0.26IR_{t-1} -0.0056	Heteroscedasticity 0.05<0.35
Money Supply	ECT_{t-1}={1.00 MS $_{t-1}$ -2.112 BRENT $_{t-1}$ +0.0313}	Serial Correlation LM test Lag 1 0.05<0.12
	Money Supply as a target variable:	Normality 0.05<0.40
	⌂MS i_t= -0.875 ECT_{t-1}+ 0.171 BRENT $_{t-1}$ -0.902 MS_{t-1} +0.0055	Heteroscedasticity 0.05<0.23
Current Account	ECT_{t-1}={1.00 CA $_{t-1}$ -24.91BRENT $_{t-1}$ +0.30}	Serial Correlation LM test Lag 1 0.05<0.25
	Current Account as a target variable:	Lag 2 0.05<0.27

	$\triangle CA\ i_t = -0.00012\ ECT_{t-1} - 0.471\ BRENT_{t-1} - 0.435 BRENT_{t-2} - 0.266\ BRENT_{t-3} - 0.00252\ CA_{t-1} - 0.02128\ CA_{t-2} - 0.0140\ CA_{t-3} + 0.0063$	Lag 3 0.02<0.45 Normality 0.05<0.38 Heteroscedasticity 0.05<0.54
Foreign Direct Investment	$ECT_{t-1} = \{1.00\ FDI_{t-1} - 0.16\ BRENT_{t-1} + 0.05\}$ FDI as a target variable: $\triangle FDI\ i_t = -0.069 ECT_{t-1} - 0.24\ BRENT_{t-1} - 0.005 FDI_{t-1} - 0.0054$	Serial Correlation LM test Lag 1 0.05<0.87 Normality 0.05<0.12 Heteroscedasticity 0.05<0.18
Foreign Exchange Reserve	$ECT_{t-1} = \{1.00\ FOREX_{t-1} - 0.919 BRENT_{t-1} + 0.0060\}$ Forex as a target variable: $\triangle FOREX\ i_t = -1.1692\ ECT_{t-1} + 0.30\ BRENT_{t-1} + 0.07 BRENT_{t-2} - 0.455 FOREX_{t-1} - 0.102 FOREX_{t-2} + 0.0055$	Serial Correlation LM test Lag 1 0.05<0.54 Normality 0.05<0.38 Heteroscedasticity 0.05<0.45
Gold Prices	$ECT_{t-1} = \{1.00\ Gold_{t-1} - 1.9016 BRENT_{t-1} + 0.030\}$ Gold Prices as a target variable: $\triangle Gold\ i_t = -0.51\ ECT_{t-1} + 0.004\ BRENT_{t-1} - 0.130\ Gold_{t-1} - 0.00545$	Serial Correlation LM test Lag 1 0.05<0.15 Normality 0.05<0.80 Heteroscedasticity 0.05<0.36
Silver Prices	$ECT_{t-1} = \{1.00\ Silver_{t-1} + 0.0006 BRENT_{t-1} - 0.024\}$ Silver prices as a target variable: $\triangle Silver\ i_t = -0.872\ ECT_{t-1} + 0.148\ BRENT_{t-1} + 0.0138\ Silver_{t-1} - 0.0042$	Serial Correlation LM test Lag 1 0.05<0.25 Normality 0.05<0.48 Heteroscedasticity 0.05<0.56
Import	$ECT_{t-1} = \{1.00\ Import_{t-1} - 1.882\ BRENT_{t-1} + 0.0262\}$ Import as a target variable: $\triangle Import\ i_t = -0.7675\ ECT_{t-1} + 0.1618\ BRENT_{t-1} - 0.669 Import_{t-1} - 0.0057$	Serial Correlation LM test Lag 1 0.05<0.28 Normality 0.05<0.25 Heteroscedasticity 0.05<0.86
Industrial Production	$ECT_{t-1} = \{1.00\ IP_{t-1} + 3.5655\ BRENT_{t-1} - 0.0245\}$ Industrial Production as a target variable: $\triangle IP\ i_t = -0.77\ ECT_{t-1} + 0.033\ BRENT_{t-1} - 0.022\ BRENT_{t-2} - 0.0080\ BRENT_{t-3} + 0.060\ BRENT_{t-4} + 2.268 IP_{t-1} + 1.485\ IP_{t-2} + 1.21\ IP_{t-3} + 0.59\ IP_{t-4} - 0.0020$	Serial Correlation LM test Lag 1 0.05<0.16 Lag 2 0.05<0.28 Lag 4 0.05<0.68 Normality 0.05<0.40 Heteroscedasticity 0.05<0.23

Source: Authors Computation

The coefficients of the Error correction term suggest the rate of readjustment to the state of disequilibrium. This indicates that the crude oil reacts strongly to changes in macroeconomic variables and that it starts to repair the equilibrium relationship as soon as the change takes place. In Table 4.9, Exchange rate shows in Brazil (0.2%), Russia (4%), China (12%) and south Africa has 79% rate of adjustment which is highest compare to the all other remaining countries. Similarly, as per VECM model GDP shows 8% rate in Brazil which is much lower compare to south Africa (94%). Inflation explains in India (10%), Russia (3%) and south Africa (78%) speed of adjustment.

Additionally, other macroeconomic variables which shows similar pattern of adjustment in south Africa compare to other countries in BRICS. Which is Interest rate, Money supply, foreign exchange reserve, gold prices and industrial production. To conclude; in South Africa, all the variables show long term relationship with crude oil which has also high rate of adjustment to the state of disequilibrium.

Table 4.9 explains Vector auto regression models in mathematical form has been drawn for the variables which shows short term relationship with crude oil. Which explains that all the macroeconomic variables show the short-term relationship with the crude oil

Table 4.9: Results of Vector Auto Regression (VAR) of Macroeconomic variables of BRICS countries.

Variables	Short run Equation
	BRAZIL
Crude Reserve	0.873422*crude Reserve(-1)+ 0.0299 BRENT (-1)+0.2164
Exchange Rate	-0.0012*BRENT (-1) + 0.937*EXR(-1) + 0.068
Export	0.0010*BRENT (-1)+0.97*Export (-1)+0.72
FDI	0.975*FDI(-1) -0.321*BRENT (-1)+1.61
Forex	0.0018* BRENT (-1)+0.94*forex(-1)+0.71
Import	0.968*IMPORT(-1)+0.02* BRENT (-1)+0.73
Inflation	-0.0016* BRENT (-1)+0.0009 BRENT (-2)+1.47*INFLATION (-1) 0.480*INFLATION(-2)+ 0.02
Interest Rates	0.011* BRENT (-1)+1.01*IR(-1)-0.093
Silver	0.96*Silver(-1) +0..015* BRENT (-1)+0.18
	RUSSIA
Crude Reserve	0.047* BRENT (-1) + 0.840*Reserve(-1)+0.492
Current Account	0.111* BRENT (-1) +1.769* BRENT (-2)-1.730* BRENT (-3)+0.58*CA(-1) – 0.503*CA(-2)+0.5321*CA(-3)+3.01
Export	-0.180* BRENT (-1)+0.013* BRENT (-2)+1.48*Export(-1)-0.377*Export(-2)-2.083
FDI	-0.538 BRENT (-1)+ 0.96 FDI(-1)+2.57
GDP	0.39* BRENT (-1)+ 0.984 GDP(-1)-1.08
Gold	0.023* BRENT (-1)+0.98*Gold(-1)+0.126
Import	1.518*Import(-1)-0.4724*Import(-2)-0.146* BRENT (-1)+0.05* BRENT (-2)-0.72
Industrial Production	0.98*IP(-1)-0.00* BRENT (-1)+0.10
Silver Prices	0.93*Silver(-1)+0.04* BRENT (-1)+0.264
Interest Rates	0.741* BRENT (-1)-0.200*IR+1.54

INDIA	
Current Account	1.15* BRENT (-1)-0.29* BRENT (-2)-0.04*CA(-1)+0.090*CA(-2)-0.630
Exchange Rate	0.928* BRENT (-1)-0.178*ER(-1)+1.00
Export	0.9915* BRENT (-1)-0.10* BRENT (-2)+1.36*EXPORT(-1)-1.29*EXPORT(-2)-1.112
FDI	1.177* BRENT (-1)-0.40* BRENT (-2)+0.155* BRENT (-3)-0.00126*FDI(-1)-0.00126*FDI(-2)+0.0040*FDI(-3)+0.32
Foreign Exchange	1.097* BRENT (-1)-0.2198* BRENT (-2)+0.77*Forex(-1)-0.70862 Forex(-2)-0.2858
GDP	0.97167 BRENT (-1)-0.097 BRENT (-2)+5.91GDP(-1)-5.8893GDP(-2)-0.397
Gold	0.8871 BRENT (-1)+0.02718Gold (-1)+0.1868
Import	0.8932 BRENT (-1)-0.01359 BRENT (-2)+1.22 IMPORT(-1)-1.186 IMPORT(-2)-0.6587
Industrial Production	0.8872 BRENT (-1)+0.0594IP(-1)+0.2180
Silver Prices	0.933 BRENT (-1)-0.098 Silver(-1)+0.43
CHINA	
Current Account	0.0161 BRENT (-1)+0.98CA(-1)+0.44
Export	-0.0213* BRENT (-1)+0.98 Export (-1)+0.399
FDI	-0.45 BRENT (-1)+0.97FDI(-1)+2.21
GDP	0.103* BRENT (-1)-0.058 *BRENT (-2)-0.0125 *BRENT (-3)+0.0003* BRENT (-4)+0.031*GDP(-1)+0.021*GDP(-2)+0.004*GDP(-3)+0.91*GDP(-4)
Gold	-0.0018* BRENT (-1)+0.9862*GDP(-1)+0.14
Import	-0.072* BRENT (-1)+0.02510 BRENT (-2)+1.24*Import(-1)-0.239*Import(-2)+0.09
Inflation	0.0041* BRENT (-1)+0.99*INF(-1)+0.025
Interest Rates	0.0069* BRENT (-1)+0.0057* BRENT (-2)+0.8682*IR(-1)-0.138*IR(-2)+0.25
Money Supply	0.0589*BRENT (-1)+0.91*MS(-1)+2.357
Silver Prices	-0.139* BRENT (-1)+0.69*Silver(-1)+2.62

Source: Authors computation

Table 4.10 (a) to 4.10 (e) pairwise Granger causality test is performed at the optimal lag length on the level series of macroeconomic variables for BRICS and crude oil. It has been observed that the only variables in Brazil that have a unidirectional relationship with crude oil are the exchange rate, gross domestic product, and import, whereas all of the other variables share a bidirectional relationship with the commodity. Likewise, in Russia, the exchange rate, foreign exchange reserve, import, inflation, industrial production, interest rate, and silver prices have a relationship that only goes in

one direction. Additionally, it has been observed that gold prices do not have any causality with crude oil prices in Russia.

Table 4.10 Pairwise Granger Causality Test of Macroeconomic Varibles and Crude Oil of BRICS countries

Table 4.10(a) Pairwise Granger Causality Test (Russia)

Null Hypothesis:	F-Statistic	Prob.	Accept/Reject	Causality
CA does not Granger Cause WTI Crude	0.2894	0.7496	Accept	
WTI Crude does not Granger Cause CA	1.00107	0.3729	Accept	Bi-Directional
ER does not Granger Cause WTI Crude	18.5609	0.000	Reject	
WTI Crude does not Granger Cause ER	1.84314	0.1656	Accept	Uni-Directional
EXPORT does not Granger Cause WTI Crude	70.3774	0.000	Reject	
WTI Crude does not Granger Cause EXPORT	4.15123	0.0196	Reject	No Causality
FDI does not Granger Cause WTI Crude	0.5936	0.5551	Accept	
WTI Crude does not Granger Cause FDI	1.48928	0.2327	Accept	Bi-Directional
FOREX does not Granger Cause WTI Crude	8.73988	0.0004	Reject	
WTI Crude does not Granger Cause FOREX	1.06349	0.3505	Accept	Uni Directional
GDP does not Granger Cause WTI Crude	1.69805	0.1902	Accept	
WTI Crude does not Granger Cause GDP	0.8336	0.4386	Accept	Bi-Directional
GOLD does not Granger Cause WTI Crude	4.38369	0.0159	Reject	
WTI Crude does not Granger Cause GOLD	4.15153	0.0196	Reject	No-Causality
IMPORT does not Granger Cause WTI Crude	18.8695	0.000	Reject	
WTI Crude does not Granger Cause IMPORT	2.96611	0.0577	Accept	Uni-Directional
Inflation does not Granger Cause WTI Crude	1.32845	0.2712	Accept	
WTI Crude does not Granger Cause Inflation	7.21543	0.0014	Reject	Uni-Directional
IP does not Granger Cause WTI Crude	0.49568	0.6112	Accept	
WTI Crude does not Granger Cause IP	5.62876	0.0053	Reject	Uni-Directional
IR does not Granger Cause WTI Crude	8.75005	0.0004	Reject	
WTI Crude does not Granger Cause IR	1.05753	0.3526	Accept	Uni-Directional
MS does not Granger Cause WTI Crude	1.03413	0.3607	Accept	
WTI Crude does not Granger Cause MS	0.22635	0.798	Accept	Bi-Directional
Silver does not Granger Cause WTI Crude	3.57011	0.0332	Reject	
WTI Crude does not Granger Cause SILVER	0.12095	0.8863	Accept	Uni-Directional

Table 4.10 (b) Pairwise Granger Causality Test (India)

Null Hypothesis:	F-Statistic	Prob.	Accept/Reject	Causality
CA does not Granger Cause WTI Crude	0.87385	0.4217	Accept	
WTI Crude does not Granger Cause CA	9.54937	0.0002	Reject	Uni-Directional
ER does not Granger Cause WTI Crude	1.15408	0.321	Accept	
WTI Crude does not Granger Cause ER	3.14225	0.0491	Reject	Uni-Directional
EXPORT does not Granger Cause WTI Crude	31.8077	0.10	Reject	
WTI Crude does not Granger Cause EXPORT	0.53512	0.5879	Accept	Uni-Directional
FDI does not Granger Cause WTI Crude	0.26596	0.7672	Accept	
WTI Crude does not Granger Cause FDI	1.31569	0.2746	Accept	Bi-Directional
FOREX does not Granger Cause WTI Crude	3.93473	0.0238	Reject	
WTI Crude does not Granger Cause FOREX	1.36404	0.2621	Accept	Uni-Directional
GDP does not Granger Cause WTI Crude	12.5825	0.000	Reject	
WTI Crude does not Granger Cause GDP	1.47506	0.2355	Accept	Uni-Directional
GOLD does not Granger Cause WTI Crude	2.83381	0.0653	Accept	
WTI Crude does not Granger Cause GOLD	1.43754	0.2442	Accept	Bi-Directional
IMPORT does not Granger Cause WTI Crude	12.2829	0.000	Reject	
WTI Crude does not Granger Cause IMPORT	1.60596	0.2077	Accept	Uni-Directional
Inflation does not Granger Cause WTI Crude	0.35421	0.7029	Accept	
WTI Crude does not Granger Cause Inflation	3.4566	0.0368	Reject	Uni-Directional
IP does not Granger Cause WTI Crude	1.09247	0.3408	Accept	
WTI Crude does not Granger Cause IP	0.44047	0.6454	Accept	Bi-Directional
IR does not Granger Cause WTI Crude	2.35477	0.1021	Accept	
WTI Crude does not Granger Cause IR	2.69445	0.0743	Accept	Bi-Directional
MS does not Granger Cause WTI Crude	0.34204	0.7114	Accept	
WTI Crude does not Granger Cause MS	7.20124	0.0014	Reject	Uni-Directional
SILVER does not Granger Cause WTI Crude	1.02123	0.3652	Accept	
WTI Crude does not Granger Cause SILVER	1.45119	0.241	Accept	Bi-Directional

Table 4.10 (c) Pairwise Granger Causality Test (China)

Null Hypothesis:	F-Statistic	Prob.	Accept/ Reject	Causality
CA does not Granger Cause WTI Crude	0.19007	0.8273	Accept	
WTI Crude does not Granger Cause CA	3.99378	0.0226	Reject	Uni-Directional
ER does not Granger Cause WTI Crude	1.45864	0.2392	Accept	Uni-Directional

WTI Crude does not Granger Cause ER	5.51149	0.0059	Reject	
EXPORT does not Granger Cause WTI Crude	4.92285	0.0099	Reject	
WTI Crude does not Granger Cause EXPORT	0.86249	0.4264	Accept	Uni-Directional
FDI does not Granger Cause WTI Crude	1.02098	0.3653	Accept	
WTI Crude does not Granger Cause FDI	1.12593	0.3299	Accept	Bi-Directional
FOREX does not Granger Cause WTI Crude	4.04757	0.0215	Reject	
WTI Crude does not Granger Cause FOREX	0.33781	0.7144	Accept	Uni-Directional
GDP does not Granger Cause WTI Crude	0.30416	0.7387	Accept	
WTI Crude does not Granger Cause GDP	0.21896	0.8039	Accept	Bi-Directional
GOLD does not Granger Cause WTI Crude	5.56448	0.0056	Reject	
WTI Crude does not Granger Cause GOLD	0.58781	0.5581	Accept	Uni-Directional
IMPORT does not Granger Cause WTI Crude	27.9117	0.000	Reject	
WTI Crude does not Granger Cause IMPORT	2.68417	0.075	Accept	Uni-Directional
Inflation does not Granger Cause WTI Crude	0.53857	0.5859	Accept	
WTI Crude does not Granger Cause Inflation	1.19607	0.3082	Accept	Bi-Directional
IP does not Granger Cause WTI Crude	0.14703	0.8635	Accept	
WTI Crude does not Granger Cause IP	0.29404	0.7461	Accept	Bi-Directional
IR does not Granger Cause WTI Crude	8.15053	0.0006	Reject	
WTI Crude does not Granger Cause IR	0.42591	0.6548	Accept	Uni-Directional
MS does not Granger Cause WTI Crude	0.56932	0.5684	Accept	
WTI Crude does not Granger Cause MS	0.85487	0.4296	Accept	Bi-Directional
SILVER does not Granger Cause WTI Crude	1.14698	0.3233	Accept	
WTI Crude does not Granger Cause SILVER	0.35344	0.7035	Accept	Bi-Directional

Table 4.10 (d) Pairwise Granger Causality Test (South Africa)

Null Hypothesis:	F-Statistic	Prob.		
ER does not Granger Cause WTI Crude	13.9879	7.00E-06	Reject	
WTI Crude does not Granger Cause ER	3.34717	0.0407	Reject	No Causality
EXPORT does not Granger Cause WTI Crude	1.91364	0.1549	Accept	
WTI Crude does not Granger Cause EXPORT	3.14189	0.0491	Reject	Uni-Directional
GDP does not Granger Cause WTI Crude	2.17883	0.1205	Accept	
WTI Crude does not Granger Cause GDP	0.76901	0.4672	Accept	Bi-Directional
Inflation does not Granger Cause WTI Crude	4.6601	0.0125	Reject	
WTI Crude does not Granger Cause Inflation	1.20072	0.3069	Accept	Uni-Directional

IR does not Granger Cause WTI Crude	0.30335	0.7393	Accept	
WTI Crude does not Granger Cause IR	3.8556	0.0256	Accept	Bi-Directional
MS does not Granger Cause WTI Crude	0.7007	0.4995	Accept	
WTI Crude does not Granger Cause MS	1.05725	0.3527	Accept	Bi-Directional
CA does not Granger Cause WTI Crude	1.37405	0.2595	Accept	
WTI Crude does not Granger Cause CA	1.23797	0.296	Accept	Bi-Directional
FDI does not Granger Cause WTI Crude	0.80667	0.4503	Accept	
WTI Crude does not Granger Cause FDI	0.31156	0.7333	Accept	Bi-Directional
FOREX does not Granger Cause WTI Crude	3.82102	0.0264	Reject	
WTI Crude does not Granger Cause FOREX	0.50809	0.6038	Accept	Uni-Directional
GOLD does not Granger Cause WTI Crude	1.81373	0.1703	Accept	
WTI Crude does not Granger Cause GOLD	3.60503	0.0321	Reject	Uni-Directional
SILVER does not Granger Cause WTI Crude	1.59461	0.21	Accept	
WTI Crude does not Granger Cause SILVER	0.33309	0.7178	Accept	Bi-Directional
IMPORT does not Granger Cause WTI Crude	0.45534	0.636	Accept	
WTI Crude does not Granger Cause IMPORT	5.96795	0.004	Reject	Uni-Directional
IP does not Granger Cause WTI Crude	1.57688	0.2136	Accept	
WTI Crude does not Granger Cause IP	6.3875	0.0028	Reject	Uni-Directional

Source: Authors computation

In a similar way, in India, foreign direct investment, gold prices, industrial production, interest rate, and silver prices all have a relationship with crude oil that goes in bi directions. In addition, foreign direct investment, gross domestic product, inflation, industrial production, and money supply all demonstrate a bidirectional relationship in China. Silver prices also reflect this association. The relationship between crude oil and South Africa's exports, inflation, foreign exchange reserves, gold prices, and imports is unidirectional.

The null hypothesis H_{01} is rejected that the no significant relationship between macroeconomic variable and crude oil and accepted that there is a relationship between the crude oil and macroeconomic variables. From the above results is has been clearly demonstrated that change in Crude oil prices leads to change in macroeconomic variables. The results are in the line with (***Burdbidge and Harrison, 1984)***, **(*Lee, Ni, and Raati, 1995)*, (Rodriguez and Sanchez, 2010), *(Nusair & Kisswani, 2016)***.

Chapter 5

Relationship between Crude Oil Prices and Sectorial Stock Market Indices of BRICS Countries.

5.1 Introduction

The present section attempts to understand the relationship between the sectoral indices and crude oil prices of BRICS countries**.** The data set is comprised of observations made on a daily basis beginning on April 1, 1999 and ending on March 31, 2021. The current goals make use of daily data of BRICS sectoral indices obtained from the respective stock exchanges of the respective countries, namely Brazil's (Bovespa Stock Exchange), Russia's (Moscow Stock Exchange), India's (National Stock Exchange), China's (Shanghai Stock Exchange), and South Africa's (JSE) (Johannesburg Stock Exchange). The information came from several stock exchanges, Bloomberg, Yahoo Finance, and Investing websites respectively. In order to investigate the interrelationships between various industries and crude oil, ten equity sector indices from five different markets have been chosen for analysis. These indices represent the Chemical, Const. & Material, Oil & Gas, Manufacturing, Real Estate, Pharmaceuticals, Textiles, Industrial Mining, Financial, Fast-Moving Consumer Goods sector respectively. The results for the same are discussed in this section.

5.2 Results and Discussion

Table 5.1 presents the information of descriptive statistics of BRICS sectoral indices. In Table 5.1(a) explains descriptive statistics of Brazil sectoral indices. The mean value of chemical, oil and gas, manufacturing, textiles, financial are lesser than the median value, which suggest the data falls onto the left-hand size of bell shape curve. However, the mean

value of construction and material, real estate, pharmaceuticals, industrial mining, FMCG are more significant then median, which means most of the data falls onto right hand side of the bell-shaped curve. Construction and material, manufacturing, real estate, textile, FMCG, are negatively skewed which indicates the data falls on to the left-hand side of the normal curve and other remaining sectors are positively skewed. Kurtosis measures flatness or peakedness of the distribution of the variable. Kurtosis value is more than 3 for all the sectors. Which means distribution is peaked compared to expected.

Table 5.1: Descriptive statistics of Sectoral indices and Crude oil of BRICS countries

Table 5.1 (a): Descriptive statistics of Sectoral indices of Brazil

Industry	Mean	Medium	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	P-Value
Chemical	0.088	0.123	5.98	-7.26	1.22	0.18	4.97	3.79	0.00
Const. & Material	0.077	0.059	9.46	-6.90	1.48	-0.29	5.67	33.01	0.00
Oil & Gas	0.038	0.059	5.47	-8.31	1.23	0.44	5.33	78.87	0.00
Manufacturing	0.064	0.121	5.38	-4.65	1.09	-0.78	15.26	7.95	0.00
Real Estate	0.073	0.055	7.82	-6.55	1.38	-0.36	4.34	64.95	0.00
Pharmaceuticals	0.049	0.048	9.33	-11.74	1.24	0.13	4.82	5.39	0.00
Textiles	0.079	0.092	5.32	-8.05	1.42	-0.61	6.22	96.12	0.00
Industrial Mining	0.071	0.030	9.84	-7.05	1.68	0.28	5.00	72.74	0.00
Financial	0.032	0.109	9.90	-6.99	1.08	0.20	6.46	87.45	0.00
FMCG	0.095	0.020	10.25	-11.60	1.47	-0.27	4.99	20.96	0.00
Brent Crude Oil	0.017	0.047	8.43	-5.92	2.23	-0.24	5.00	17.05	0.00

Source: Authors computation, *p-values at 5% level of Significance

Table 5.1 (b): Descriptive statistics of Sectoral indices of Russia

Industry	Mean	Medium	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	P-Value
Chemical	0.036	0.029	5.98	-7.26	1.17	-0.05	2.97	1.79	0.00
Const. & Material	0.025	0.029	9.46	-6.90	1.43	-0.52	3.67	31.01	0.00
Oil & Gas	0.014	0.091	5.47	-8.31	1.18	-0.19	3.33	76.87	0.00
Manufacturing	0.012	0.025	5.38	-4.65	1.04	-1.01	13.26	5.95	0.00

Real Estate	0.021	0.018	7.82	-6.55	1.33	-0.39	2.34	62.95	0.00
Pharmaceuticals	0.003	0.062	9.33	-11.74	1.19	-0.1	2.82	3.39	0.00
Textiles	0.027	0	5.32	-8.05	1.37	-0.74	4.22	94.12	0.00
Industrial			9.84	-7.05	1.63		3		0.00
Mining	0.019	0.079				0.05		70.74	
Financial	-0.02	-0.01	9.90	-6.99	1.03	-0.03	4.46	85.45	0.00
FMCG	0.043	0.017	10.25	-11.60	1.42	-0.5	2.99	18.96	0.00
Brent Crude Oil	-0.035	0.029	8.43	-5.92	2.18	-0.47	3	15.05	0.00

Source: Authors computation, *p-values at 5% level of Significance

Table 5.1 (c): Descriptive statistics of Sectoral indices of India

Industry	Mean	Medium	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	P-Value
Chemical	0.038	0.123	5.98	-7.26	1.22	0.18	4.97	5.84	0.00
Const. &									
Material	0.027	0.059	9.46	-6.90	1.48	-0.29	5.67	175.06	0.00
Oil & Gas	0.212	0.059	5.47	-8.31	1.23	0.04	5.33	80.92	0.00
Manufacturing	0.014	0.121	5.38	-4.65	1.09	-0.78	15.26	90	0.00
Real Estate	0.023	0.055	7.82	-6.55	1.38	-0.16	4.34	67	0.00
Pharmaceuticals	0.099	0.048	9.33	-11.74	1.24	0.13	4.82	7687.44	0.00
Textiles	0.029	0.092	5.32	-8.05	1.42	-0.51	6.22	-101.83	0.00
Industrial									
Mining	0.021	0.030	9.84	-7.05	1.68	0.28	5.00	-25.21	0.00
Financial	0.082	0.109	9.90	-6.99	1.08	0.20	6.46	389.5	0.00
FMCG	0.045	0.020	10.25	-11.60	1.47	-0.27	4.99	23.01	0.00
Brent Crude Oil	0.067	0.047	8.43	-5.92	2.23	-0.24	5.00	5.84	0.00

Source: Authors computation, *p-values at 5% level of Significance

Table 5.1 (d): Descriptive statistics of Sectoral indices of China

Industry	Mean	Medium	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	P-Value
Chemical	0.118	0.123	5.98	-7.26	1.22	-0.05	5.12	5.79	0.00
Const. &									
Material	0.107	0.059	9.46	-6.90	1.48	-0.52	5.8	175.01	0.00
Oil & Gas	0.292	0.059	5.47	-8.31	1.23	-0.19	5.7	80.87	0.00
Manufacturing	0.094	0.121	5.38	-4.65	1.09	-1.01	5.36	89.95	0.00

Real Estate	0.103	0.055	7.82	-6.55	1.38	-0.39	15.29	66.95	0.00
Pharmaceuticals	0.179	0.048	9.33	-11.74	1.24	-0.1	4.37	7687.39	0.00
Textiles	0.109	0.092	5.32	-8.05	1.42	-0.74	4.85	101.88	0.00
Industrial									
Mining	0.101	0.030	9.84	-7.05	1.68	0.05	6.25	25.26	0.00
Financial	0.162	0.109	9.90	-6.99	1.08	-0.03	6.25	389.45	0.00
FMCG	0.125	0.020	10.25	-11.60	1.47	-0.5	5.03	22.96	0.00
Brent Crude Oil	0.147	0.047	8.43	-5.92	2.23	-0.47	6.49	5.79	0.00

Source: Authors computation, *p-values at 5% level of Significance

The descriptive statistics of Russia's various sectoral indicators are presented in Table 5.1(b). According to the findings, the mean value of the construction and materials, oil and gas, manufacturing, and pharmaceuticals industries is lower than the median value. This indicates that the data falls onto the left-hand side of the bell-shaped curve, which is consistent with the hypothesis that the bell-shaped curve represents the distribution of values. The results of the kurtosis test show that the value is smaller than three for the chemical, real estate, and pharmaceutical industries.

Table 5.1 (e): Descriptive statistics of Sectoral indices of South Africa

Industry	**Mean**	**Medium**	**Maximum**	**Minimum**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Jarque-Bera**	**P-Value**
Chemical	0.208	0.123	5.98	-7.26	1.22	0.18	4.97	105.79	0.00
Const. & Material	0.197	0.059	9.46	-6.90	1.48	-0.29	5.67	275.01	0.00
Oil & Gas	0.382	0.059	5.47	-8.31	1.23	0.04	5.33	180.87	0.00
Manufacturing	0.184	0.121	5.38	-4.65	1.09	-0.78	15.26	189.95	0.00
Real Estate	0.193	0.055	7.82	-6.55	1.38	-0.16	4.34	166.95	0.00
Pharmaceuticals	0.269	0.048	9.33	-11.74	1.24	0.13	4.82	7787.39	0.00
Textiles	0.199	0.092	5.32	-8.05	1.42	-0.51	6.22	1.88	0.00
Industrial									
Mining	0.191	0.030	9.84	-7.05	1.68	0.28	5.00	74.74	0.00
Financial	0.252	0.109	9.90	-6.99	1.08	0.20	6.46	489.45	0.00
FMCG	0.215	0.020	10.25	-11.60	1.47	-0.27	4.99	122.96	0.00
Brent Crude Oil	0.237	0.047	8.43	-5.92	2.23	-0.24	5.00	105.79	0.00

Source: Data Analysis, *p-values at 5% level of Significance

As a result, this series is platykurtic, which indicates that the distribution is uniform. In contrast, the distribution is leptokurtic across the other fields, which means that there are more concentrated peaks than there is overall. When compared to the values of the other sectors, the mean value of the chemical, construction and material, manufacturing, real estate, textile, industrial mining, and financial sectors in Table 5.1 (c) is lower than the median value, and the Kurtosis value for each of the sectors is greater than 3. In a similar manner, the median value of the value for the financial sector is lower than the value for the manufacturing sector. This suggests that the distribution does, in fact, include a peak in compared to what was anticipated.

In addition, the findings of Table 5.1 (d) reveal the descriptive statistics of China. It is possible to observe that the mean value of the chemical and manufacturing sector is lower than the median value, whereas the mean value of all the other sectors shows a higher value in comparison to the median value. Because of this, we can conclude that the mean value is lower than the median value. The conclusion that can be drawn from this is that the data lie on the left-hand side of the bell-shaped curve, and that the kurtosis vale for each of the industries is more than 3.

The series can be classified as leptokurtic. Table 5.1 (e) provides a more in-depth breakdown of the descriptive statistics of South Africa's main sector indices. The fact that the mean values of all of the sectoral indices are higher than the values of their medians suggests that the data sits on the right-hand side of the bell-shaped curve. In a manner analogous to this, the kurtosis value for each of the industries is higher than 3, which indicates that the data is leptokurtic.

Table 5.2 explains Correlation analysis of Sectoral Indices and Crude oil in BRICS countries. In Table 5.2 (a) explanation has been provided for the correlation between Russian sectoral indices and crude oil. When compared to all of the other sectors, the FMCG and real estate sectors have a significantly higher level of positive correlation, with a value of 0.82 and 0.79, respectively. The financial sector exhibits the negative correlation which is -0.14.

Table 5.2 Correlation analysis of Sectoral Indices and Crude oil of BRICS countries from 01st April 1999 to 31 March 2021

Table 5.2 (a) Correlation analysis of Sectoral Indices and Crude oil of Brazil

Industry	Chemical	Const. & Material	Oil & Gas	Manufacturing	Real Estate	Pharmaceuticals	Textiles	Industrial Mining	Financial	FMCG	Brent Crude Oil
Chemical	1	0.21	0.52	0.62	0.83	0.42	0.43	0.05	0.54	0.09	0.36
Const. & Material	0.21	1	0.58	0.75	0.12	0.32	0.00	0.00	0.64	0.80	0.43
Oil & Gas	0.52	0.58	1	0.56	0.52	0.41	0.08	0.08	0.65	-0.11	0.30
Manufacturing	0.62	0.75	0.56	1	0.63	0.02	0.65	1.00	0.11	-0.04	0.08
Real Estate	0.83	0.12	0.52	0.63	1	0.85	0.56	0.48	0.62	0.52	-0.65
Pharmaceuticals	0.42	0.32	0.41	0.02	0.85	1	0.45	0.65	0.89	0.42	0.90
Textiles	0.43	0.00	0.08	0.65	0.56	0.45	1	0.45	0.69	0.52	0.10
Industrial Mining	0.05	0.00	0.08	1.00	0.48	0.65	0.45	1	0.45	0.47	0.43
Financial	0.54	0.64	0.65	0.11	0.62	0.89	0.69	0.45	1	0.12	-0.04
FMCG	0.09	0.80	-0.11	-0.04	0.52	0.42	0.52	0.47	0.12	1	0.65
Brent Crude Oil	0.36	0.43	1.00	0.08	-0.65	0.90	0.10	0.43	-0.04	0.65	1

Source: Authors Computation

Table 5.2 (b) Correlation analysis of Sectoral Indices and Crude oil of Russia

Industry	Chemical	Const. & Material	Oil & Gas	Manufacturing	Real Estate	Pharmaceuticals	Textiles	Industrial Mining	Financial	FMCG	Brent Crude Oil
Chemical	1	0.35	0.66	0.76	0.97	0.56	0.57	0.19	0.68	0.23	0.50
Const. & Material	0.35	1	0.72	0.89	0.26	0.46	0.14	0.14	0.78	0.94	0.57

Oil & Gas	0.66	0.72	1	0.70	0.66	0.55	0.22	0.22	0.79	-0.10	0.20
Manufacturing	0.76	0.89	0.70	1	0.77	0.16	0.79	0.14	0.25	0.66	0.22
Real Estate	0.97	0.26	0.66	0.77	1	0.99	0.70	0.62	0.76	0.79	0.79
Pharmaceuticals	0.56	0.46	0.55	0.16	0.99	1	0.59	0.79	0.03	0.04	0.04
Textiles	0.57	0.14	0.22	0.79	0.70	0.59	1	0.59	0.83	0.24	0.24
Industrial	0.19							1	0.59	0.57	0.57
Mining		0.14	0.22	0.14	0.62	0.79	0.59				
Financial	0.68	0.78	0.79	0.25	0.76	0.03	0.83	0.59	1	-0.14	-0.14
FMCG	0.23	0.94	-0.03	-0.10	0.66	0.56	0.66	0.61	0.14	1	0.82
Brent Crude Oil	0.50	0.57	1.00	0.22	0.79	0.04	0.24	0.57	-0.14	0.82	1

Source: Authors Computation

Table 5.2 (c) Correlation analysis of Sectoral Indices and Crude oil of India

Industry	**Chemical**	**Const. & Material**	**Oil & Gas**	**Manufacturing**	**Real Estate**	**Pharmaceuticals**	**Textiles**	**Industrial Mining**	**Financial**	**FMCG**	**Brent Crude Oil**
Chemical	1	0.29	0.54	0.64	0.85	0.44	0.45	0.07	0.56	0.11	0.44
Const. & Material	0.29	1	0.60	0.77	0.14	0.34	0.02	0.02	0.66	0.82	0.51
Oil & Gas	0.54	0.66	1	0.58	0.54	0.43	0.10	0.10	0.67	-0.15	0.94
Manufacturing	0.64	0.77	0.58	1	0.65	0.04	0.67	0.02	0.13	-0.22	0.16
Real Estate	0.85	0.14	0.54	0.65	1	0.87	0.58	0.5	0.64	0.54	0.73
Pharmaceuticals	0.44	0.34	0.43	0.04	0.87	1	0.47	0.67	-0.09	0.44	-0.08
Textiles	0.45	0.02	0.10	0.67	0.58	0.47	1	0.47	0.71	0.54	0.50
Industrial	0.07	0.02	0.10	0.02	0.50	0.67	0.53	1	0.47	0.49	0.51

Mining											
Financial	0.56	0.66	0.67	0.13	-0.09	-0.09	0.73	0.47	1	0.52	0.64
FMCG	0.11	0.82	-0.15	-0.22	0.44	0.44	-0.03	0.49	0.52	1	0.12
Brent Crude Oil	0.44	0.51	0.94	0.16	0.73	-0.08	0.5	0.51	0.64	0.12	1

Source: Authors Computation

Table 5.2 (d) Correlation analysis of Sectoral Indices and Crude oil of China

Industry	**Chemical**	**Const. & Material**	**Oil & Gas**	**Manufacturing**	**Real Estate**	**Pharmaceuticals**	**Textiles**	**Industrial Mining**	**Financial**	**FMCG**	**Brent Crude Oil**
Chemical	1	0.23	0.54	0.64	0.85	0.44	0.45	0.07	0.56	0.11	0.38
Const. & Material	0.23	1	0.6	0.77	0.14	0.34	0.02	0.02	0.66	0.82	0.45
Oil & Gas	0.54	0.60	1	0.58	0.54	0.43	0.1	0.1	0.67	-0.15	0.88
Manufacturing	0.64	0.77	0.58	1	0.65	0.04	0.67	0.02	0.13	-0.22	-0.10
Real Estate	0.85	0.14	0.54	0.65	1	0.87	0.58	0.5	0.64	0.54	-0.67
Pharmaceuticals	0.44	0.34	0.43	0.04	0.87	1	0.47	0.67	-0.09	0.44	-0.08
Textiles	0.45	0.02	0.10	0.67	0.58	0.47	1	0.47	0.71	0.54	0.12
Industrial Mining	0.07	0.02	0.10	0.02	0.50	0.67	0.47	1	0.47	0.49	0.45
Financial	0.56	0.66	0.67	0.13	0.64	-0.09	0.71	0.47	1	0.52	-0.50
FMCG	0.11	0.82	-0.15	-0.22	0.54	0.44	0.54	0.49	0.52	1	0.22
Brent Crude Oil	0.38	0.45	0.88	-0.10	-0.67	-0.08	0.12	0.45	-0.50	0.22	1

Source: Authors Computation

Table 5.2 (e) Correlation analysis of Sectoral Indices and Crude oil of South Africa

Industry	Chemical	Const. & Material	Oil & Gas	Manufacturing	Real Estate	Pharmaceuticals	Textiles	Industrial Mining	Financial	FMCG	Brent Crude Oil
Chemical	1	0.18	0.49	0.59	0.8	0.39	0.4	0.02	0.51	0.06	0.33
Const. & Material	0.18	1	0.55	0.72	0.09	0.29	-0.03	-0.03	0.61	0.77	0.4
Oil & Gas	0.49	0.55	1	0.53	0.49	0.38	0.05	0.05	0.62	-0.2	0.83
Manufacturing	0.59	0.72	0.53	1	0.6	-0.01	0.62	-0.03	0.08	-0.27	0.05
Real Estate	0.80	0.09	0.49	0.6	1	0.82	0.53	0.45	0.59	0.49	0.62
Pharmaceuticals	0.39	0.29	0.38	-0.01	0.82	1	0.42	0.62	-0.14	0.39	-0.13
Textiles	0.40	-0.03	0.05	0.62	0.53	0.42	1	0.42	0.66	0.49	0.07
Industrial Mining	0.02	-0.03	0.05	-0.03	0.45	0.62	0.42	1	0.42	0.44	0.4
Financial	0.51	0.61	0.62	0.08	0.59	-0.14	0.66	0.42	1	0.47	-0.55
FMCG	0.06	0.77	-0.2	-0.27	0.49	0.39	0.49	0.44	0.47	1	0.32
Brent Crude Oil	0.33	0.40	0.83	0.05	0.62	-0.13	0.07	0.4	-0.55	0.32	1

Source: Authors Computation

Similarly, all of the industries in India exhibit a positive correlation with one another, with the exception of the pharmaceutical industry, which demonstrates a negative correlation. Furthermore, the oil and gas sector are the only sector that displays a positive correlation with crude oil.

Table 5.2 explains Correlation analysis of Sectoral Indices and Crude oil of BRICS. In Table 5.2 (d) and 5.2 (e), which demonstrate the correlation analysis of China and South Africa sectoral industries, respectively. Except for manufacturing (-0.10), real estate (-0.67), pharmaceuticals (-0.08), and financial services (-0.50), all of China's sectors have a positive correlation with one another. In a manner comparable, the pharmaceuticals (-0.13) and financial sectors (-0.55) in South Africa are adversely correlated when compared to all other industries.

In addition, the results of the unit root test, also known as the Augmented Dickey Fuller test, are presented in Table 5.3 for the sectoral indices and crude oil of the BRICS nations. The table makes it abundantly evident that, with the exception of the real estate and financial sectors, all of the variables in Brazil are stationary at first difference. Second, with the exception of the expanding manufacturing and financial sectors, all industries in Russia are operating at the same degree of stability. Thirdly, all of the sectors in India are stationary at first difference only.

The stationary at level that was discovered throughout all of China's industries, with the exception of the construction materials, finance, and construction industries. While the markets for all other industries are stationary at first difference, the markets for the oil and gas, real estate, fast moving consumer goods (FMCG), and financial sectors in South Africa are all stationary at level.

Table 5.3 Unit Root Test (Augmented Dickey-Fuller Test) for Sectoral Indices and Crude oil of BRICS countries

Variables	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference
	BRAZIL		RUSSIA		INDIA		CHINA		SOUTH AFRICA	
Chemical	-3.72492	-8.16996	-1.13614	-7.98716	-0.34223	-8.48035	-1.14542	-6.06563	-0.84088	-6.73934
	[0.4149]	[0.00]	[0.9411]	[0.00]	[0.9128]	[0.00]	[0.6939]	[0.00]	[0.8016]	[0.00]
Const. &	-2.46145	-9.6007	-2.92457	-5.02314	-1.78339	-7.31295	-3.57833		-1.65237	-7.5547
Material	[0.5479]	[0.00]	[0.3196]	[0.00]	[0.3861]	[0.00]	[0.008]		[0.4512]	[0.00]
Oil & Gas	-1.75404	-6.17625	-2.63591	-14.5632	-1.0082	-9.06961	-0.70663	-8.9821	-4.68916	-
	[0.826112]	[0.00]	[0.4596]	[0.00]	[0.7469]	[0.00]	[0.838]	[0.00]	[0.00]	
Manufacturing	-1.72061	-1.0718	-5.14724	-	-2.5472	-5.20907	-2.62015	-3.19761	-0.97193	-3.3028
	[0.8.4836]	[0.00]	[0.00]		[0.1085]	[0.00]	[0.09]	[0.023]	[0.75]	[0.0181]
Real Estate	-4.85937	-	-1.45429	-8.84229	-1.06712	-3.04692	-2.07172	-8.2649	-5.05074	-
	[0.00]		[0.8935]	[0.00]	[0.7251]	[0.035]	[0.2566]	[0.00]	[0.00]	
Pharmaceuticals	-2.05238	-5.95399	-2.78969	-4.86363	-1.39952	-8.62212	-3.0294	-6.20809	-1.76112	-9.00535
	[0.7307]	[0.00]	[0.383]	[0.00]	[0.5785]	[0.00]	[0.0365]	[0.00]	[0.397]	[0.00]
Textiles	-2.39816	-6.48063	-3.41596	-10.6207	-2.18396	-15.3609	-1.95788	-6.4186	-0.53181	-4.17921
	[0.579]	[0.011]	[0.1409]	[0.00]	[0.2138]	[0.00]	[0.304]	[0.00]	[0.8784]	[0.00]
Industrial	-3.4276	-2.44386	-3.87093	-8.49685	-2.08944	-10.6466	-3.0103	-8.7221	-1.85085	-5.42327
Mining	[0.1376]	[0.00]	[0.0534]	[0.00]	[0.2495]	[0.00]	[0.0382]	[0.00]	[0.3537]	[0.00]
Financial	-4.72075	-	-3.34273	-	1.21135	-5.95293	-6.42394	-	-3.94576	-
	[0.00]		[0.00]		[0.998]	[0.00]	[0.00]		[0.00]	
FMCG	-1.75404	-8.17625	-2.63591	-14.5632	-1.0082	-9.06961	-0.70663	-8.9821	-4.68916	-
	[0.826112]	[0.00]	[0.4596]	[0.00]	[0.7469]	[0.00]	[0.838]	[0.00]	[0.00]	
Brent Crude Oil	-1.72061	-1.0718	-5.14724	-	-2.5472	-5.20907	-2.62015	-3.19761	-0.97193	-3.3028
	[0.8.4836]	[0.00]	[0.00]		[0.1085]	[0.00]	[0.09]	[0.023]	[0.75]	[0.0181]

Source: Author's Computation

Table 5.4. Granger Causality test for sectoral Indices and Crude oil of BRICS Countries

Table 5.4(a) Granger Causality test for sectoral Indices and Crude oil of Brazil

Industry	Chemical	Const. & Material	Oil & Gas	Manufacturing	Real Estate	Pharmaceuticals	Textiles	Industrial Mining	Financial	FMCG	Brent Crude Oil
Chemical		0.23	0.54	0.64	0.58	1.09	1.1	1.2	0.59	0.14	0.41
		(0.10)*	(0.05)**	(0.12)	(0.25)	(0.06)*	(0.06)*	(0.03)**	(0.05)**	(0.12)	(0.02)**
Const. & Material	0.45		0.6	0.77	0.45	0.99	0.67	0.77	0.69	0.85	0.48
	(0.13)		(0.06)*	(0.15)	(0.08)**	(0.15)	(0.03)**	(0.15)	(0.25)	(0.32)	(0.08)*
Oil & Gas	0.74	0.06		0.58	0.54	1.08	0.75	0.85	0.7	0.12	0.91
	(0.01)**	(0.08)*		(0.25)	(0.09)**	(0.18)	(0.08)*	(0.60)	(0.02)**	(0.05)*	(0.06)*
Manufacturing	0.84	0.77	0.58		0.52	0.69	1.32	1.42	0.16	0.19	0.13
	(0.02)**	(0.04)**	(0.18)		(0.10)*	(0.15)	(0.25)	(0.19)	(0.30)	(0.06)*	(0.01)**
Real Estate	0.85	0.41	0.54	0.65		1.52	1.23	1.33	0.67	0.57	0.7
	(0.00)***	(0.02)**	(0.19)	(0.13)		(0.52)	(0.85)	(0.10)*	(0.50)	(0.00)***	(0.00)***
Pharmaceuticals	0.41	0.43	0.43	0.34	0.78		1.12	1.22	0.06	0.47	0.05
	(0.15)	(0.18)	(0.16)	(0.15)	(0.36)		(0.09)*	(0.45)	(0.20)	(0.09)*	(0.03)**
Textiles	0.54	0.20	0.10	0.67	0.56	1.12		1.75	0.74	0.57	0.15
	(0.66)	(0.10)*	(0.00)***	(0.25)	(0.52)	(0.68)		(0.05)**	(0.07)*	(0.01)**	(0.08)*
Industrial Mining	0.70	0.12	0.10	0.02	0.05	1.32	1.12		0.5	0.52	0.48
	(0.10)*	(0.00)***	(0.17)	(0.68)	(0.68)	(0.08)*	(0.05)**		(0.08)*	(0.06)*	(0.06)*
Financial	0.65	0.64	0.67	0.13	0.52	0.56	1.36	1.46		0.55	0.11
	(0.23)	(0.58)	(0.65)	(0.85)	(0.05)**	(0.00)***	(0.10)*	(0.00)***		(0.05)**	(0.08)*
FMCG	0.15	0.28	-0.15	-0.22	0.54	1.09	1.19	1.29	0.55		0.47
	(0.10)*	(0.65)	(0.41)	(0.10)*	(0.00)***	(0.05)*	(0.30)	(0.02)**	(0.10)*		(0.00)***
Brent Crude Oil	0.38	0.54	0.88	0.10	0.77	0.57	0.77	0.87	0.47	0.25	
	(0.56)	(0.45)	(0.02)**	(0.00)***	(0.00)***	(0.15)	(0.10)*	(0.03)**	(0.56)	(0.02)**	

Source: Authors Computation, * represents significant at 1%, ** represents at 5% and *** represents at 10% level of significance.

The results of a Granger causality test that was performed on the sectoral indicators of the BRICS countries and crude oil are displayed in Table 5.4. The Granger causality test is a sort of econometric analysis that determines whether or not one variable can accurately predict the behaviour of another variable by comparing the two variables' patterns of activity. A more in-depth analysis of the association between several Brazilian sectorial indices and their corresponding causes and consequences may be found in Table 5.4 (a).

The vertical column illustrates the flow of causality from crude oil to sectoral indices, whereas the horizontal column illustrates the flow of causality in the reverse manner, from sectoral indices to crude oil. In Brazil, there is only one path that the chain of causality may travel, and that is from the sector of crude oil to the sector of chemicals, as well as the construction and materials sector, the pharmaceutical industry, and the financial sector.

Each of the subsequent industries exhibits bidirectional causality at significance levels of 1%, 5%, and 10%, respectively, in a manner that is remarkably comparable to that which was detailed in the previous section. Second, as can be seen in table 5.4(b), which outlines the relationship that exists between the price of crude oil and a number of other indices that measure the performance of different industries in Russia, the price of crude oil has a positive correlation with these indices.

The chemical, construction and material, pharmaceutical, and financial sectors all have a unidirectional relation with crude oil, whereas other industries have bidirectional causality at levels of importance of 1%, 5%, and 10% respectively. This is because the chemical, construction and material, and pharmaceutical sectors all rely heavily on crude oil. The chemical, construction, and financial sectors in India each show a unidirectional association with crude oil, while all other sectors share a bidirectional relationship with crude oil at the 1%, 5%, and 10% levels of significance, as shown in table 5.4(c).

This finding holds true at all three levels of significance. In a similarly, the causality between the price of crude oil and several sector indices is broken down and analysed in table 5.4. (d). Which explains chemical and pharmaceutical sectors show unidirectional link with crude oil, whereas other sectors show bidirectional causal relationship with crude oil.

Table 5.4(b) Granger Causality test for sectoral Indices and Crude oil of Russia

Industry	Chemical	Const. & Material	Oil & Gas	Manufacturing	Real Estate	Pharmaceuticals	Textiles	Industrial Mining	Financial	FMCG	Brent Crude Oil
Chemical		0.84	0.88	0.17	0.46	1.12	1.32	1.47	0.88	0.17	1.50
		(0.05)**	(0.23)	(0.25)	(0.87)	(0.09)*	(0.06)*	(0.02)**	(0.01)**	(0.11)	(0.04)**
Const. & Material	0.99		0.56	0.65	0.48	0.95	0.64	0.3	0.68	0.88	1.21
	(0.10)*		(0.09)*	(0.56)	(0.86)	(0.17)	(0.87)	(0.05)**	(0.27)	(0.56)	(0.05)**
Oil & Gas	0.78	0.72		0.45	0.67	1.40	0.96	0.95	0.4	0.17	0.91
	(0.01)**	(0.07)*		(0.33)	(0.55)	(0.14)	(0.09)*	(0.67)	(0.09)*	(0.03)*	(0.10)*
Manufacturing	0.56	0.11	0.17		0.54	1.23	1.45	1.65	0.78	0.14	0.17
	(0.12)	(0.77)	(0.17)		(0.34)	(0.14)	(0.77)	(0.18)	(0.38)	(0.07)*	(0.01)**
Real Estate	0.66	0.26	0.34	0.78		0.12	1.33	1.31	0.78	0.56	0.74
	(0.00)***	(0.02)**	(0.15)	(0.22)		(0.98)	(0.78)	(0.00)***	(0.14)	(0.00)***	(0.00)***
Pharmaceuticals	0.45	0.35	0.65	0.35	0.43		1.11	1.33	0.98	0.23	0.50
	(0.75)	(0.17)	(0.19)	(0.89)	(0.66)		(0.03)**	(0.45)	(0.20)	(0.08)*	(0.06)*
Textiles	0.56	0.69	0.14	0.89	0.65	1.7		1.45	0.78	0.54	0.16
	(0.86)	(0.02)**	(0.00)***	(0.33)	(0.46)	(0.45)		(0.07)*	(0.08)*	(0.01)**	(0.09)*
Industrial Mining	0.45	0.98	0.35	0.77	0.79	1.32	1.17		0.55	0.12	0.12
	(0.16)	(0.0)***	(0.56)	(0.89)	(0.68)	(0.07)*	(0.07)*		(0.08)*	(0.05)**	(0.05)**
Financial	0.79	0.78	0.77	0.69	0.35	0.786	1.45	0.78		0.55	0.14
	(0.03)**	(0.88)	(0.44)	(0.56)	(0.03)**	(0.00)***	(0.00)**	(0.00)***		(0.07)*	(0.09)*
FMCG	0.99	067	0.45	-0.82	0.38	1.09	1.00	1.45	0.57		0.78
	(0.10)*	(0.67)	(0.45)	(0.02)*	(0.04)**	(0.04)**	(0.56)	(0.05)**	(0.04)**		(0.04)**
Brent Crude Oil	0.23	0.56	0.12	0.65	0.15	0.77	0.36	0.78	0.47	0.45	
	(0.77)	(0.49)	(0.04)**	(0.00)***	(0.01)**	(0.45)	(0.04)**	(0.08)*	(0.88)	(0.08)*	

Source: Authors Computation**,** * represents significant at 1%, ** represents at 5% and *** represents at 10% level of significance

Table 5.4(c) Granger Causality test for sectoral Indices and Crude oil of India

Industry	Chemical	Const. & Material	Oil & Gas	Manufacturing	Real Estate	Pharmaceuticals	Textiles	Industrial Mining	Financial	FMCG	Brent Crude Oil
Chemical		0.96	0.59	0.93	0.56	1.02	1.33	1.35	0.88	0.27	0.50
		(0.05)**	(0.78)	(0.35)	(0.88)	(0.07)*	(0.23)	(0.01)**	(0.44)	(0.16)	(0.03)**
Const. & Material	0.45		0.76	0.41	0.44	0.15	0.61	0.34	0.78	0.48	0.21
	(0.07)*		(0.08)*	(0.96)	(0.78)	(0.14)	(0.98)	(0.04)**	(0.45)	(0.15)	(0.08)*
Oil & Gas	0.89	0.23		0.25	0.64	1.30	0.45	0.66	0.44	0.67	0.41
	(0.00)***	(0.04)**		(0.43)	(0.25)	(0.55)	(0.09)*	(0.56)	(0.08)*	(0.78)	(0.10)*
Manufacturing	0.66	0.56	0.77		0.54	1.43	1.56	1.50	0.65	0.54	0.57
	(0.45)	(0.77)	(0.14)		(0.69)	(0.69)	(0.45)	(0.78)	(0.02)**	(0.08)*	(0.05)**
Real Estate	0.45	0.78	0.44	0.86		0.82	1.45	1.41	0.45	0.86	0.64
	(0.00)***	(0.04)**	(0.17)	(0.15)		(0.45)	(0.78)	(0.00)***	(0.16)	(0.01)**	(0.07)*
Pharmaceuticals	0.55	0.45	0.65	0.42	0.47		1.48	1.23	0.15	0.33	0.55
	(0.45)	(0.14)	(0.15)	(0.02)**	(0.63)		(0.04)**	(0.55)	(0.27)	(0.08)*	(0.07)*
Textiles	0.12	0.12	0.24	0.78	0.56	1.8		1.45	0.25	0.24	0.14
	(0.89)	(0.01)**	(0.00)***	(0.05)**	(0.45)	(0.78)		(0.07)*	(0.08)*	(0.01)**	(0.08)*
Industrial Mining	0.36	0.32	0.95	0.65	0.45	1.45	1.32		0.45	0.72	0.19
	(0.17)	(0.00)***	(0.56)	(0.09)*	(0.77)	(0.07)*	(0.10)*		(0.48)	(0.04)**	(0.06)**
Financial	0.14	0.56	1.02	0.45	0.23	0.74	1.45	0.48		0.65	0.45
	(0.02)**	(0.83)	(0.02)**	(0.12)	(0.02)**	(0.00)***	(0.00)***	(0.00)***		(0.06)*	(0.07)*
FMCG	0.25	087	0.78	-0.72	0.78	1.49	1.00	1.45	0.66		0.79
	(0.00)***	(0.01)**	(0.95)	(0.23)	(0.04)**	(0.03)**	(0.78)	(0.03)**	(0.04)**		(0.03)**
Brent Crude Oil	0.45	0.89	1.12	0.56	0.15	0.57	0.88	0.68	0.45	0.75	
	(0.67)	(0.50)	(0.04)**	(0.00)***	(0.01)**	(0.07)*	(0.03)**	(0.09)*	(0.98)	(0.09)*	

Source: Authors Computation, * represents significant at 1%, ** represents at 5% and *** represents at 10% level of significance

Table 5.4(d) Granger Causality test for sectoral Indices and Crude oil of China

Industry	Chemical	Const. & Material	Oil & Gas	Manufacturing	Real Estate	Pharmaceuticals	Textiles	Industrial Mining	Financial	FMCG	Brent Crude Oil
Chemical		0.45	0.36	0.14	0.45	1.36	1.11	0.48	0.88	0.78	1.45
		(0.09)*	(0.63)	(0.15)	(0.89)	(0.08)*	(0.08)*	(0.02)**	(0.01)**	(0.18)	(0.07)*
Const. & Material	0.56		0.55	0.67	0.56	0.95	0.78	0.35	0.48	0.13	1.24
	(0.10)*		(0.78)	(0.66)	(0.88)	(0.47)	(0.87)	(0.04)**	(0.45)	(0.54)	(0.04)**
Oil & Gas	0.77	0.36		0.6	0.56	1.50	0.45	0.15	0.46	0.96	0.95
	(0.01)**	(0.06)*		(0.83)	(0.57)	(0.54)	(0.07)*	(0.70)	(0.08)*	(0.05)**	(0.10)*
Manufacturing	0.55	0.78	0.75		0.45	1.45	1.56	1.50	1.56	0.63	0.63
	(0.56)	(0.56)	(0.23)		(0.34)	(0.64)	(0.45)	(0.78)	(0.45)	(0.06)*	(0.02)**
Real Estate	0.654	0.65	0.65	0.48		0.78	1.45	1.41	1.45	0.45	0.45
	(0.00)***	(0.01)**	(0.96)	(0.82)		(0.88)	(0.78)	(0.00)***	(0.78)	(0.00)***	(0.04)**
Pharmaceuticals	0.47	0.25	0.45	0.78	0.78		1.48	1.23	1.48	0.89	0.96
	(0.89)	(0.45)	(0.45)	(0.99)	(0.02)**		(0.04)**	(0.55)	(0.04)**	(0.06)*	(0.02)**
Textiles	0.65	0.45	0.48	0.89	0.36	1.50		1.45	1.45	0.56	0.16
	(0.65)	(0.063)**	(0.00)***	(0.63)	(0.48)	(0.55)		(0.07)*	(0.00)***	(0.04)**	(0.09)*
Industrial Mining	0.78	0.36	0.69	0.36	0.79	1.45	1.32		1.32	0.45	0.15
	(0.78)	(0.00)***	(0.23)	(0.05)**	(0.56)	(0.09)*	(0.10)*		(0.10)*	(0.03)**	(0.04)**
Financial	0.69	0.74	0.98	0.89	0.45	0.76	1.45	0.48		0.45	0.49
	(0.03)**	(0.98)	(0.65)	(0.57)	(0.02)**	(0.00)***	(0.00)***	(0.00)***		(0.09)*	(0.07)*
FMCG	1.50	0.78	0.45	-0.72	0.48	1.89	1.00	1.45	1.00		0.46
	(0.90)	(0.45)	(0.78)	(0.02)*	(0.05)**	(0.04)**	(0.78)	(0.03)**	(0.78)		(0.03)**
Brent Crude Oil	0.78	0.56	0.88	0.56	0.49	0.65	0.88	0.68	0.88	0.26	
	(0.57)	(0.02)**	(0.05)**	(0.00)***	(0.02)**	(0.78)	(0.03)**	(0.09)*	(0.03)**	(0.06)*	

Source: Authors Computation, * represents significant at 1%, ** represents at 5% and *** represents at 10% level of significance

Table 5.4(e) Granger Causality test for sectoral Indices and Crude oil of South Africa

Industry	Chemical	Const. & Material	Oil & Gas	Manufacturing	Real Estate	Pharmaceuticals	Textiles	Industrial Mining	Financial	FMCG	Brent Crude Oil
Chemical		0.32	0.54	0.45	0.58	0.36	1.1	1.2	0.59	0.14	0.41
		(0.10)*	(0.05)**	(0.12)	(0.25)	(0.63)	(0.06)*	(0.03)**	(0.05)**	(0.12)	(0.02)**
Const. &	0.42		0.6	0.77	0.45	0.55	0.67	0.77	0.69	0.85	0.48
Material	(0.13)		(0.06)*	(0.15)	(0.08)**	(0.78)	(0.03)**	(0.15)	(0.25)	(0.32)	(0.08)*
Oil & Gas	0.45	0.05		0.58	0.54	0.45	0.75	0.85	0.7	0.12	0.91
	(0.12)	(0.07)*		(0.25)	(0.09)**	(0.45)	(0.08)*	(0.60)	(0.02)**	(0.05)*	(0.06)*
Manufacturing	0.45	0.17	0.58		0.52	0.75	1.32	1.42	0.16	0.19	0.13
	(0.02)**	(0.04)**	(0.18)		(0.10)*	(0.23)	(0.25)	(0.19)	(0.30)	(0.06)*	(0.01)**
Real Estate	0.85	0.14	0.54	0.65		0.65	1.23	1.33	0.67	0.57	0.7
	(0.00)***	(0.02)**	(0.19)	(0.13)		(0.96)	(0.85)	(0.10)*	(0.50)	(0.00)***	(0.00)***
Pharmaceuticals	0.41	0.54	0.43	0.34	0.78		1.12	1.22	0.06	0.47	0.05
	(0.05)**	(0.08)**	(0.16)	(0.15)	(0.36)		(0.09)*	(0.45)	(0.20)	(0.09)*	(0.03)**
Textiles	0.54	0.20	0.10	0.67	0.56	0.48		1.75	0.74	0.57	0.15
	(0.66)	(0.10)*	(0.00)***	(0.25)	(0.52)	(0.00)***		(0.05)**	(0.07)*	(0.01)**	(0.08)*
Industrial	0.70	0.21	0.10	0.02	0.05	0.69	1.12		0.5	0.52	0.48
Mining	(0.16)	(0.00)***	(0.17)	(0.68)	(0.68)	(0.23)	(0.05)**		(0.08)*	(0.06)*	(0.06)*
Financial	0.65	0.44	0.67	0.13	0.52	0.98	1.36	1.46		0.55	0.11
	(0.23)	(0.05)**	(0.65)	(0.85)	(0.05)**	(0.65)	(0.10)*	(0.00)***		(0.05)**	(0.08)*
FMCG	0.15	0.82	-0.15	-0.22	0.54	0.45	1.19	1.29	0.55		0.47
	(0.10)*	(0.65)	(0.41)	(0.10)*	(0.00)***	(0.78)	(0.30)	(0.02)**	(0.10)*		(0.00)***
Brent Crude Oil	0.38	0.18	0.88	0.10	0.77	0.88	0.77	0.87	0.47	0.25	
	(0.56)	(0.05)**	(0.02)**	(0.00)***	(0.00)***	(0.05)**	(0.10)*	(0.03)**	(0.56)	(0.02)**	

Source: Authors Computation,* represents significant at 1%, ** represents at 5% and *** represents at 10% level of significance

In addition, as can be seen in Table 5.4(e), the relationship between South Africa's chemical and financial sectors and crude oil is one-sided, whereas the relationship between crude oil and the other sectors is ambivalent. This is illustrated by the fact that the relationship between crude oil and the other sectors is bidirectional. This is evidenced by the fact that the relationship that exists between crude oil and the other industries is one of causation.

The alternative hypothesis H_{02}, which states that there is a significant relationship between crude oil prices and stock market indices of BRICS countries, is accepted, which means that the null hypothesis H_{02} must be rejected. According to the findings presented above, it is possible to draw the conclusion that the fluctuation in the price of crude oil has had an effect on each and every industry. The most important observations are in agreement with the findings of ***(Creti, Ftiti, & Guesmi, 2014), (Caporale, Ali, & Spagnolo, 2015), (Gokmenoglu & Fazlollahi, 2015), and (Rahmanto, Riga, & Indriana, 2016)*** all of which have the potential to have significant implications for international investors.

Chapter 6

The volatility Transmission between Crude Oil prices and BRICS Stock Market returns

6.1. Introduction

This chapter deals with the interlinkages and weak form of efficiency of BRICS countries we have used daily stock indices of BRICS countries including Brazil Stock Exchange, Moscow Stock Exchange, National Stock Exchange, Shanghai Stock Exchange and Johannesburg Stock Exchange and Brent Crude oil prices starting from 01st April 1999 to 31st March 2020.All the data has been extracted from Bloomberg data base. We have filtered the data and considered only those days where all the five stock markets were open for trading. This has reduced our data set to 5267 observations and to sudy the volatility transmission we have used Unit root test, Lo and MacKinlay variance ratio, Impulse Response Function (IRF), Granger Causality Test, Johansen Cointegration Test, ARCH- GARCH MODEL and then we have drawn the conclusion.

6.2. Results and discussion

6.2.1. Descriptive Statistics

The daily continuously compounded returns are calculated for all the indices by taking the first difference of their natural logarithms. Table 6.1 shows that the mean values of stock returns of Brazil, Russia, China, India and South Africa are 0.035%, 0.0008%, -2.1774%, -0.7315% and -0.0002%. The average returns obtained is highest in Brazil and very much lesser in China. Skewness is the measure of asymmetry of the distribution of the series around mean. The skewness of a normal distribution is zero. From this measure we found that the stock market of BRICS is positive except for India and Russia which is negatively skewed. Kurtosis value for all

the variable is more then 3, which signifies that the distribution is leptokurtic relative to normal with fat tails. The results are also confirmed by Jarque bera statistics as well.

Table 6.1: Descriptive Statistics of BRICS Stock Indices and Crude Oil (1st April 1999 – 31st March 2020)

Series	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA	BRENT
Mean	0.0305	0.0008	-2.1774	-0.7315	-0.0002	0.0305
Median	0.0000	-0.0003	-0.0003	-0.0002	-0.0006	0.0000
Maximum	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Minimum	-0.1465	-0.0985	-5842.9	-2264.0	-0.0707	-0.1465
Std. Dev.	0.1746	0.0371	113.28	38.134	0.0182	38.134
Skewness	5.3154	22.150	-51.280	-53.510	31.4653	-53.510
Kurtosis	29.565	596.07	2630.7	2933.5	1724.17	2933.5
Jarque-Bera	179607	775938	0.0000	0.0000	0.0000	0.0000
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Source: Authors computation

6.2.2 Karl Pearson's Correlation

Table 6.2 explains whether or not there is a correlation between the various stock indexes that are being investigated in this study. The fact that each of the five countries has a considerable positive correlation with the others is evidence of the robust relationship that exists between them at the present time. This positive link can be traced to the advancement of technology as well as globalization. Additionally, the availability of internet connectivity has encouraged investors to engage in online trading and invest in the economies of other nations.

Table 6.2: Karl- Pearson's Correlation Matrix

Probability		BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA	BRENT
BRAZIL	Pearson Correlation	1.0000					
	Sig. (2 tailed)	-----					
CHINA	Pearson Correlation	0.0251*	1.0000				
	Sig. (2 tailed)	0.0682	-----				
INDIA	Pearson Correlation	0.0022*	-0.0029**	1.0000			
	Sig. (2 tailed)	0.0698	0.0283	-----			
RUSSIA	Pearson Correlation	0.0056***	-0.0043*	-0.0003*	1.0000		
	Sig. (2 tailed)	0.0033	0.0503	0.0789	-----		

SOUTH AFRICA	Pearson Correlation	0.0583***	0.2686***	0.0003*	0.0020*	1.0000	
	Sig. (2 tailed)	0.0000	0.0000	0.0810	0.0527	-----	
BRENT	Pearson Correlation	0.0854**	0.6585***	0.0036**	0.0300*	0.0300*	1.0000
	Sig. (2 tailed)	0.0000	0.0752	0.0368	0.0362	0.0458	------

Source: Authors computation, Note: *** Significant at 1%, ** Significant at 5%, * Significant at 10%

Since notable correlations have been found between the variables under consideration so further econometric tools would be applied to them. However, one important point to be noted here is that a high or low degree of correlation doesn't signify or rules out causality. It merely points towards the positive or negative linear relationship that exist between the two variables.

6.2.3 Unit Root Test

After correlation is to check the stationarity of the series by applying parametric unit root tests including ADF (Augmented Dickey Fuller) which is non-parametric test. Table 6.3 explains the unit root test results with the null hypothesis i.e. time series has a unit root, could not be rejected for the time series of all the countries except Brazil, Russia and South Africa (at 5% level of significance) at level using both ADF test. Thus, we are getting the same results as per both parametric and non-parametric unit root tests. By taking the first order differencing for all these series, the null hypothesis for non-stationary was rejected for all series at the same confidence level lending continuity in the modelling process.

Table 6.3 ADF Unit root test results stock market indices and Crude Oil of BRICS countries

	Level	First Difference
Variable	ADF	ADF
BRAZIL	-26.9321	-36.1478***
RUSSIA	-72.5798**	-89.8563*
INDIA	-11.5508	-26.8451***
CHINA	-32.5204	-42.5689***
SOUTH AFRICA	-109.2093	-155.5263***
Brent	-1.550	-52.5685***

Source: Authors computation, Note: ***Significant at 1% (t- Statistics), **Significant at 5% (t- Statistics).

The results of unit root tests support the null hypothesis that all the stock indices series except Russia, Brazil, India and South Africa markets follow random walk or a weak form of efficiency as they are non-stationary.

Table 6.4 Variance Ratio Test for Stock Market Indices and Crude Oil of BRICS countries Lo & Mackinlay Test

	Lags	2	4	8	16
BRAZIL	Var. Ratio	0.9064	0.4701	0.2397	0.1214
	Z- Statistics	-4.2300***	-4.2300***	-8.5533	-7.5920
RUSSIA	Var. Ratio	0.5001	0.2502	0.1253	0.0628
	Z- Statistics	-1.3387	-1.3387	-1.3387	-1.3387
INDIA	Var. Ratio	0.5001	0.2502	0.1253	0.0628
	Z- Statistics	-1.4137	-1.2242	-0.9895	-0.8929
CHINA	Var. Ratio	0.7730	0.4470	0.2256	0.1128
	Z- Statistics	-23.1900***	-3.7403***	-2.9694***	-2.7625***
SOUTH	Var. Ratio	0.5080	0.2597	0.1288	0.0652
AFRICA	Z- Statistics	-31.2088***	-26.3434***	-20.4242***	-25.3937***
	Var. Ratio	0.7730	0.4470	0.2256	0.1128
BRENT	Z- Statistics	-53.1900***	-13.7403***	-20.9694***	-21.7625***

Source: Authors computation, Note: *** Significant at 1% level

In addition, we have applied the variance ratio test in order to examine whether or not the stock markets of Brazil, Russia, India, China, and South Africa are subject to a random walk or a sort of efficiency that is not very robust. According to the findings in Table 6.4, only the markets in Russia and India have a low level of efficiency. This is due to the fact that their variance ratios are lower than one, and their Z values are not statistically significant. The remaining markets do not behave as though they were following a random walk.

6.2.4 Granger Causality test

Due to the fact that the Granger causality test is sensitive to the lag selection of endogenous variables, the optimal lag length is chosen using the AIC and SIC criterion. Due to the fact that the stock market is typically believed to be a dynamic market, we do not generally expect the lag to be more than one or two. This has led to the result that there is only one lag.

Table 6.5 Granger Causality Test results – 1 lag (Log Differenced Series) For Stock Market Indices and Crude Oil of BRICS countries

(Lag1)	Dlog Brazil	Dlog Russia	Dlog India	Dlog South Africa	Dlog China
Dlog Brazil	-	** Unidirectional	** Bidirectional	** Bidirectional	-
Dlog China	-	-	-	-	-
Dlog South Africa	** Bidirectional	-	-	-	-
Dlog BRENT	** Unidirectional	** Bidirectional	** Unidirectional	** Unidirectional	** Bidirectional

Source: Authors computation, Note: ** Significant at 5% level

The Granger causality results are clearly shown in Table 6.5, showing that the Brazilian stock market leads the Russian, Indian, and South African stock markets. Only the unidirectional relationship with Russia and the bidirectional relationships with India and South Africa are shown. The Brazilian stock market is led by both India and South Africa. Additionally, we can observe that the relationship between the Brent and Russia and China is bidirectional, while it is unidirectional with Brazil, India, and South Africa. Foreign Institutional Investors and Foreign Direct Investment also account for the majority of investment in Asian economies.

6.2.5 Impulse Response Analysis

Figure 6.2 illustrates how one stock market indicator reacts in response to another. With the exception of Brazil's stock market, the other four stock markets have shown a positive response that can last anywhere from two to six days. While Brazil has been impacted, the shocks caused by Russia, India, China, and South Africa have also had an effect on Brazil.

If we take into account markets in other countries such as India, China, South Africa, and Russia, we see that they all follow a similar pattern to the one followed by Brazil's market. We come to the conclusion that every single country that makes up the BRICS has an effect on the others. Wherever we see any negative or positive news triggered, then it will have an impact on the overall economy for around two to six days, and this is what we mean when we talk about the short term.

6.2.6 Johansen Cointegration Test

The Johansen cointegration test is conducted with five different models in order to check for a long-term relationship based on both Trace and Maximum eigen values, and the findings are analysed. These five models are as follows: model 1, which has no intercept and no trend; model

2, which has no intercept and no trend; model 3, which has no linear intercept and no trend; model 4, which has linear intercept and trend; and model 5, which has quadratic intercept and trend.

6.2.7 ARCH- GARCH Model

In addition to study the volatility spillovers that occur between China, India, Russia, Brazil, and South Africa. study We have made an effort to investigate the potential causes of spillovers, which may include geographical closeness or other factors such as market maturity and openness to trade. The Auto Regressive Conditional Heteroskedasticity (ARCH) model demands that each of these conditions be met. The first need is that there should be volatility clustering, and the second requirement is that the residual diagnostic ARCH test for the presence of heteroskedasticity must be refused. We have performed an individual application of the model on each of the five stock markets. The equation that represents the mean of the Brazil market may be written as:

DlogBrazil = C(1) + C(2)*DlogBrazil(-1)+ e ……. Eq. (3)

The identical equation can be rewritten to include the countries of Russia, India, China, and South Africa. The mean equation described earlier can be applied to research on volatility clustering; it can also be used to examine the ARCH effect across all markets; and it can be modelled using the ARCH-GARCH framework.

The second equation to check the volatility in Brazil we can used the variance equation as follows:

H_t = C(3) + C(4) * $e^2_{(t-1)}$ + C(5)* $H_{(t-1)}$ + C(6) * DlogRussia + C(7) * DlogIndia + C(8) * DlogChina + C(9) * DlogSouth Africa……..…….….Eq. (4)

Where Ht represents the variance of the residual error term derived from equation (3) it is the volatility of Brazil stock returns; e2(t-1) is the previous day's squared residual derived from equation (4) it is known as the previous day's stock return information about ARCH term; and H(t-1) elaborates the previous day's residual variance called the GARCH term.

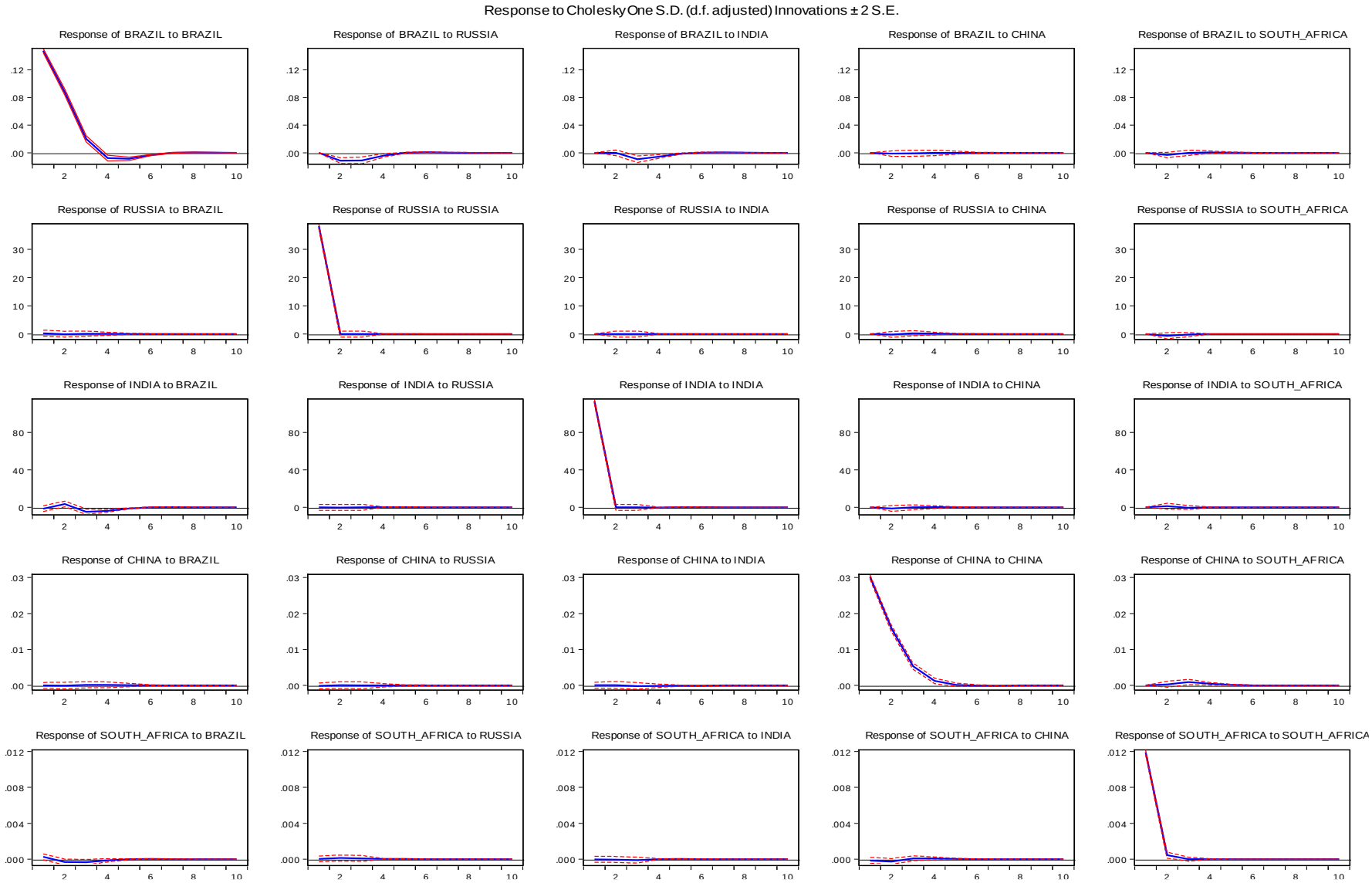


Figure 6.2 Results of Impulse Response Analysis of Stock Market Indices and Crude Oil of BRICS countries

Table 6.6 Johansen Cointegration Test (Log Series) for stock market indices and crude oil of BRICS countries

Variable	Test Type	Number of Co-integrating Relations by Model				
		No Intercept, No trend	**Intercept, No Trend**	**Linear and Intercept, No Trend**	**Linear Intercept and Trend**	**Quadratic Intercept and Trend**
BRENT Brazil	Trace	1	1	1	1	1
	Max-Eigen	1	1	1	1	1
BRENT Russia	Trace	1	1	1	1	1
	Max-Eigen	1	1	1	1	1
BRENT India	Trace	1	1	1	1	1
	Max-Eigen	1	1	1	1	1
BRENT China	Trace	1	1	1	1	1
	Max-Eigen	1	1	1	1	1
BRENT South Africa	Trace	1	1	1	1	1
	Max-Eigen	1	1	1	1	1
BRENT Brazil Russia India China South Africa	Trace	0	0	0	0	0
	Max-Eigen	3	3	3	3	3

Source: Authors Computation

DlogRussia, DlogIndia, DlogChina, and DlogSouth Africa are all examples of exogenous variables that can be used to test how the market volatility in other nations affects the Brazilian market. It is possible to write an equation quite similar to this for every other country.

The outcomes of Johansen's cointegration test are broken down in greater detail with the use of the Trace and Max- Eigen tests in Table 6.6. The examination validates the long-term relationship that exists between all of the BRICS countries. In the table, it is easy to see that the groups have a long-term link with one another. We can also see that there is a significant connection between the stock market indices of five countries and crude oil at a level of 5% significance. This paves the way for potential long-term benefits for the diversification of portfolios across various markets.

The Normal Gaussian distribution is utilized in this investigation, and the findings are broken out in greater detail in Table 6.7. Based on the findings, it has been determined that the ARCH and GARCH terms are significant for all countries with the exception of South Africa. The

significance of the ARCH term means that the returns of the previous day can have an effect on the returns of the current day, whereas the GARCH term implies that the volatility of the previous day can have an effect on the volatility of the current day. The volatility of the stock market in Brazil is sensitive to influences from the stock markets of all other countries. A situation quite similar to this may be found in Russia as well as India and China; nevertheless, it is interesting to note that South Africa's volatility is only impacted by Russia and China, which is considerable at the 10% level.

Table 6.7 ARCH- GARCH model for Stock Market Indices and Crude Oil of BRICS countries

Dependent Variable/ Coefficients	BRAZIL	RUSSIA	INDIA	CHINA	SOUTH AFRICA	BRENT
$e^2_{(t-1)}$ previous Error Term	34.49**	53.14**	26.62**	9.04**	40.21	53.14**
Garch(-1) Previous Volatility	-27.42**	39.04**	-5.45**	-1.72**	-2.00*	39.04**
Volatility- BRAZIL	-	668.43	77.24**	4.92**	21.23	668.43
Volatility- RUSSIA	9.29**	-	9.23**	-	668.43	-
Volatility- INDIA	68.58**	187.90**	-	7.64**	317.01	-
Volatility- CHINA	31.25**	37.49**	27.77**	-	17.12*	27.77**
Volatility- SOUTH AFRICA	29.56	-119.32**	262.44	6.99**	-	262.44**
Volatility- BRENT	56.29**	63.56*	77.24**	8.06**	83.23*	-

Source: Authors compilation, Note: **Significant at 5% level, * at 10% level.

DlogRussia, DlogIndia, DlogChina, and DlogSouth Africa are examples of exogenous variables that can be used to analyse how the volatility in these countries influences the market in Brazil. Each of the other countries can be represented by an equation that is very similar to this one.

The Normal Gaussian distribution was used for this investigation, and the results are broken down in more detail in Table 6.7. According to the findings, both the ARCH and GARCH terms are relevant for all of the countries, with the exception of South Africa. The significance of the ARCH term suggests that the returns of the previous day can have an effect on the returns of the current day, whereas the significance of the GARCH term implies that the volatility of the previous day can have an effect on the volatility of the current day. It is possible for the stock market volatility in Brazil to be influenced by the stock market volatility in other countries. A similar situation may be found in Russia, India, and China; however, it is interesting to note that South Africa's volatility is only impacted by Russia and China, which is considerable at the 10% level.

Table 6.8 (a) Correlation between Conditional Volatilities (Pearson Correlation) of Stock Market Indices and Crude Oil of BRICS countries

	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA	BRENT
		-0.0978**	-0.1080*	0.0818*	-0.3169*	0.0618*
BRAZIL	1.0000	0.0480	0.0681	0.0815	0.7521	0.0484
			-0.0746**	-0.0631**	-0.1593**	-0.1154**
CHINA		1.0000	0.4820	0.3250	0.2569	0.4823
				0.0539***	-0.4660*	0.0852*
INDIA			1.0000	0.0000	0.6585	0.4585
					-0.1400***	-0.1254**
RUSSIA				1.0000	0.0000	0.0000
						-0.0588**
SOUTH AFRICA					1.0000	0.0000
BRENT						1.0000

Source: Authors compilation, Note: *** significant at 1% level, **Significant at 5% level, * at 10% level.

Table 6.8 (b) Correlation between Unconditional Volatilities (Pearson Correlation) of Stock Market Indices and Crude Oil of BRICS countries

	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA	BRENT
		-0.1044***	-0.1267*	-0.0275*	-0.1546**	0.0446**
BRAZIL	1.0000	0.0000	0.6520	0.5245	0.0250	0.0500
			0.0446**	0.1401*	-0.0943***	-0.1044***
CHINA		1.0000	0.0500	0.0000	0.0000	0.0000
				0.0229**	-0.3071*	0.0229**
INDIA			1.0000	0.0356	0.0825	0.0356
					0.0254**	-0.1267*
RUSSIA				1.0000	0.0452	0.6520
SOUTH						0.3071*
AFRICA					1.0000	0.0825
						1.0000
BRENT						

Source: Authors compilation, Note: *** significant at 1% level, **Significant at 5% level, * at 10% level.

Similarly, Table 6.8 explains the Correlation between Conditional Volatilities and Unconditional Volatilities (Pearson Correlation) of Stock Market Indices and Crude Oil of BRICS countries. Table 6.8 (a) and 6.8 (b) shows that there is also a positive and significant relationship between standardized residuals of all the five countries at 1%, 5% and 10% level of significance. The null hypothesis H_{03} is rejected that non-existence of volatility transmission between crude oil and BRICS stock market returns. The similar results were reported in (Lo & MacKinlay, 1988), (Jarret, 2008), (Bos, 1994) and (Hamma, Jarboui, & Ghorbel, 2014).

Chapter 7

The Structural Events Impact on Crude Oil Prices and Stock Market Indices of BRICS Countries

7.1 Introduction

In this chapter, we discuss the structural events that occurred and their impact on the prices of crude oil and stock market indices in BRICS countries. The data that we used for this chapter range from April 1, 1999 to March 31, 2021. The event such as the dot-com bubble, the attacks on September 11, the energy crisis, the low spare capacity, the Chinese stock bubble, the global financial collapse, OPEC cutting production targets by 4.2 mbpd, the Brazilian economic crisis, the Russian economic crisis, OPEC production quota remaining unchanged, the collapse of the Chinese stock market, and a global pandemic. Yahoo Finance, Bloomberg, and the Federal Reserve database were utilised in order to compile the data collection that represents the BRICS nations. Only those days have been taken into account in which all five stock exchanges were open for trading after the data was filtered and cleansed. Our data collection now only contains 5267 observations as a result of this. Correlation, unit root analysis, regression analysis, and the granger causality test were the methods that we utilised for the analysis. The Study have made an effort to determine the effect of certain occurrences both before and after they took place, and we have tried to draw a conclusion from our findings.

7.2 Results and Discussion

7.2.1 Descriptive Statistics

Table 7.1 explains the descriptive statistics of the crude oil and stock market indexes of the BRICS nations. It is clear from the data that the median value is higher than the mean value for all stock indices. Therefore, the data lies on the bell-shaped curve's left side. While negative skewness explains why the data lies on the left side of the normal distribution curve. For China, Russia, India, South Africa, and countries with kurtosis values more than 3, the distribution has peaked relative to expected.

A unit root test has been performed in table 7.2 to ensure that the values are stationary. It explains that there is no unit root found in the data set at level. Additionally, correlation study reveals that there is a positive association between the crude oil price and the stock market indices of the BRICS. According to table 7.3, there is a significant degree of connection (0.57) between crude oil and the indexes of the South African stock market. Additionally, there is a negligibly small (0.01) positive association between Russia and crude oil.

Table 7.1: Summary Statistics of Stock Market Returns and Brent (Q1- 1999 to Q1-2021) of Stock Market Indices and Crude Oil of BRICS Countries

	Brazil	Russia	India	South Africa	China	Brent
Mean	10.10497	7.403528	9.313379	10.42172	7.720730	4.018807
Median	10.26244	7.428060	9.706817	10.83163	7.737062	4.068514
Maximum	11.02979	8.077112	10.64430	11.69131	8.714741	4.978732
Minimum	8.720669	0.000000	0.000000	0.000000	0.000000	2.761907
Std. Dev.	0.707083	0.658551	1.375082	1.393583	0.394174	0.458793
Skewness	-0.402153	-9.07409	-4.38847	-5.688353	-2.889177	-0.347823
Kurtosis	1.727393	101.7792	30.03354	42.64179	58.13809	2.246047
Jarque-Bera	493.1385	2194695.	175774.0	370087.7	668763.8	228.9780
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Source: Authors Computation

Table 7.2 Results of the Augmented Dickey–Fuller test of Stock Market Indices and Crude Oil of BRICS countries.

Variable	ADF test statistics	Probability
Brazil	-24.12087	0.0000***
Russia	-25.69918	0.0000***
India	-25.05972	0.0000***
China	-26.04582	0.0000***
South Africa	-69.83175	0.0000***
Brent	-74.58326	0.0000***

Source: Authors Computation

Table 7.3 Correlation between Stock Market Indices and Brent (Q1- 1999 to Q1- 2021) of Stock market indices and crude oil of BRICS countries

	Brent	Brazil	India	China	Russia	South Africa
Brent	1.00					
Brazil	0.41	1.00				
India	0.40	0.36	1.00			
China	0.31	0.38	0.43	1.00		
Russia	0.01	0.05	0.08	0.01	1.00	
South Africa	0.57	0.54	0.65	0.64	0.12	1.00

Source: Authors Computation

Table 7.4 Results of serial correlation and Heteroscedasticity of Stock market indices and crude oil of BRICS countries

	Breusch–Godfrey serial correlation LM test		Heteroscedasticity test: ARCH	
Variables	F-statistic	Prob. Chi-square	F-statistic	Prob. Chi-square
Brent	0.524612	0.8319	0.02379	0.9902
Brazil	0.65786	0.6704	0.029689	0.8769
Russia	0.254665	0.8036	0.016249	0.7997
India	1.730847	0.7661	0.028895	0.8627
China	1.786762	0.7486	0.161248	0.8777
South Africa	1.143747	0.5586	0.02379	0.7997

Source: Author's compilation

Table 7.5 Results of Granger Causality test of Stock Market Indices and Crude Oil of BRICS Countries

Causation effect from Brent to Stock Market Returns			Causation effect from Stock Market returns to Brent		
Variables	F-statistic	Probability	Variables	F-statistic	Probability
Brazil	180.084	0.000***	Brazil	0.056	0.945
Russia	0.1352	0.87	Russia	0.08878	0.915
China	16.0284	0.000***	China	154.85	0.000***
India	104.085	0.000***	India	262.285	0.000***
South Africa	2.5355	0.079*	South Africa	0.76057	0.4675

Source: Author's compilation, * Signifies Significant at 1%, * signifies significant at 10%**

The findings of the serial correlation test and the heteroscedasticity test are summarized in table 7.4. The breush–Godfrey LM test and the ARCH test were used in the heteroskedasticity and for serial correlation, respectively. The fact that the probability value for both tests is greater than 0.05, as shown in the table, indicates that the data do not contain either serial correlation or heteroscedasticity.

Test of granger causality test is explained in the Table 7.5. Causation effect from Brent to stock market indices as well as causation effect from stock market indices to Brent has been shown. This would indicate that there is a flow of causality in both directions between the indices of the Chinese and Indian stock markets with crude oil. In a similarly, there is evidence of a unidirectional cause and effect in the stock market indices of Brazil and South Africa, however there is no evidence of causality found in the stock market indices of Russia.

7.2.2 Correlation and Regression analysis of Structural Events and its Impact on Stock Market Indices

This section explains correlation and regression analysis of structural events and its impact on stock market indices during the period of the study. The period of the event has been divided into three parts 1. Pre-Dummy (which states the period before occurrence of the event), 2. Day dummy (The day of the event), 3. Post dummy (Which states the period after occurrence of the event). With the correlation and regression, study has also used CUSUM plot to understand the stability of the model. Study used 12 structural events occurred in the period of study.

Table 7.6 Dot Com Bubble (Correlation Analysis)

	Pre- Dot Com Bubble							Post Dot Com Bubble					
	Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA		Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA
Brent	1.00	0.42	0.32	0.41	0.02	0.58	Brent	1.00	0.50	-0.17	0.12	0.79	-0.81
BRAZIL	0.42	1.00	0.38	0.36	0.05	0.54	BRAZIL	0.50	1.00	0.09	0.23	0.25	-0.07
CHINA	0.32	0.38	1.00	0.43	0.00	0.64	CHINA	-0.17	0.09	1.00	-0.11	-0.04	0.30
INDIA	0.41	0.36	0.43	1.00	0.08	0.65	INDIA	0.12	0.23	-0.11	1.00	0.05	0.03
RUSSIA	0.02	0.05	0.00	0.08	1.00	0.11	RUSSIA	0.79	0.25	-0.04	0.05	1.00	-0.54
SOUTH AFRICA	0.58	0.54	0.64	0.65	0.11	1.00	SOUTH AFRICA	-0.81	-0.07	0.30	0.03	-0.54	1.00

Source: Authors Compilation

Table 7.6 (a) Regression analysis of Pre and Post Dot Com Bubble

	Dot Com Bubble Pre-Dummy		Dot Com Bubble Day Dummy		Dot Com Bubble Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	-2.41	0.00	5.78	0.00	-14.80	0.00
BRAZIL	0.03	0.00	-0.01	0.05	0.01	0.55
CHINA	-0.04	0.01	0.02	0.72	0.12	0.01
INDIA	**0.02**	0.00	0.02	0.00	-0.01	0.37
RUSSIA	**0.03**	0.00	-0.01	0.12	0.53	0.00
SOUTH AFRICA	**0.62**	0.00	-0.32	0.00	1.26	0.00
R-squared	0.68		0.65		0.74	
Adjusted R-squared	0.66		0.62		0.72	
Durbin-Watson stat	1.50		1.48		1.46	

Source: Authors Compilation

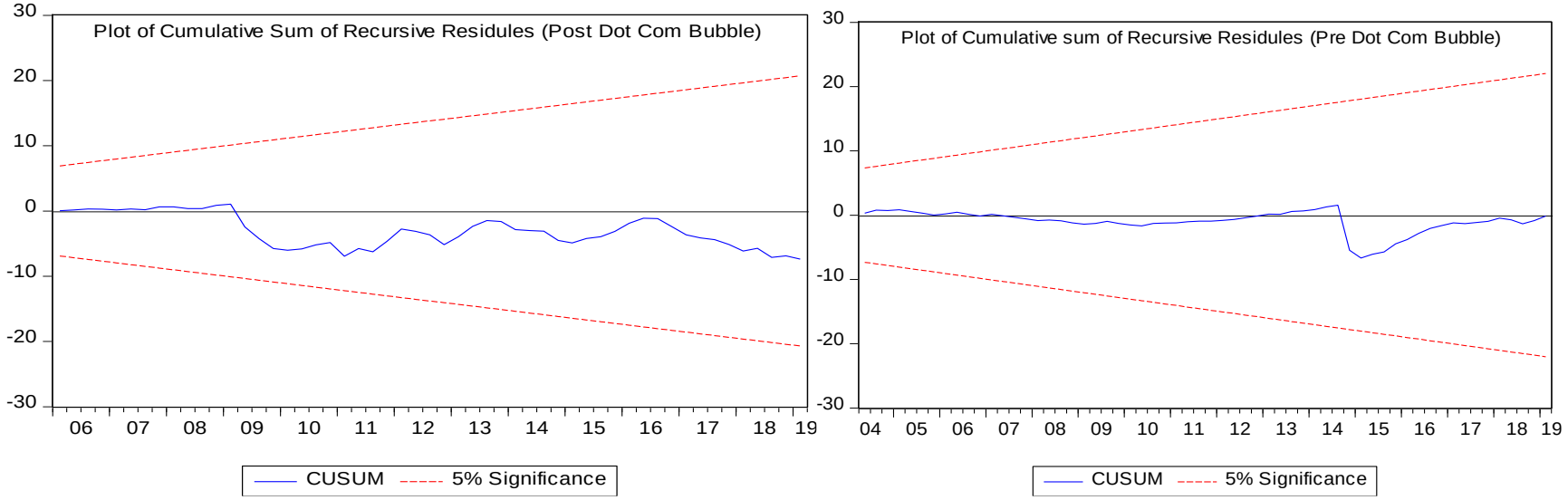


Figure 7.1. CUSUM plot of Pre and Post Dot Com Bubble

Table 7.7 9-11 attacks (Correlation Analysis)

	Pre 9/11 Attack						Post 9/11 Attack					
	Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA		Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA
Brent	1.00	0.07	-0.13	0.16	-0.03	-0.18	Brent	1.00	0.33	0.23	0.28	-0.16	0.34
BRAZIL	0.07	1.00	-0.03	-0.02	0.05	0.01	BRAZIL	0.33	1.00	0.39	0.35	-0.02	0.53
CHINA	-0.13	-0.03	1.00	-0.05	-0.05	0.73	CHINA	0.23	0.39	1.00	0.43	-0.04	0.65
INDIA	0.16	-0.02	-0.05	1.00	0.08	-0.03	INDIA	0.28	0.35	0.43	1.00	0.01	0.65
RUSSIA	-0.03	0.05	-0.05	0.08	1.00	-0.10	RUSSIA	-0.16	-0.02	-0.04	0.01	1.00	0.04
SOUTH AFRICA	-0.18	0.01	0.73	-0.03	-0.10	1.00	SOUTH AFRICA	0.34	0.53	0.65	0.65	0.04	1.00

Source: Authors Compilation

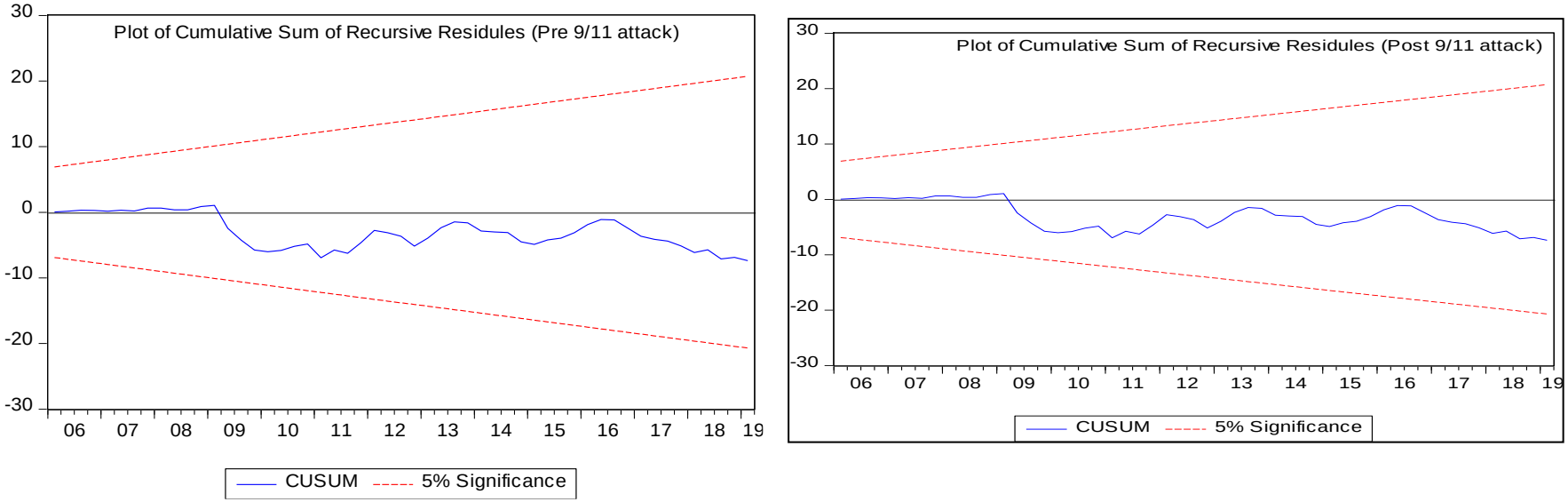


Figure 7.2 CUSUM plot of Pre and Post 9/11 attacks

Table 7.7 (a) Regression Analysis of Pre and Post 9/11 Attack

	9/11 Attack Pre-Dummy		9/11 Attack Day Dummy		Post 9/11 Attack Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	5.78	0.00	-0.46	0.26	3.00	0.00
BRAZIL	0.01	0.05	0.01	0.00	0.06	0.00
CHINA	0.02	0.72	0.72	0.00	-0.01	0.49
INDIA	0.02	0.00	0.02	0.00	-0.03	0.00
RUSSIA	-0.01	0.12	0.00	0.91	-0.12	0.00
SOUTH AFRICA	-0.32	0.00	1.00	0.00	-0.12	0.00
R-squared	0.658		0.628		0.68	
Durbin-Watson stat	1.70		1.68		1.50	
Adjusted R-squared	0.581		0.57		0.62	

Source: Authors Compilation

Table 7.6 and Table 7.6 (a) depicts the correlation between Brent crude oil and stock market indices of BRICS countries at a time of Dot com bubble. It can be found that there is a positive correlation between the variables at a pre dot com bubble period but in the post period of Dot com bubble south Africa and China shows negative correlation with the crude oil prices. In addition, the results of regression analysis showed that during the pre-dummy period, the Chinese stock market had a negative relationship with the price of crude oil, whereas other markets had a positive relationship with the price of crude oil. Brazil, Russia, and South Africa all had a negative impact on crude oil prices on the day of the event.

Similarly, in the post-dummy, the sole Indian stock market was having a negative impact on crude oil prices. The regression model describes 68% and 74% of the relationship between the variables, and no auto correlation was discovered because the DW statistics is less than 4. Similarly, the model's stability is proven by the CUSUM plot in Figure 7.1.

The attacks on September 11th, 2001 were considered a second incident. Tables 7.7 and 7.7 (a) present the results of a correlation and regression analysis performed on data relating to crude oil and stock market indices. Prior to the attacks of September 11, China (-0.13), Russia (-0.03), and South Africa (-0.18) all had a negative association with crude oil.

After the attacks of September 11, it was discovered that all markets, with the exception of Russia, had a positive association with crude oil. In the pre-dummy period regression analysis, Brazil, India, and South Africa were shown to be statistically significant. The connection between South Africa and crude oil was found to be negative. On the day of the event, a positive association between crude oil and all of the markets was observed. In a similar manner, the entire market was negatively affected as a result of the catastrophe. Figure 7.2 CUSUM plot suggests that the model can be considered stable and model explains 65 and 68 percent of the connection while exhibiting no signs of autocorrelation.

Table 7.8 Energy Crisis (Correlation Analysis)

	Pre-Energy Crisis							Post Energy Crisis					
	Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA		Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA
Brent	1.00	0.33	0.30	0.41	0.09	0.85	Brent	1.00	-0.02	-0.59	-0.25	-0.46	-0.64
BRAZIL	0.53	1.00	0.19	0.16	0.01	0.37	BRAZIL	-0.25	1.00	0.12	0.15	0.46	0.20
CHINA	0.30	0.19	1.00	0.22	-0.08	0.46	CHINA	-0.59	0.12	1.00	0.15	0.40	0.29
INDIA	0.61	0.16	0.22	1.00	0.01	0.46	INDIA	0.32	0.15	0.15	1.00	0.38	0.39
RUSSIA	0.19	0.01	-0.08	0.01	1.00	0.04	RUSSIA	-0.46	0.46	0.40	0.38	1.00	0.75
SOUTH AFRICA	0.85	0.37	0.46	0.46	0.04	1.00	SOUTH AFRICA	-0.64	0.20	0.29	0.39	0.75	1.00

Source: Authors Compilation

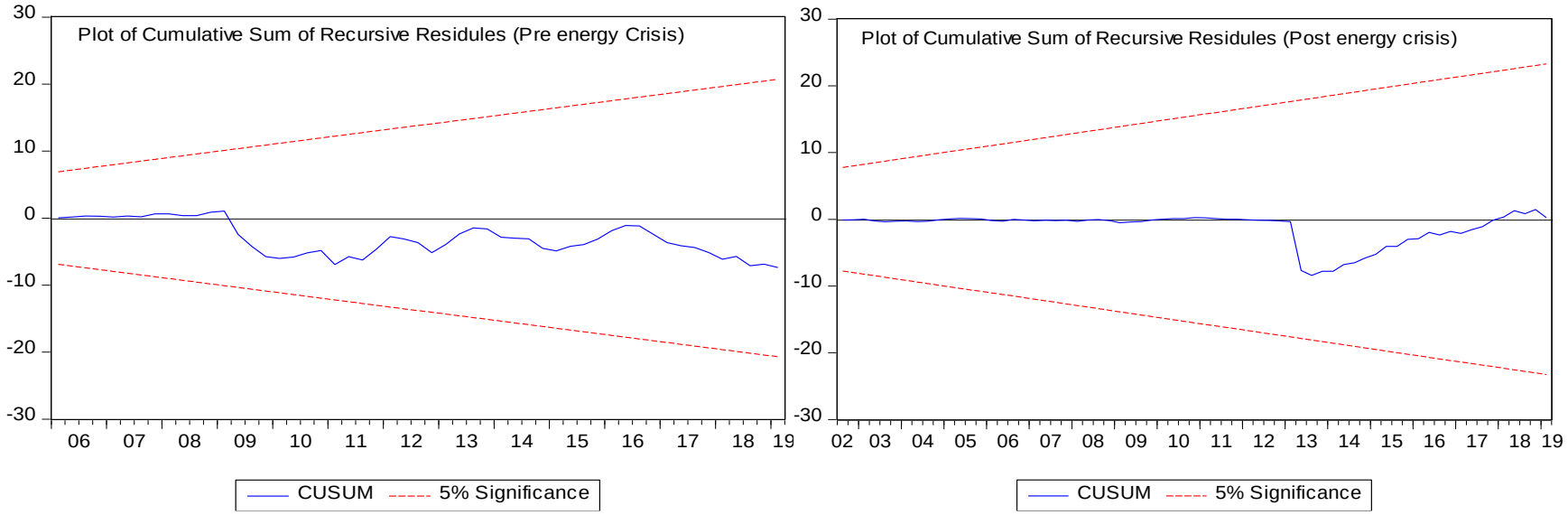


Figure 7.3. CUSUM plot of Pre and Post Energy Crisis

Table 7.8 (a) Regression analysis of Pre and Post Energy Crisis

	Energy Crisis Pre-Dummy		Energy Crisis Day Dummy		Energy Crisis Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	-3.85	0.00	15.47	0.00	16.74	0.00
BRAZIL	0.11	0.02	0.14	0.00	0.06	0.00
CHINA	-0.12	0.00	0.83	0.00	-0.87	0.00
INDIA	0.01	0.00	-0.01	0.08	0.00	0.77
RUSSIA	0.32	0.00	0.85	0.00	0.24	0.00
SOUTH AFRICA	0.86	0.00	0.78	0.00	-0.76	0.00
R-squared	0.73		0.58		0.62	
Durbin-Watson stat	1.70		1.68		1.50	
Adjusted R-squared	0.581		0.57		0.62	

Source: Authors Compilation

In the midst of an energy crisis, correlation analysis and regression analysis are broken down and explained in Table 7.8 and Table 7.8(a), respectively. It is possible to deduce from table 7.8 that all of the stock market indices have a positive correlation with crude oil before the start of the energy crisis, but that correlation becomes negative during the crisis and continues to be negative after the crisis, with the exception of India. Only in South Africa can you find both the highest positive correlation and the highest negative correlation at pre and post period. According to the results of the regression analysis, all of the independent variables are statistically significant at the pre-dummy period.

Furthermore, with the exception of China, all of the stock market indices share a positive relationship with crude oil. In a similarly, on the day of the event, every country other than India is thought to have a negative relationship with the crude oil, which is statistically significant. During the post-crisis period, China exhibited a sign of a negative relationship. The model has no autocorrelation because of DW statistics which is less than 4. However, as far as stability and reliability are concerned, the CUSUM plot in Figure 7.3 indicated that model is stable and reliable.

Table 7.9 Low Spare Capacity (Correlation Analysis)

	Pre-Low Spare Capacity							Post Low Spare Capacity					
	Brent	**BRAZIL**	**CHINA**	**INDIA**	**RUSSIA**	**SOUTH AFRICA**		**Brent**	**BRAZIL**	**CHINA**	**INDIA**	**RUSSIA**	**SOUTH AFRICA**
Brent	1.00	0.12	-0.56	0.14	0.15	0.71	Brent	1.00	-0.01	-0.10	-0.20	-0.27	-0.38
BRAZIL	0.12	1.00	-0.06	-0.01	0.01	0.08	BRAZIL	-0.01	1.00	0.27	0.19	0.15	0.32
CHINA	-0.56	-0.06	1.00	-0.07	-0.18	-0.33	CHINA	-0.10	0.27	1.00	0.26	0.07	0.44
INDIA	0.14	-0.01	-0.07	1.00	0.02	0.06	INDIA	-0.20	0.19	0.26	1.00	0.23	0.50
RUSSIA	0.15	0.01	-0.18	0.02	1.00	0.14	RUSSIA	-0.27	0.15	0.07	0.23	1.00	0.37
SOUTH AFRICA	0.71	0.08	-0.33	0.06	0.14	1.00	SOUTH AFRICA	-0.38	0.32	0.44	0.50	0.37	1.00

Source: Authors Compilation

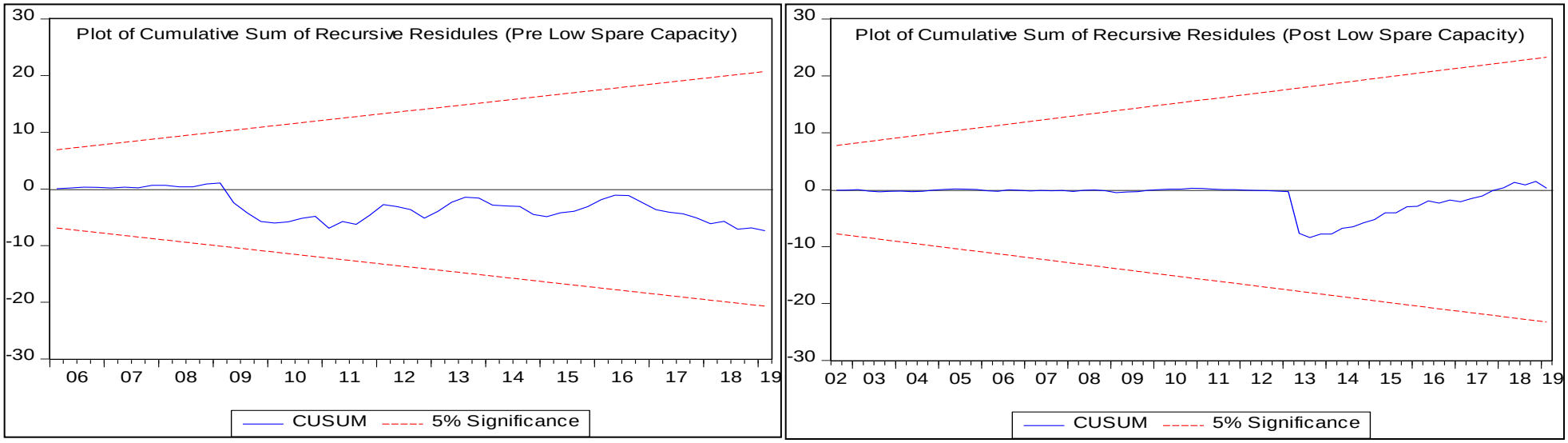


Figure 7.4 CUSUM plot Pre and Post Low Spare Capacity

Table 7.9 (a) Regression Analysis of Pre and Post Low Spare Capacity

	Low Spare Capacity Pre-Dummy		Low Spare Capacity Day Dummy		Low Spare Capacity Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	-0.46	0.26	3.00	0.00	7.82	0.00
BRAZIL	0.01	0.00	0.06	0.00	0.05	0.00
CHINA	-0.72	0.00	0.01	0.49	0.04	0.00
INDIA	0.02	0.00	0.04	0.00	0.00	0.69
RUSSIA	0.00	0.91	-0.14	0.00	-0.14	0.00
SOUTH AFRICA	1.00	0.00	0.12	0.00	-0.33	0.00
R-squared	0.64		0.63		0.68	
Adjusted R-squared	0.61		0.60		0.67	
Durbin-Watson stat	1.58		1.70		1.65	

Source: Authors Compilation

Table 7.9 and Table 7.9(a) present a correlation and regression analysis performed before and after the low spare capacity. According to the findings of the study on correlation, at the pre-event time all of the stock market indexes, with the exception of China's, shared a positive association. In a similar manner, following the occurrence of the event, the majority of markets have a tendency to have a negative correlation with crude oil. Every single one of the indices in the regression analysis for the pre-event phase is statistically significant, with the exception of Russia. China is perceived to have a bad link with crude oil inside the countries that make up the world's economy.

On the day of the event, all of the market indices, with the exception of Russia's, have a positive link with crude oil. During the post-event phase, Russia and South Africa frequently have a similar tendency to share a negative relationship with the crude oil. There is no autocorrelation in this model, and a constant and stable association can be detected in the CUSUM plot that is shown in Figure 7.4. This model describes 64% and 68% of the relationship between the variables.

Table 7.10 Chinese stock bubble (2007) (Correlation Analysis)

	Pre-Chinese stock bubble (2007)						Post Chinese stock bubble (2007)					
	Brent	**BRAZIL**	**CHINA**	**INDIA**	**RUSSIA**	**SOUTH AFRICA**	**Brent**	**BRAZIL**	**CHINA**	**INDIA**	**RUSSIA**	**SOUTH AFRICA**
Brent	1.00	0.46	0.42	0.49	0.02	0.82	1.00	0.39	-0.20	0.23	0.57	0.56
BRAZIL	0.46	1.00	0.32	0.28	-0.02	0.50	-0.39	1.00	-0.25	0.25	0.61	0.35
CHINA	0.32	0.32	1.00	0.31	-0.09	0.53	-0.20	-0.25	1.00	-0.18	-0.55	-0.08
INDIA	0.69	0.28	0.31	1.00	-0.02	0.55	-0.13	0.25	-0.18	1.00	0.35	0.29
RUSSIA	0.12	-0.02	-0.09	-0.02	1.00	-0.02	0.47	0.61	-0.55	0.35	1.00	0.44
SOUTH AFRICA	0.12	0.50	0.53	0.55	-0.02	1.00	0.06	0.35	-0.08	0.29	0.44	1.00

Source: Authors Compilation

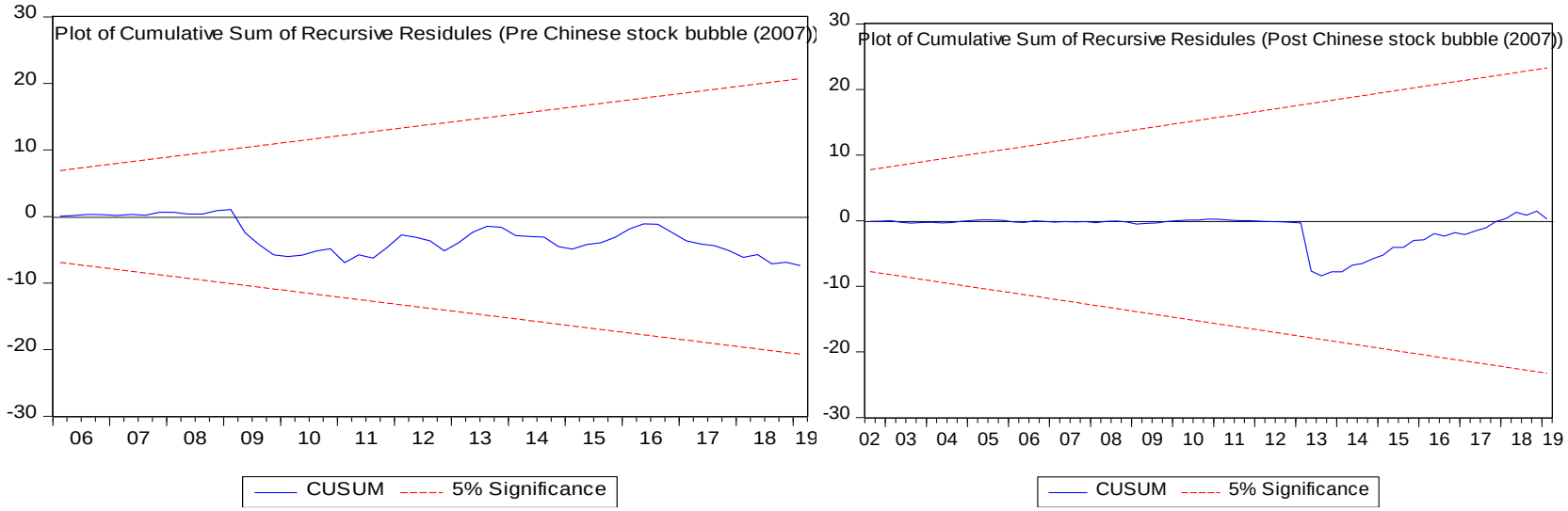


Figure 7.5 CUSUM plot Pre and Post Chinese Stock Bubble (2007)

Table 7.10 (a) Regression analysis of Pre and Post Chinese stock bubble (2007)

	Chinese stock bubble (2007) Pre-Dummy		Chinese stock bubble (2007) Day Dummy		Chinese stock bubble (2007) Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	-2.41	0.00	5.78	0.00	-14.80	0.00
BRAZIL	0.03	0.00	-0.01	0.05	-0.01	0.55
CHINA	0.04	0.01	-0.02	0.72	-0.12	0.01
INDIA	0.02	0.00	0.02	0.00	0.01	0.37
RUSSIA	0.03	0.00	-0.01	0.12	0.53	0.00
SOUTH AFRICA	0.62	0.00	-0.32	0.00	1.26	0.00
R-squared	0.88		0.65		0.84	
Adjusted R-squared	0.76		0.62		0.72	
Durbin-Watson stat	1.50		1.48		1.46	

Source: Authors Compilation

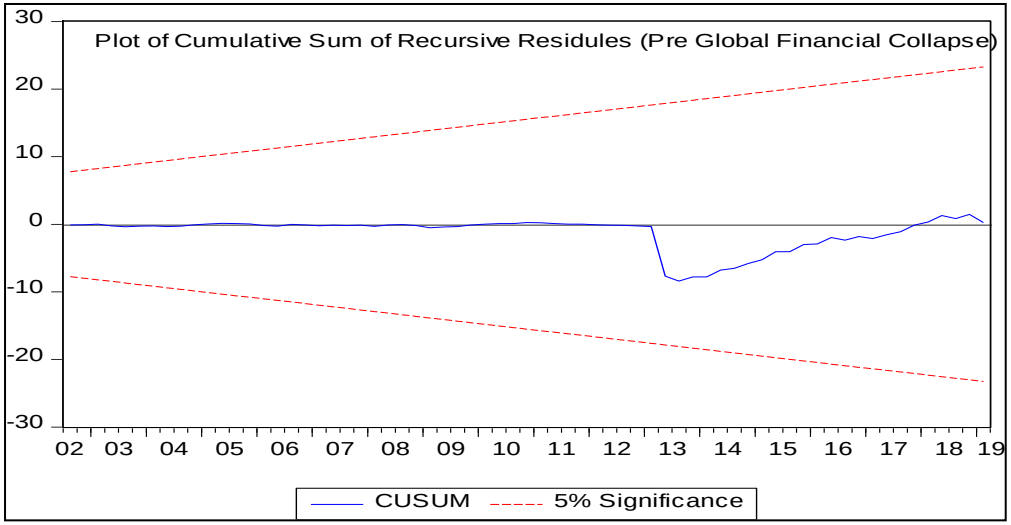
The correlation and regression analysis that was performed at the time of the occurrence of the Chinese stock bubble is explained in Table 7.10 and Table 7.10(a). Before the occurrence of the event, correlation analysis showed that all of the stock indices had a positive correlation with the price of crude oil. This was before the incident occurred. India was the country that showed the strongest positive correlation with crude oil when compared to other countries. In a similarly, during the period following the crisis, every market, with the exception of China and South Africa, reacted negatively to crude oil. Insofar as the pre-event period is concerned, all of the stock indices were statistically significant at the 5% level, and each of them had a positive relationship with crude oil.

When the event actually occurred, every market displayed a negative sign of connection, which was statistically significant. In addition, throughout the years following the crisis, South Africa and Russia stock market indices were enjoying a constructive partnership with regard to crude oil. The model has no autocorrelation, but it nevertheless manages to explain 88 percent and 84 percent of the association. Similarly, the CUSUM plot in Figure 7.5 demonstrates a reliable and stable association.

Table 7.11 Global Financial Collapse (Correlation Analysis)

	Pre-Global financial collapse						Post Global financial collapse					
	Brent	**BRAZIL**	**CHINA**	**INDIA**	**RUSSIA**	**SOUTH AFRICA**		**Brent**	**BRAZIL**	**CHINA**	**INDIA**	**RUSSIA**	**SOUTH AFRICA**
Brent	1.00	0.32	0.30	0.40	0.13	0.84	Brent	1.00	-0.03	-0.56	-0.25	-0.39	-0.58
BRAZIL	0.32	1.00	0.19	0.16	0.03	0.36	BRAZIL	-0.03	1.00	0.18	0.18	0.49	0.26
CHINA	0.30	0.19	1.00	0.22	-0.07	0.46	CHINA	-0.56	0.18	1.00	0.19	0.49	0.39
INDIA	0.40	0.16	0.22	1.00	0.03	0.45	INDIA	-0.25	0.18	0.19	1.00	0.41	0.42
RUSSIA	0.13	0.03	-0.07	0.03	1.00	0.08	RUSSIA	-0.39	0.49	0.49	0.41	1.00	0.80
SOUTH AFRICA	0.24	0.36	0.46	0.45	0.08	1.00	SOUTH AFRICA	-0.51	0.26	0.39	0.42	0.80	1.00

Source: Authors Compilation



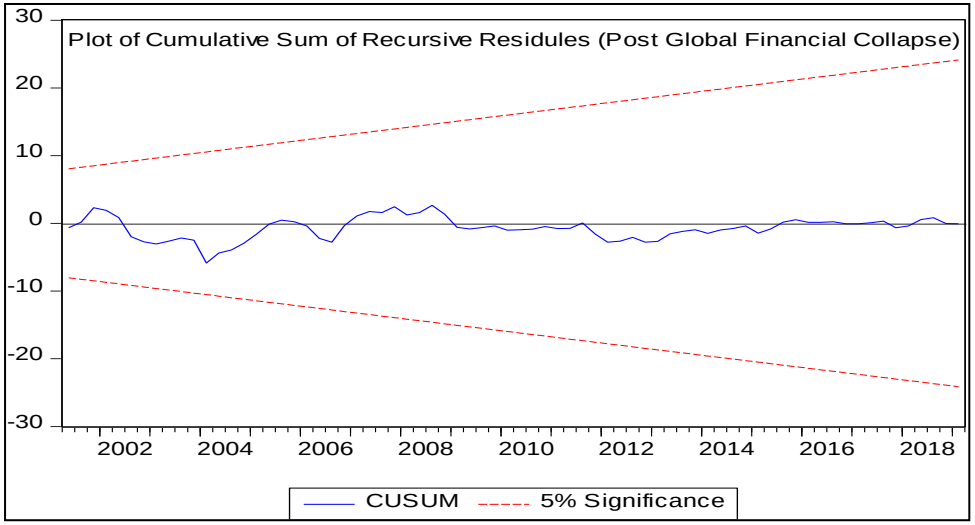


Figure 7.6 CUSUM plot Pre and Post Global financial collapse

Table 7.11 (a) Regression Analysis of Pre and Post Global Financial Collapse

	Global financial collapse Pre- Dummy		Global financial collapse Day Dummy		Global financial collapse Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	-3.84	0.00	-0.46	0.26	15.47	0.00
BRAZIL	0.01	0.03	0.01	0.00	-0.04	0.00
CHINA	-0.12	0.00	-0.72	0.00	-0.83	0.00
INDIA	0.01	0.00	0.02	0.00	-0.01	0.08
RUSSIA	0.03	0.00	0.00	0.91	-0.45	0.00
SOUTH AFRICA	0.86	0.00	1.00	0.00	-0.78	0.00
R-squared	0.72		0.68		0.65	
Adjusted R-squared	0.70		0.62		0.60	
Durbin-Watson stat	0.04		0.04		0.04	

Source: Authors Compilation

Similarly, when the global financial collapse first began, there was a shift in the relationship between the price of crude oil and the indices of the stock market. This shift, which can be demonstrated using correlation and regression analysis in Table 7.11 and 7.11(a), respectively. Before the global financial and economic crisis, the correlations in table 7.11 show that all of the markets exhibited positive correlation. This was the case even though the crisis occurred. In comparison to the other countries, India has the strongest correlation. However, following the occurrence of the global financial crisis, the relationship between the two variables has shifted in an unfavorable direction across all market indices, with the Chinese market bearing the greatest impact.

When compared to all of the other markets, the Chinese market displayed the greatest impact on the day of the collapse; however, not long after the collapse, all of the markets turned negative with crude oil. Regression analysis conducted prior to the occurrence of the event revealed that all markets, with the exception of China, had a positive relationship with crude oil. Figure 7.6 of the CUSUM plot presents evidence that the model accurately represents a consistent and dependable association. The model is able to explain 72% of the pre-relationship and 65% of the post-relationship, and it does so without any autocorrelation.

Table 7.12 OPEC cuts production targets 4.2 mmbpd (Correlation Analysis)

	Pre OPEC cuts production targets 4.2 mmbpd							Post OPEC cuts production targets 4.2 mmbpd					
	Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA		Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA
Brent	1.00	0.33	0.30	0.41	0.09	0.85	Brent	1.00	-0.02	-0.59	-0.25	-0.46	-0.64
BRAZIL	0.33	1.00	0.19	0.16	0.01	0.37	BRAZIL	-0.02	1.00	0.12	0.15	0.46	0.20
CHINA	0.30	0.19	1.00	0.22	-0.08	0.46	CHINA	-0.59	0.12	1.00	0.15	0.40	0.29
INDIA	0.41	0.16	0.22	1.00	0.01	0.46	INDIA	-0.25	0.15	0.15	1.00	0.38	0.39
RUSSIA	0.09	0.01	-0.08	0.01	1.00	0.04	RUSSIA	-0.46	0.46	0.40	0.38	1.00	0.75
SOUTH AFRICA	0.85	0.37	0.46	0.46	0.04	1.00	SOUTH AFRICA	-0.64	0.20	0.29	0.39	0.75	1.00

Source: Authors Compilation

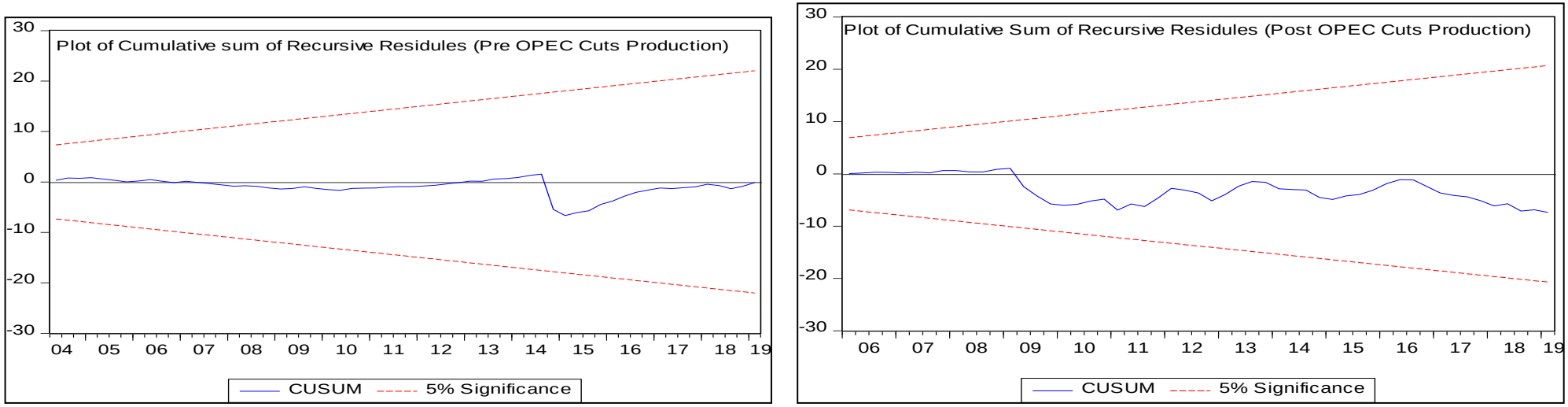


Figure 7.7 CUSUM plot Pre and Post OPEC cuts production targets 4.2 mmpbd

Table 7.12 (a) Regression analysis of Pre and post OPEC cuts production targets 4.2 mmbpd

	OPEC cuts production targets 4.2 mmbpd Pre-Dummy		OPEC cuts production targets 4.2 mmbpd Day Dummy		Post OPEC cuts production targets 4.2 mmbpd Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	-3.85	0.00	15.47	0.00	16.74	0.00
BRAZIL	0.01	0.02	0.04	0.00	0.06	0.00
CHINA	-0.12	0.00	0.83	0.00	-0.87	0.00
INDIA	0.01	0.00	-0.01	0.08	0.00	0.77
RUSSIA	0.02	0.00	0.45	0.00	0.24	0.00
SOUTH AFRICA	0.86	0.00	-0.78	0.00	-0.76	0.00
R-squared	0.73		0.58		0.62	
Adjusted R-squared	0.73		0.52		0.62	
Durbin-Watson stat	1.64		1.74		1.44	

Source: Authors Compilation

In a same manner, Table 7.12 and Table 7.12(a) explain the impact of OPEC reducing production targets prior to and after the event, respectively. Prior to the cuts made by OPEC, there was a positive correlation between the stock market and crude oil. Nevertheless, a short time after the occurrence, stock markets around the world begin to see a downward trend, with South Africa having the strongest negative correlation.

The regression analysis indicates that all of the markets have a positive relationship with crude oil and are adversely reacting to crude oil, which is statistically significant. All of the markets have a positive link with crude oil and are negatively reacting to crude oil. On the day of the event, all stock market indices showed a large positive association with crude oil, with India and South Africa being the two notable exceptions. After the event, the most major influence, which can be observed in the Chinese and South African markets, is likely to have been caused by it, and this finding is statistically significant. According to the CUSUM plot Figure 7.7, which indicates a reliable and consistent model, the r square is 73% for the before model and 62% for the post model.

Table 7.13 Brazil Economic Crisis (2014) (Correlation Analysis)

	Pre Brazil-Economic Crisis (2014)							Post Brazil Economic Crisis (2014)					
	Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA		Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA
Brent	1.00	0.07	-0.13	0.16	-0.03	-0.18	Brent	1.00	0.33	0.23	0.28	-0.16	0.34
BRAZIL	0.47	1.00	-0.03	-0.02	0.05	0.01	BRAZIL	-0.83	1.00	0.39	0.35	-0.02	0.53
CHINA	-0.23	-0.03	1.00	-0.05	-0.05	0.73	CHINA	0.33	0.39	1.00	0.43	-0.04	0.65
INDIA	0.16	-0.02	-0.05	1.00	0.08	-0.03	INDIA	0.28	0.35	0.43	1.00	0.01	0.65
RUSSIA	-0.03	0.05	-0.05	0.08	1.00	-0.10	RUSSIA	-0.16	-0.02	-0.04	0.01	1.00	0.04
SOUTH AFRICA	-0.18	0.01	0.73	-0.03	-0.10	1.00	SOUTH AFRICA	0.34	0.53	0.65	0.65	0.04	1.00

Source: Authors Compilation

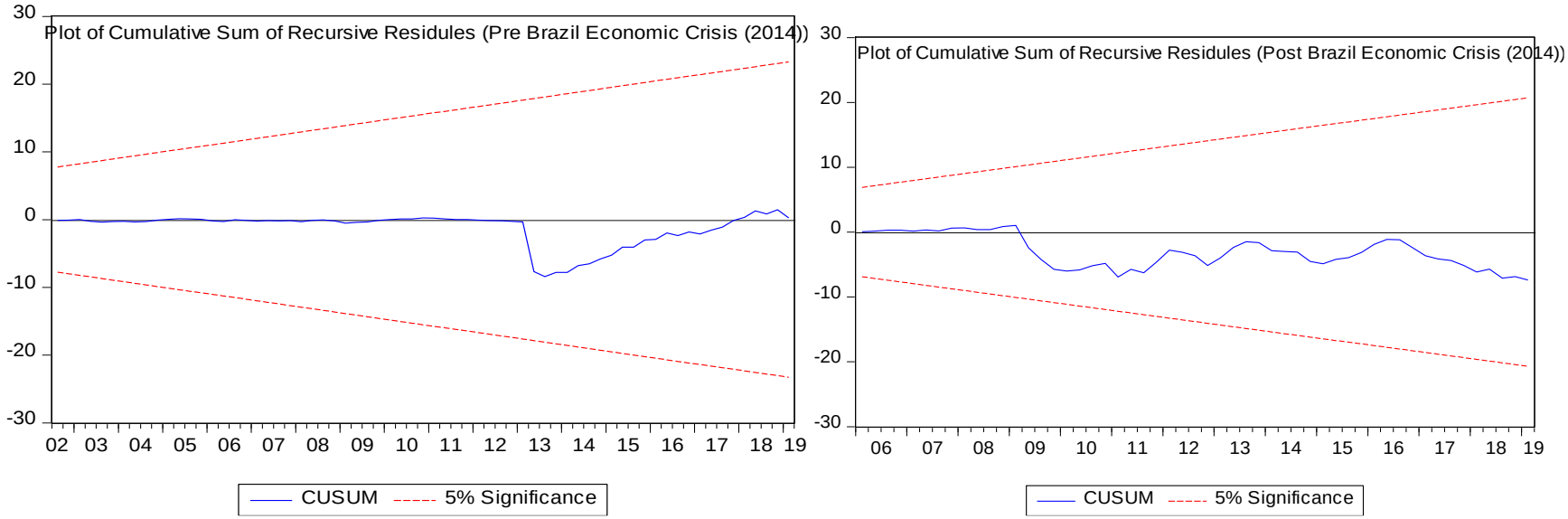


Figure 7.8 CUSUM plot Pre and Post Brazil Economic Crisis (2014)

Table 7.13 (a) Regression Analysis of Pre and Post Brazil Economic Crisis (2014)

	Brazil Economic Crisis (2014) Pre-Dummy		Brazil Economic Crisis (2014) Day Dummy		Brazil Economic Crisis (2014) Attack Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	3.78	0.00	-0.46	0.26	-7.00	0.00
BRAZIL	0.01	0.05	-0.21	0.00	-0.16	0.00
CHINA	0.02	0.72	0.72	0.00	-0.01	0.49
INDIA	0.02	0.00	0.02	0.00	0.03	0.00
RUSSIA	-0.01	0.12	0.00	0.91	-0.12	0.00
SOUTH AFRICA	-0.32	0.00	1.00	0.00	0.12	0.00
R-squared	0.68		0.68		0.68	
Durbin-Watson stat	1.70		1.68		1.50	
Adjusted R-squared	0.51		0.57		0.62	

Source: Authors Compilation

The correlation and regression analyses conducted during the Brazilian economic crisis are detailed in Table 7.13 and 7.13(a), which also illustrate the relationship between crude oil and the stock market indices of the BRICS nations. Before the economic crisis in Brazil, the stock market indices of China, Russia, and South Africa all exhibited a negative correlation with crude oil. However, shortly after the crisis, only Russia and Brazil showed a negative correlation with crude oil.

The regression analysis revealed that prior to the crisis, only South Africa had a statistically significant negative link with crude oil; however, on the day of the crisis as well as following it, Brazil and Russia had a statistically significant negative relationship with crude oil. The model not only explains 68% of the link between before and after the crisis but also has no autocorrelation, as can be seen in Figure 7.8 CUSUM plot, which also confirms the model's predictions.

Table 7.14 Russian Economic Crisis (2014) (Correlation Analysis)

	Russian Economic Crisis (2014)							Russian Economic Crisis (2014)					
	Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA		Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA
Brent	1.00	0.42	0.32	0.41	0.02	0.58	Brent	1.00	0.50	-0.17	0.12	0.79	-0.81
BRAZIL	0.32	1.00	0.38	0.36	0.05	0.54	BRAZIL	-0.50	1.00	0.09	0.23	0.25	-0.07
CHINA	0.22	0.38	1.00	0.43	0.00	0.64	CHINA	-0.17	0.09	1.00	-0.11	-0.04	0.30
INDIA	0.51	0.36	0.43	1.00	0.08	0.65	INDIA	-0.12	0.23	-0.11	1.00	0.05	0.03
RUSSIA	0.82	0.05	0.00	0.08	1.00	0.11	RUSSIA	-0.79	0.25	-0.04	0.05	1.00	-0.54
SOUTH AFRICA	0.68	0.54	0.64	0.65	0.11	1.00	SOUTH AFRICA	-0.81	-0.07	0.30	0.03	-0.54	1.00

Source: Authors Compilation

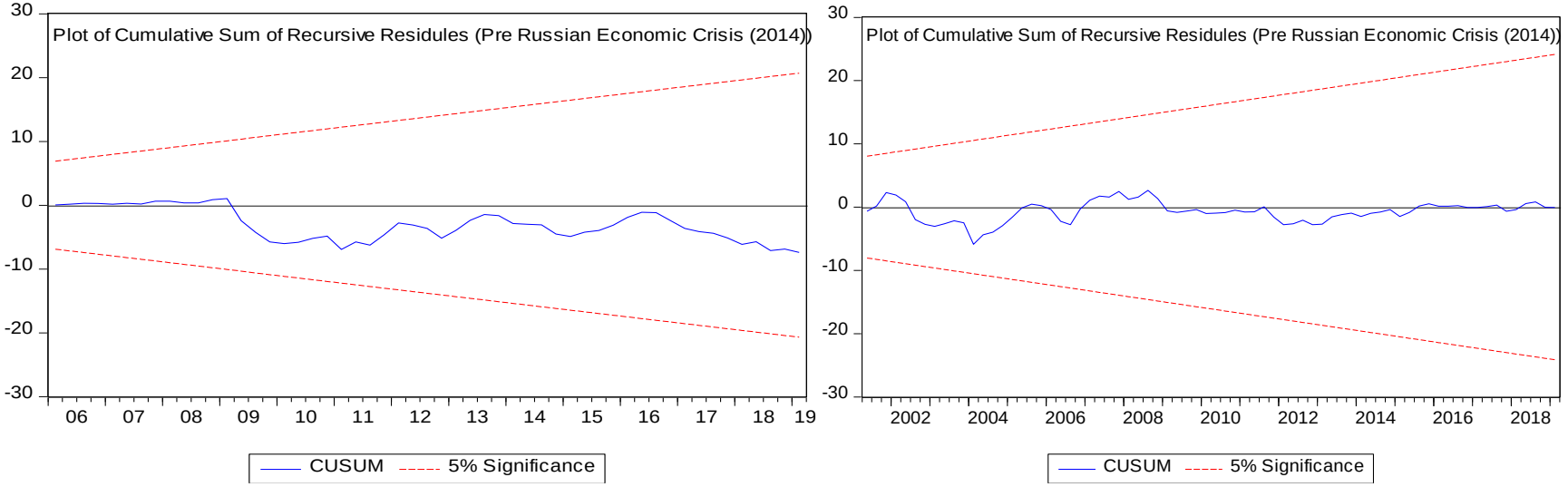


Figure 7.9 CUSUM plot Pre and Post Russian Economic Crisis (2014)

Table 7.14 (a) Regression analysis of Pre and Post Russian Economic Crisis (2014)

	Russian Economic Crisis (2014) Pre-Dummy		Russian Economic Crisis (2014) Day Dummy		Russian Economic Crisis (2014) Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	-1.21	0.00	4.78	0.00	-14.80	0.00
BRAZIL	0.13	0.00	-0.01	0.05	0.01	0.55
CHINA	-0.14	0.01	0.02	0.72	0.12	0.01
INDIA	0.05	0.00	0.02	0.00	-0.01	0.37
RUSSIA	0.04	0.00	-0.01	0.09	-0.53	0.00
SOUTH AFRICA	0.64	0.00	-0.32	0.00	1.26	0.00
R-squared	0.64		0.55		0.64	
Adjusted R-squared	0.62		0.52		0.62	
Durbin-Watson stat	1.50		1.48		1.46	

Source: Authors Compilation

The Russian economic crisis changes the relationship between crude oil and stock market indices, as shown in Table 7.14 and Table 7.14. (a). Correlation study demonstrates that prior to the crisis, all stock market indexes were positively correlated with crude oil, but that this changed later on. According to the regression analysis, China was the only country that had a negative relationship with crude oil before to the crisis. However, on the day and after the crisis, Russia is affected than any other country, which is statistically significant at 10% and 1%, respectively. The model explained 64% of the relationship for both pre and post-crisis, with no autocorrelation, it's also confirmed by CUSUM plot in Figure 7.9. When OPEC decided not to change its production quota in 2015, the correlation between crude oil and stock market indices changed. Tables 7.15 and 7.15(a) show the correlation analysis, which shows that prior to the decision, the stock market indices and crude oil had a positive correlation with crude oil, but that immediately after the decision, the Chinese market becomes negative with crude oil. According to the regression analysis, only Chinese stock indices had a negative connection with crude oil before to the occurrence. However, immediately after the decision, Brazil and South Africa turn shown negative relationship with crude oil. It can be shown in the post-decision phase that the decision's effect has faded and turned positive. According to the CUSUM plot in Figure 7.10, the model is reliable and stable. The model explains 68% and 74% of the relationship between the variables, respectively, with no auto correlation.

Table 7.15 OPEC production quota unchanged (Correlation Analysis)

	Pre OPEC production quota unchanged							Post OPEC production quota unchanged					
	Brent	**BRAZIL**	**CHINA**	**INDIA**	**RUSSIA**	**SOUTH AFRICA**		**Brent**	**BRAZIL**	**CHINA**	**INDIA**	**RUSSIA**	**SOUTH AFRICA**
Brent	1.00	0.46	0.42	0.49	0.02	0.82	Brent	1.00	0.39	-0.20	0.23	0.57	0.56
BRAZIL	0.46	1.00	0.32	0.28	-0.02	0.50	BRAZIL	0.39	1.00	-0.25	0.25	0.61	0.35
CHINA	0.42	0.32	1.00	0.31	-0.09	0.53	CHINA	-0.20	-0.25	1.00	-0.18	-0.55	-0.08
INDIA	0.49	0.28	0.31	1.00	-0.02	0.55	INDIA	0.23	0.25	-0.18	1.00	0.35	0.29
RUSSIA	0.02	-0.02	-0.09	-0.02	1.00	-0.02	RUSSIA	0.57	0.61	-0.55	0.35	1.00	0.44
SOUTH AFRICA	0.82	0.50	0.53	0.55	-0.02	1.00	SOUTH AFRICA	0.56	0.35	-0.08	0.29	0.44	1.00

Source: Authors Compilation

Table 7.15 (a) Regression analysis of Pre and Post OPEC production quota unchanged

	Pre OPEC production quota unchanged		**OPEC production quota unchanged**		**Post OPEC production quota unchanged**	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	-2.41	0.00	5.78	0.00	-14.80	0.00
BRAZIL	0.03	0.00	-0.01	0.05	0.01	0.55
CHINA	-0.04	0.01	0.02	0.72	0.12	0.01
INDIA	0.02	0.00	0.02	0.00	-0.01	0.37
RUSSIA	0.03	0.00	-0.01	0.12	0.53	0.00
SOUTH AFRICA	0.62	0.00	-0.32	0.00	1.26	0.00
R-squared	0.68		0.65		0.74	
Adjusted R-squared	0.66		0.62		0.72	
Durbin-Watson stat	1.50		1.48		1.46	

Source: Authors Compilation

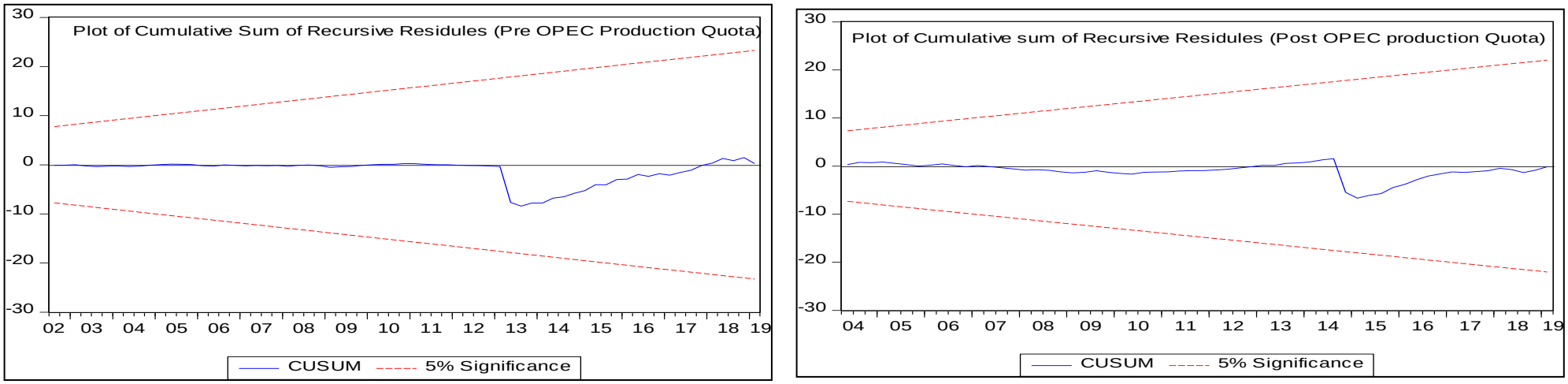


Figure 7.10 CUSUM plot Pre and Post OPEC production quota unchanged

Table 7.16 Chinese Stock Market Crash (2015) (Correlation Analysis)

	Pre-Chinese Stock Market Crash (2015)						Post-Chinese Stock Market Crash (2015)					
	Brent	**BRAZIL**	**CHINA**	**INDIA**	**RUSSIA**	**SOUTH AFRICA**		**Brent**	**BRAZIL**	**CHINA**	**INDIA**	**RUSSIA**	**SOUTH AFRICA**
Brent	1.00	0.12	-0.56	0.14	0.15	0.71	Brent	1.00	-0.01	-0.10	-0.20	-0.27	-0.38
BRAZIL	0.12	1.00	-0.06	-0.01	0.01	0.08	BRAZIL	-0.01	1.00	0.27	0.19	0.15	0.32
CHINA	0.56	-0.06	1.00	-0.07	-0.18	-0.33	CHINA	-0.78	0.27	1.00	0.26	0.07	0.44
INDIA	0.14	-0.01	-0.07	1.00	0.02	0.06	INDIA	-0.20	0.19	0.26	1.00	0.23	0.50
RUSSIA	0.15	0.01	-0.18	0.02	1.00	0.14	RUSSIA	-0.27	0.15	0.07	0.23	1.00	0.37
SOUTH AFRICA	0.71	0.08	-0.33	0.06	0.14	1.00	SOUTH AFRICA	-0.38	0.32	0.44	0.50	0.37	1.00

Source: Authors Compilation

Table 7.16 (a) Regression Analysis of Pre and Post Chinese Stock Market Crash (2015)

	Chinese Stock Market Crash (2015) pre-Dummy		Chinese Stock Market Crash (2015) Day Dummy		Chinese Stock Market Crash (2015) Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	-0.55	0.26	3.00	0.00	4.72	0.00
BRAZIL	0.01	0.00	0.06	0.00	0.05	0.00
CHINA	-0.72	0.00	-0.82	0.49	-0.69	0.00
INDIA	-0.02	0.00	-0.04	0.00	-0.00	0.69
RUSSIA	0.00	0.91	-0.14	0.00	-0.14	0.00
SOUTH AFRICA	1.00	0.00	0.12	0.00	-0.33	0.00
R-squared	0.64		0.65		0.69	
Adjusted R-squared	0.61		0.60		0.67	
Durbin-Watson stat	1.58		1.70		1.65	

Source: Authors Compilation

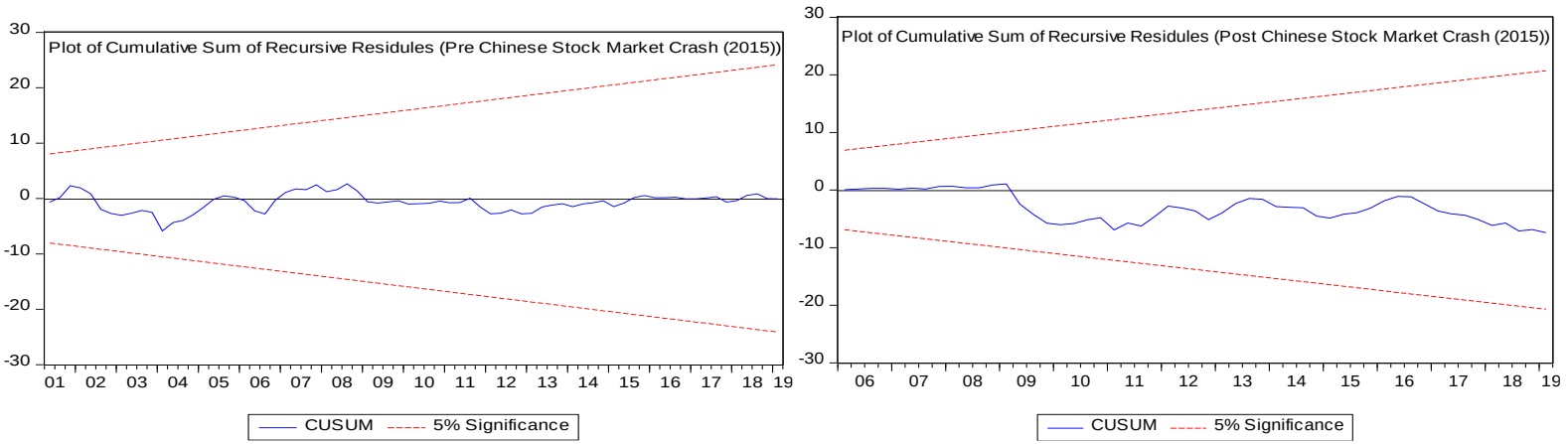


Figure 7.11 CUSUM plot Pre and Post Chinese Stock Market Crash (2015)

Table 7.17 Global Pandemic (Correlation Analysis)

	Pre-Global Pandemic							Post Global Pandemic					
	Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA		Brent	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA
Brent	1.00	0.42	0.32	0.41	0.02	0.58	Brent	1.00	0.50	-0.17	0.12	0.79	-0.81
BRAZIL	0.42	1.00	0.38	0.36	0.05	0.54	BRAZIL	-0.50	1.00	0.09	0.23	0.25	-0.07
CHINA	0.32	0.38	1.00	0.43	0.00	0.64	CHINA	-0.17	0.09	1.00	-0.11	-0.04	0.30
INDIA	0.41	0.36	0.43	1.00	0.08	0.65	INDIA	-0.12	0.23	-0.11	1.00	0.05	0.03
RUSSIA	0.02	0.05	0.00	0.08	1.00	0.11	RUSSIA	-0.79	0.25	-0.04	0.05	1.00	-0.54
SOUTH AFRICA	0.58	0.54	0.64	0.65	0.11	1.00	SOUTH AFRICA	-0.81	-0.07	0.30	0.03	-0.54	1.00

Source: Authors Compilation

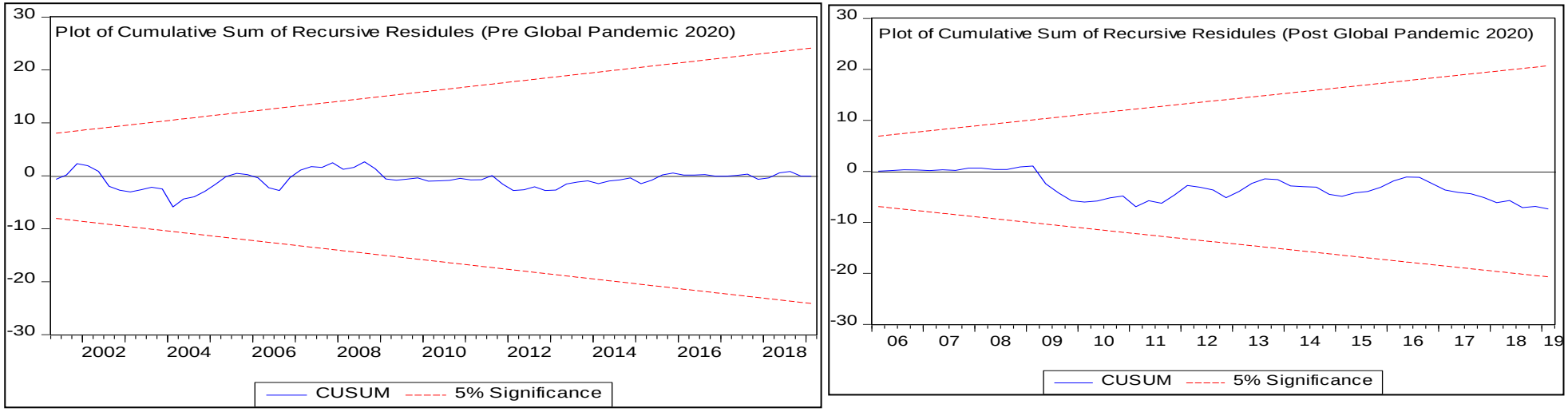


Figure 7.12 CUSUM plot Pre and Post Global Pandemic

Table 7.17 (a) Regression analysis of pre and post Global Pandemic

	Global Pandemic Pre-Dummy		Global Pandemic Day Dummy		Global Pandemic Post Dummy	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	1.08	0.00	6.74	0.00	-0.77	0.04
BRAZIL	0.05	0.00	-0.06	0.00	-0.33	0.00
CHINA	-0.14	0.00	-0.87	0.00	-0.01	0.07
INDIA	0.02	0.00	-0.00	0.77	-0.00	0.09
RUSSIA	-0.04	0.00	-0.24	0.00	-0.33	0.00
SOUTH AFRICA	0.36	0.00	-0.76	0.00	-0.14	0.00
R-squared	0.76		0.82		0.96	
Adjusted R-squared	0.75		0.80		0.95	
Durbin-Watson stat	1.58		1.58		1.75	

Source: Authors Compilation

The Chinese stock market crisis in 2015 changed the relationship between stock indices and crude oil. Correlation and regression analysis are explained in Table 7.16 and Table 7.16(a). According to correlation analysis, before to the Chinese stock market crash, stock market indices were positively correlated with crude oil. Similarly, following the crisis, all stock market indices are adversely connected.

According to the regression analysis, China, India, and Brazil had a negative connection with crude oil before to the crisis. Similarly, India and Russia had a significant negative correlation on the day of the crisis, whereas Brazil and South Africa had a positive relationship. However, with the exception of the Brazilian stock indices, all stock market indices showed a negative relationship after the crisis period. The aforementioned model is validated by the CUSUM plot in the Figure 7.11, and 64% and 69% of the model explain the relationship between the pre and post crisis periods, respectively, with no auto correlation.

Because of the lockdown, the financial market and crude oil prices have suffered severely as a result of the global pandemic that began in 2019. Correlation analysis is explained in Tables 7.17 and 7.17(a). All stock market indices were positively connected with crude oil prices prior to the pandemic. However, shortly after the global pandemic began, all financial market indices were inversely correlated with crude oil.

The regression analysis is explained in Table 7.17 (a), which reveals that before the pandemic, Russia and China were negatively related to crude oil prices. However, on the day of the pandemic, the all market indices went negative, and a similar situation can be witnessed in the post-pandemic period. This was corroborated by the CUSUM plot in the Figure 7.12, and the model explains 76% and 96% of the relationship, respectively, with no autocorrelation. The null hypothesis from H_{04} to H_{15} is rejected that no significant impact of structural event on stock market indices of BRICS countries. The similar results were reported in ***(Arouri, Foulquier, & Fouquau, 2011), (Bjornland, 2008), (Le & Chang, 2011), (Jones, Leiby, & Paik, 2004), (Mendoza & Vera, 2010), (Boubaker & Raza, 2017).***

Chapter 8

Findings, Conclusions and Suggestions

In this section, the findings and conclusions drawn for each objective of the study, policy implications, contribution of the study, and scope for future research are presented.

8.1 Findings of the Study

8.1.1 Findings from Objective I analysis

Objective 1. To Examine the relationship between Crude Oil and Macroeconomic Variables of BRICS Countries

8.1.1.1 It can be observed that positive skewness in Brazil for Current account and exchange rate, In Russia; Exchange rate GDP and Interest rate, In India and China; Exchange rate Inflation and Interest rates and in South Africa we can see a exchange rate, GDP, Money supply, current account, FOREX and Gold prices are positively skewed. All other variables are negatively skewed.

8.1.1.2 Augmented Dickey–Fuller test (ADF) test is used to understand the stationary properties of the variables. Whereas we found all the macroeconomic variables are stationary at first difference and further stated that we can run Cointegration test to know the relationship between the variables.

8.1.1.3 The Cointegration test has been performed by taking lag interval as 1 to 2, which has been selected as per the optimum lag length suggested by different tests like Akaie Information Criterion (AIC), Schwarz Criterion (SC) and the Likelihood Ratio (LR) test.

8.1.1.4 The result of Johansen's Co-integration test indicates presence of at least one co-integrating vectors for Brazil and Russia at the 5% level of significance. This result has been supported by Trace test as well as Max Eigen values.

8.1.1.5 Cointegration result shows that in all countries at least one variable is cointegrated, so VECM is applied with one or two cointegrating factor and two lags in each country equation has been estimated.

8.1.1.6 Whereas for India, China and South Africa null hypothesis of no Co-integration can be rejected at 5% level of significance as P-value is less than 0.05. Thus, on

the basis of above observation, it can be concluded that there exists a long-term relationship among all the variables pertaining to BRICS Countries.

8.1.1.7 The study also concludes that there exist a long and stable relationship between the variables as Error Correction Term is negative and significant.

8.1.1.8 As per Granger Causality test; From Brazil; Exchange rate, GDP and Import shares a Unidirectional relationship. Whereas all remaining variables show the bi-directional relationship.

8.1.1.9 In Russia, exchange rates, imports, inflation, industrial production, interest rates, silver prices, and forex have unidirectional relationships with crude oil, whereas the current account, GDP, FDI, and money supply have bidirectional relationships. export and gold prices show no causality with regards to crude oil prices

8.1.1.10 In India, FDI, gold prices, industrial production, interest rates, and silver prices all have a bi-directional relationship with crude oil, while the rest have a uni-directional relationship.

8.1.1.11 In China; FDI, silver prices, industrial production, GDP, inflation, and money supply show bi-directional relationships while other variables show uni-directional relationships.

8.1.1.12 In South Africa, FDI, Money Supply, Silver Prices, Interest Rates, GDP, and current account have bi-directional relationships with crude oil, whereas exchange rates have no causality and the remaining variables have a uni-directional relationship with crude oil.

8.1.1.13 In the Correlation analysis between the macroeconomic variables and Crude oil prices and found that in in Brazil; Exchange rate (-0.21), Export (-0.07), GDP (-0.10), Inflation (-0.10), Interest rates (-0.67), Current Account (-0.08), and Import (-0.10).

8.1.1.14 In Russia; Interest rates (-0.87) and FDI (-0.10) are negatively correlated and remaining variables are positively correlated with Crude oil.

8.1.1.15 In India we found only one variable i.e. FDI (-0.54) which is Negatively correlated with crude oil. In China; Exchange rate (-0.79), FDI (-0.14) and Industrial Production (-0.04) found to be negatively correlated with the crude oil prices.

8.1.1.16 In addition in South Africa Exchange rate (-0.13), Inflation (-0.09), Interest rates (-0.01), Money Supply (-0.05), FDI(-0.12) and Gold Prices (-0.29) are found to be negatively correlated and other variables are positively correlated with crude oil prices.

8.1.1.17 In Regression analysis of the Macroeconomic variables and crude oil of BRICS countries we found that in Oil importing countries inflation, Money supply and gold prices has a negative impact on crude oil prices.

8.1.1.18 Similarly, in Oil importing and exporting countries, especially in China exchange rate, Inflation, Money supply, Forex, Gold prices are negatively impacted on crude oil but in Brazil results indicates exchange rate, export, GDP, Interest rates and Current account found to be negatively impacting the crude oil prices.

8.1.1.19 In Crude oil exporting country like Russia GDP, Inflation, Gold prices, Silver prices, Import are negatively impacting as the crude oil price increase. But Money supply, Industrial production and Exports are found to be positively impacting towards increase in crude oil prices.

8.1.2 Findings from Objective II analysis

Objective 2: To Study the relationship between Crude Oil Prices and Sectorial Stock Market Indices of BRICS Countries

8.1.2.1 Correlation analysis describes that In Brazil; Real estate and financial sector has a negative correlation with -0.65 and -0.04 respectively but all the other sectors are found to be positively correlated with Crude oil prices.

8.1.2.2 In Russia, all the sectors have been positively correlated except one. Financial sector. Similarly, in India; all the sectors are positively correlated except pharmaceuticals sectors with -0.08 correlation.

8.1.2.3 In China results indicates that Brent crude is positively correlated with Chemical, Construction and material, Oil and Gas, Textiles, Industrial mining and FMCG but other sectors found to be negatively corelated.

8.1.2.4 In South Africa, except pharmaceuticals and financial sectors are negatively correlated and all other variables are positively correlated with Brent crude oil.

8.1.2.5 In the ADF unit root test we found all the variables are stationary at level or at first difference.

8.1.2.6 Chemical, construction and material, and financial industries in Brazil have a Uni directional relationship, while all other sectors have a Bi directional relationship.

8.1.2.7 Similarly, in Russia, Chemical, Constructions and material, pharmaceuticals, financial and industrial mining discovered unidirectional relationship while other

sector had bi directional relationship except FMCG which has no Cause-and-effect relationship.

8.1.2.8 The chemical and manufacturing industries in India have a uni directional relationship with crude oil, while the financial sector has discovered bidirectional relationship link. In China, our study finds out unidirectional relationship between chemical, real estate, and pharmaceuticals.

8.1.2.9 In addition, South Africa, construction and materials, real estate, pharmaceuticals, has bi directional relationship. Textiles, on the other hand, have a unidirectional relationship with crude oil and no causality.

8.1.3 Findings from Objective III analysis

Objective 3. To Study the volatility Transmission between Crude Oil prices and BRICS Stock Market returns

8.1.3.1 The results of unit root tests support the null hypothesis that all the stock indices series except Russia, Brazil, India and South Africa markets follow random walk or a weak form of efficiency as they are non-stationary.

8.1.3.2 As per the results of Variance ratio test only Russia and India markets are having weak form of efficiency because their variance ratios are less than one and Z values are not significant. The remaining markets do not follow random walk.

8.1.3.3 Granger causality results where Brazil stock market leads Russia, India and South African stock markets.

8.1.3.4 We can only see that there is unidirectional relationship between Russia, Bidirectional with India and South Africa. As India and South Africa also leads the Brazilian stock market.

8.1.3.5 Moreover, we can also see the Brent Crude oil has unidirectional relationship with Brazil, India and South Africa and Bidirectional with Russia and China.

8.1.3.6 As per the Normal Gaussian distribution; ARCH and GARCH term are significant for all the countries except for South Africa.

8.1.3.7 The volatility in the Brazil stock market can be affected by all the other countries. Similar situation can be found in Russia, India and China but interestingly in South Africa the volatility is only impacted by Russia and China which is significant at 10% level.

8.1.3.8 The study found that there is a positive and significant relationship between standardized residuals of all the five countries at 1%, 5% and 10% level of significance.

8.1.3.9 As per the Impulse response function there is a positive response observed in all the other four stock markets excluding Brazil that lasts for up to 2-6 days. While, Brazil has been impacted the shocks created by Russia, India, China and South Africa.

8.1.3.10 The study concludes that each and every country in BRICS impacts one and another. Wherever we see any negative and positive news triggered then it will have impact on overall economy for around 2- 6 days that is in short run.

8.1.4 Findings from Objective IV analysis

Objective 4: To analyse the Structural Events Impact on Crude Oil Prices and Stock Market Indices of BRICS Countries

8.1.4.1 As per the ADF unit root test we found that all the stock market indices are stationary at level

8.1.4.2 Correlation analysis indicated there is a positive correlation between Brent crude oil and stock market indices.

8.1.4.3 As the result indicates in Breusch–Godfrey serial correlation LM test and Heteroscedasticity test we found no serial correlation and heteroscedasticity in the Stock market indices and crude oil prices.

8.1.4.4 Granger causality result indicates that Brazil, China and India has a causation effect from Brent Crude oil to Stock market indices at 1% level of Significance also in South Africa causality flow from Brent to stock market indices at 10% level of significance.

8.1.4.5 In addition to above we have also found that in China and India the causation effect from stock market to Brent crude oil is exist. So, in both the countries we fount bi directional relationship of stock market indices with Crude oil prices.

8.1.4.6 In the Dot com bubble crises, we found China and South Africa was having a positive correlation with crude oil in pre crises period but in post crises it has turn up negatively correlated. All the other countries stock market indices were positively corelated before and after the crises but the intensity has reduced in Post crises.

8.1.4.7 Similarly, regression analysis results show that on pre crises China was having negative relationship with crude oil but on the day of crises and post cries it has turned to be positive.

8.1.4.8 In 9-11 attack we found China, Russia and South Africa has negatively corelated but after the attack we found that China and South Africa turned in positive correlation with Crude oil prices.

8.1.4.9 Regression analysis confirm that there was a negative impact on crude oil prices of 9-11 attack because we have found that all the stock market indices has turned negative after the attack except Brazil.

8.1.4.10 Energy crisis has also shown a negative correlation of stock market indices with the crude oil in post crisis period except India. Similarly, in regression analysis we can see a change in coefficient from positive to negative but the affect is very moderated after the crises.

8.1.4.11 In the event of low spare capacity, we can see all the stock market indices are turned negatively correlated in the post era. In addition to it we can see that Russia and South Africa relationship towards crude oil is became negative after the event.

8.1.4.12 In Chinese stock bubble we can see all the stock market indices has negatively correlated with Brent crude oil which was positive earlier. In regression analysis we can see all the markets where positively reacting towards change in crude oil prices but after and on the day of stock bubble Brazil and China has negatively reacted.

8.1.4.13 In global financial crises has a major impact on all stock market indices which was never before. We found that all the stock market indices have got negatively correlated after the post crisis period. Similarly, we have seen in regression analysis where we found all the markets turned negative in the post crisis period.

8.1.4.14 In the event of OPEC cuts the production of crude oil we have also seen the negative impact of the news on the market indices which shifted to negatively correlated in the post event. In regression analysis we found that only China has negative relationship with the crude oil before and after the event.

8.1.4.15 In Brazil economic crises; China, Russia and South Africa was having a negative correlation with the crude oil prices but in the post crises we can see only China and India has shown positive correlation. In regression we have seen Brazil has impacted a lot more than any other country because as crude oil price increased

after the crisis Brazil stock market indices shows a negative relationship with the crude oil.

8.1.4.16 In addition to it Russian Economic crises has a high impact on all the countries of BRICS, whereas all the stock market indices were having a positive correlation with crude oil before the crises which has move to negative. As the regression analysis shows the similar results for all the countries. But after the crises all the countries recovered except India and Russia.

8.1.4.17 In the event of OPEC production quota unchanged we can see that all the countries stock market indices are positively correlated with the crude oil except China which was shited to negative after the event. Similarly, it this event has shown very marginal effect of the stock market indices.

8.1.4.18 Chinese stock market crash has shown very tremendous impact on the economies of the BRICS, we have found that all the stock market indices has negatively correlated with the crude oil after the happening of the event. As per the regression analysis we can see the relationship of stock market indices with crude oil has change to negative on the day of the happening and in the post era.

8.1.4.19 Global pandemic has impacted all the world leading stock market indices and similarly we have found that it has also impacted the BRICS countries. We found in the regression analysis that stock market indices of all the countries have impacted because of pandemic and shows negative relationship with crude oil.

8.2. Conclusion of the study

The research intended to unveiled relationship between crude oil prices and Macroeconomic variables. Also, this study will examine the nexus between former variable and Stock market indices as whole. As we have understood from the study that BRICS is considered as a major developing cluster in the world. BRICs countries are also considered as a major petroleum consumer and have exceeded America's oil consumption since 2011.

Firstly, the study attempts to identify major macroeconomic variables which impacts the crude oil prices. Considering the literature and the information from major institutions study identified 13 macroeconomic variables understand the relationship Unit root test, cointegration, VECM, and Granger causality test are used. The study found that all the countries has at least one variable cointegrated. So VECM approach has been applied and concluded that there is long and stable relationship between the variables. Similarly, as granger causality test suggested that Exchange rate, Import and GDP has a unidirectional

cause and effect relationship with crude oil. The results are similar to ***(Mork, 1994), (Eltony and Al-Awadi, 2001), (LI, 2013), (Omran, 2003), (AKRAM, 2004), (Jiménez-Rodríguez, 2009).***

Secondly, the study also tries to understand the relationship between Crude oil Prices and Sectoral stock market indices of BRICs countries. For this we have used Correlation analysis, Unit root analysis and Granger Causality test. Study considers ten equity sector indices across five markets are selected which includes Chemical, Const. & Material, Oil & Gas, Manufacturing, Real Estate, Pharmaceuticals, Textiles, Industrial Mining, Financial, Fast-Moving Consumer Goods sector. In the Correlation analysis we found that in all the countries Financial sector is negatively correlated with crude oil and all the other sectors are positively correlated. In BRICs out of the all the sector under study only Chemical sector is having Bi directional relationship with the crude oil in all the countries whereas some sectors are having unidirectional and bidirectional relationship in each country. Thirdly, the present study is also tries to check the weak form of Stock market efficiency, Interlinkages and Volatility spillovers between stock market indices and crude oil of all the five countries namely Brazil, Russia, India, China and South Africa. We have also investigated the presence of short run interlinkages and long run integration between the countries.

The results indicated that there is a presence of positive and negative correlation between the stock market of all five countries and crude oil. The similar results were reported in ***(Lo & MacKinlay, 1988), (Jarret, 2008), (Bos, 1994) and (Hamma, Jarboui, & Ghorbel, 2014)***.The study contributes to the existing literature by giving the significant results. Finally; study tries to understand the structural event impact on the crude oil and stock market indices of BRICs countries and found that It appears that the relationship between all the five stock indices and oil returns are less or more responsive to shocks. The effects on growth are the largest in both the pre-crisis and post-crisis periods. In terms of their magnitude, duration and significance, the effects of oil prices on economy are considerably more serious in the post-crisis period than in the pre-crisis period. Oil prices respond more significantly and strongly to economies output growth in the post-crisis period than in the pre-crisis period.

8.3 Policy Implications and Suggestions

The political, financial, and economic circumstances that prevail in a given nation each give rise to a unique set of circumstances that influence the policies that nation's government chooses to implement. One of the primary goals of every nation is to develop a robust

economy, and the role that the financial system plays in providing support for the economy is of the utmost importance. It is necessary to have a capital market that is not only open and transparent but also regulated because the role of the stock market is significant in the overall financial and economic development of a country. A constructive part for the government and the regulatory authorities to play in the functioning of the operations of the stock market should be a priority. It is imperative that the government come up with policies to defend and safeguard the interests of investors. A legislative structure like this might entice investors from both the domestic and international markets. This section's goal is to make policy proposals that can be considered by domestic investors, overseas investors, regulatory organizations for bank and stock markets, and stock market analysts. The decision-makers in charge of policy should take the necessary actions to guarantee an effective and efficient system.

8.3.1 The results of this study will have significant ramifications for investors and market regulators in terms of developing trade strategies and creating positive policies to increase market confidence. They will help them coherently understand the fundamentals of the relationship between macroeconomic indicators and stock market indices with crude oil.

8.3.2 The majority of VECM's findings point to a relationship, both in the long run and the short run, with the macroeconomic factors. The BRICS macroeconomic indicators demonstrate the existence of both long- and short-run effects. South Africa does not appear to be seeing any short-term effects. The lack of a long-run and short-run effect of macro variables, as well as the absence of a short-run effect in South Africa, can be linked to the influence of various other macro and micro factors on crude oil.

8.3.3 In BRICS countries mainly chemical, construction and material and financial sector shows a cause-and-effect unidirectional relationship with crude oil. The policymakers can focus on these relationships to make investment decisions for long term or short-term period.

8.3.4 Policymakers should be cognizant of the effects of both tight and easy monetary policy on interest rates, inflation, and currency exchange rates. Stock returns could rise as a result of a weakening currency and a laxer monetary policy. Restrictive monetary policy should be avoided if at all

possible. The countercyclical strategies will help during both expansionary and contractionary business cycles.

8.4. Future research Scope

8.4.1 The sufficient large number of studies has been conducted on the area of Crude Oil prices, but all the studies has been focusing on the fluctuation of crude oil and its Impact on the economies ***(Eltony & Al-Awadi, 2001).*** But there are very few studies which focuses on Market integrations. So, there is a scope for researchers to conduct the studies in this area

8.4.2 Many researchers has studied the impact of Crude oil on the Macro economic variables ***(Mork, 1994), (Jones & Kaul, 1996),(Bjornland, 2000),(Eltony & Al-Awadi, 2001)*** but many variables has been excluded under study which have significant impact on Crude Oil.

8.4.3 The study has also revealed that most of the researchers have been focusing on USA around 31% of articles collected ***(Y. S. Wang & Chueh, 2013),(Uri, 1982), (Davidson, 1963),(Hsu, Lin, & Chen, 2014),(Schubert & Turnovsky, 2011)***. Therefore, the research can be conducted in other developing and emerging markets.

8.4.4 There are many researches has been done on impact of Crude oil on Stock indices but there are very few studies which are focusing on industry or sector specific. So, researcher can also focus on this aspect.

8.4.5 Several articles has developed a different models ***(Devlin & Titman, 2004), (Chuku, Akpan, Sam, & Effiong, 2011), (Aloui, Nguyen, & Njeh, 2012), (Le D. , 2017)***.The future research can be done on the validation and testing of the models which are developed in different studies.

8.4.6 Many researchers have focused the period of the study 11 to 20 Years and concluded it but researcher can focus to conduct a study for more periods to generalize it.

It can be said that there is a sufficient contribution has been made in the area of Crude oil and its impact but there is always a scope of study that the researcher has to identified. There are various techniques which can be used to generalize these results and to solve the research problem. The Scope of the study is not limited to further

research but there are many other issues which are relevant and unidentified which the researcher can find out for the further study.

Research Paper Publications

- Published a research article titled "Relationship Between Crude Oil prices and Macro-economic Variables: Evidence from BRICS Countries" in International Journal of Energy Economics and Policy 2020, 10(5), 1-8. **(Scopus Indexed, Q1)**.
- Published research article titled "Nexus between Crude Oil, Exchange Rate and Stock Market Returns: An Empirical Evidence from Indian Context" in International Journal of Energy Economics and Policy, 2021, 11(3), 170-175 **(Scopus Indexed, Q1)**.
- Published Research paper on "Impact of Export, Import, and GDP on Foreign Direct Investment of BRICS Countries - A Two Decade Tale" Jour of Adv Research in Dynamical & Control Systems, Vol. 12, **(Scopus Indexed, Q3).**
- Published a research article titled "Does Crude Oil Prices have Effect on Exports, Imports and GDP on BRICS Countries? - An Empirical Evidence" in International Journal of Energy Economics and Policy 2020, 10(6), **(Scopus Indexed, Q1).**
- Published a Research paper in UGC care listed Journal Wesleyan Journal of Research titled "Crude Oil fluctuation and its impact on Sectorial Indices in India" on Vol.13 No.4 (VII); ISSN:0975-1386. **(UGC Care list Journal)**

Research Paper Presentations

- Presented a research paper in international conference on "Innovation in Technology, Business and Management" organized by Nagarjuna Education Society in Collaboration with Dhaka University Bangladesh held on 07th February 2020 with the titled "Crude Oil movements in BRICS: Motion or Commotion".
- Presented a paper in Two days international E conference on 'Changing Landscapes in Business, Finance and Economy: A Global Perspective' which was organized by Department of Commerce in collaboration with IQAC of Sidho-Kanho-Birsha University, Purulia, West Bengal, India on 28th and 29th November 2020.
- Presented a paper in Online International Conference on "Business and Education in the New Global Realities" organised by School of Commerce, Jain University on

the topic “Crude oil Fluctuation and its impact on Sectorial indices in India” on 22nd December 2020.

- Presented paper online on the title of “Effect Of Crude Oil Fluctuation On Sectorial Indices Of BRICS Countries.” in Virtual International Conference held on 06 June 2020 Organized by ARIHANT COLLEGE, Indore (M.P.), India Jointly Organized by University of Trunojoyo, Madura (Indonesia) & IDEI (Indonesia) In Collaboration of Global Research Foundation, Delhi (India)

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