

## **CAUSAL RELATIONSHIP BETWEEN STOCK MARKET INDICES, GOLD PRICES, CRUDE OIL PRICES, AND EXCHANGE RATES**

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***Abstract:** This paper analyze the impact of fluctuation in crude oil prices, gold prices and exchange rate on the stock market indices in the context of Brazil, Russia, India, China and South Africa (BRICS) using daily data and time series method for the period of January of 2003 to December of 2013. To achieve this objective unit root test, Johansen's co-integration test and granger causality test has been applied to examine the interrelationship between these variables and find out that price of oil, price of gold, exchanges rates and stock markets are interrelated among each other.*

***Keyword:** Crude oil price, gold price, exchange rate, stock markets, Johansen Cointegration Test, Granger Causality Test.*

***JEL codes:** C22; G15; F30*

### **INTRODUCTION**

Stock market plays an important role in the development of an economy. It facilitates mobilization of funds across the economy—from surplus units to deficit units. The escalation in stock market is important from both industry as well as investor's point of view. The economic position of country can be judged by performance of its stock market. The stock market indices are mainly affected by the changes in the fundamentals of the economy.

Recent rise in the prices of commodity has become a major concern for the world economy. From January of 2009 to December of 2013, price of WTI Crude oil rose by more than 150%. Rising Crude oil price can increase the cost of production and thus decrease the aggregate supply. Historical data shows that fluctuation of Crude oil has

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greater adjustment speed to equilibrium w.r.t. other commodities (Anoruo and Mustafa. 2007). Price of oil and inflation close cause and effect relationship and they tend to follow each other. Gold seen as a commodity that can maintain purchasing power and can hedge against the inflation as well historically has negative relationship with stock market slump and positive relationship with rising inflation (Filis G., 2010). With the rising commodity prices and continuously expansionary monetary policy maintained by major central banks, global inflation is expected to rise, thus make gold an attractive investment tool.

Fluctuation in exchange rate will affect international trade and economy, thus, affect stock markets. When domestic currency appreciates, domestic importers enjoy lesser cost dealing with the same amount of goods thus enjoy greater profit. This will have positive effect on the domestic stock price of the said importers. Understanding the relationship of Crude oil price, gold price, and exchange rate and stock market prices is important from global economy perspective.

#### LITERATURE REVIEW

Noel Dilrukshan and Simpson (2009) examined the direction and strength of stock price movement's influence on the dollar exchange rate along with the interaction between stock prices and USD exchange rate in Australia 2003 - 2006 by using Granger causality, co-integration and OLS. Granger causality resulted a very strong relationship between prices on the dollar exchange rate. Co-integration revealed the connection between both variables in the short-run as well as in longer-term.

Harri *et al.* (2009) used Johansen model to determine the co-integration among agricultural commodities, exchange rates and oil prices. The results found relationship between OIL oil and three commodities corn, soybeans and cotton and significant impact of exchange rates on the price relationship overtime.

Elena (2010) examined linkage between emerging equity markets and currency markets of Eastern European and Russia. For study a bivariate GARCH used by taking weekly closing price. Results showed that on returns and volatility basis there is direct linkages between currency markets and the equity markets and in currency markets to stock markets a unidirectional volatility spillover is found.

Arouri (2011) investigated the effect of change in oil prices on twelve European sector stock indices in the short-term over a period from 1/01/1998 to 06/30/2010 using multi factor asset pricing model. The results of the study found strong relationship between oil price changes and sector stock indices but with different sensitivity with respect of each sector

Chan *et al.* (2011) investigated the relationships between financial assets, commodities and real estate assets by taking monthly data for a period from January 1987 to December 2008 using Markov switching model. The study found positive stock returns during the period of economic expansion and negative stock returns during

the period of economic decline with contagion between share prices and other assets like real estate. There was not any contagion effect found between oil and real estate as well as between stocks and Treasury bonds. The results highlighted importance of investment in treasury bonds for diversification during the period of economic crises.

Sujit and Kumar (2011) examined the relationship among gold price, stock returns, exchange rate and oil price using daily data from 2nd January 1998 to 5th June 2011 by vector autoregressive and co integration technique. The result showed high effect of exchange rates on all other three variables but lesser impact of stock market on the exchange rate and gold prices are found lesser dependent on other variables. The currencies of oil exporting and importing countries reacted more to the increase in the oil prices.

Hosseini (2011) studied linkages between stock market and four macro level variables ie. OIL oil, inflation rate, money supply and industrial production in case of India and China. Study used ADF, Multivariate Co integration Test, VECM resulted into linkage between stock market indices and macro variables in long and short run.

Chaker *et al.* (2012) examined the effect of oil priced fluctuations on the stock market of twenty five emerging economies from September 1997 to November 2007 by distinguishing them into three categories the largest oil importing countries, moderately oil-dependent countries and largest oil exporting countries using international multi factor model for stock returns. It was found that oil price risk relevant for pricing emerging markets stocks and impact is asymmetric with respect to different market phases.

Kollias *et al.* (2012) examined the linkages between exchange rates and stock prices in the case of the euro-dollar rate and two composite European stock market indices: the FTSE Euro top 300 and FTSE eTX All-Share Index using daily data from 2/01/2002 to 31/12/2008. The causality between the corresponding markets was carried out through the application of rolling unit root, cointegration and granger causality tests. On the basis of the rolling cointegration analysis, it was found, there was no long-run relationship between exchange rates and stock markets. The results from the rolling Granger causality tests indicated time-varying causality.

Samanta & Zadeh (2012) studied the co-movements of macro-variables like dollar, OIL oil prices & the stock prices over a period of more than twenty years and examined the behavior of these variables using the vector auto-regression method & by spillover index. The study suggested the possibility of cointegration among these variables indicating co-movements, although the spill over indices are found to be very small.

Tripathi (2012) studied inter linkages of the Indian Stock Market with some emerging markets viz., Hungary, Brazil, Taiwan, Poland, South Africa and Mexico by taking daily data for 1992-2009. Johansen co-integration and Granger's causality test used for study found inter linkages of the Indian Stock Market with these markets has increased over the study period in short run and long run.

Malarvizhi (2012) analyzed dynamic relationship between stock market and exchange rate. The exchange rate of rupee and US Dollar and CNXNIFTY Index is used by taking monthly data from April 2001 to March 2011. ADF, co integration and granger causality test resulted into a bidirectional causal relationship between exchange rate and Nifty Index.

Kumari and Mahakud (2012) examined co integration among stock prices, monetary aggregates, rate of exchange, economic activity, interest rate and inflation using stock prices of BSE 30 and Nifty50, for money aggregates monthly data of (M1), (M3), US Dollar v/s rupee as exchange rate, for economic activity Index of industrial Production (IIP), for interest rate Treasury bill rate, whole sale price index (WPI) for inflation. Monthly data from 1996 to 2010 is used to check the long term integration. Co integration, Granger causality is used along with VECM model. Co integration results shows that for every money demand specification there are more than two co-integrating vector. Money demand function is effected by inflation, stock prices and economic activity in long run. Unidirectional causality is found from stock prices and exchange rate to demand for money function.

Singh (2012) examined whether international is fruitful or not by using daily closing levels of the benchmark indices of Brazil, Russia and China for a period of 2005-2010. For study ADF, Granger's Causality Test and Variance Decomposition Analysis revealed visible effects of stock markets on each other. The Russian, Indian and Brazilian stock exchanges affects each other and get affected by their own return but none of these affect Chinese stock exchange whether they all get affected by Chinese stock exchange.

Walid *et al.* (2013) examined the impact of global economic factors on the emerging stock markets of the BRICS countries (Brazil, Russia, India, China and South Africa) using the quantile regression approach for the period from September 1997 to September 2013 .The result showed asymmetric dependence between the BRICS stock markets on the global stock market since the onset of the recent global financial crisis while oil prices showed symmetric tail independence except South Africa and gold prices also shown co-movement with these markets.

Papadamou and Markopoulos (2014) studied the interrelationship between returns of major exchange rates like EUR/USD, GBP/USD, JPY/USD and precious metals like gold & silver using a vector autoregressive model in a multivariate asymmetric GARCH framework on the intraday frequency. Findings of the study indicated a unidirectional volatility transmission from the currencies like EUR/USD,GBP/USD to precious metals.

Walid and Nguyen (2014) studied the dynamic linkages between the exchange rates and stock market of the BRICS using Markov switching autoregressive model to detect regime-shift behaviour in the stock returns of the BRICS markets, and found the existence of two distinct regimes for all markets; a low volatility regime and a high volatility regime.

Gürüş and Kiran (2014) studied the relationship between gold prices and the US dollar/Turkish lira exchange rate between 1990–2011. The co-integration results indicated threshold co-integration relationship between the them and granger causality test found evidence of bi-directional causal relationship between these two variables. The results suggested gold to be only partial hedge against the exchange rate.

Sadorsky (2014) applied VARMA-AGARCH and DCC-AGARCH models to model volatilities and conditional correlations among emerging market stock prices ,oil prices ,copper prices and wheat prices by taking continuously compounded daily returns of these factors. The study revealed increase in the correlation among these factors after 2008, with emerging market stock prices having highest positive correlation with copper and lowest with wheat. The finding of the study indicated oil as the cheapest hedge against emerging market stocks as compare to other two commodities.

Arbes and Hoetoro (2014) examined effect of oil price, dollar exchange rate, and stock exchange index on gold price in U.S.A for a period of 2006-2012 using error correction models. The study found significant positive impact of U.S Dollar exchange rate on gold prices while stock exchange index was found to have inverse effect on gold prices in the short run .But long run impact of these three variables on gold price was found to be insignificant.

## OBJECTIVES

The objective of this study is to examine the relationship between prices of Crude oil, price of gold, exchange rate, stock indices of BRICS countries.

## DATA AND METHODOLOGY

Daily data over the period January of 2003 to December of 2013 have been used for the analysis of this study. As seen in table 1, Data would be further divided in 5 groups which consist of oil price, exchange rate, stock exchange index and gold price for each of the BRICS countries. List of symbols used are shown in table 2.

**Table 1**  
**List of Groups**

<i>Groups</i>	<i>Variables within group</i>
Brazil	BVSP,GOLD, BR-USD, OIL
Russia	RTSI, GOLD, RUBBLE-USD,OIL
INDIA	SENSEX, GOLD, INR-USD, OIL
CHINA	SSC, GOLD, YAUN-USD, OIL
SOUTH AFRICA	FTSE-JSE, GOLD, RAND-USD, OIL

*Source:* From Researcher's Sample

**Table 2**  
**List of Symbols**

<i>Symbol</i>	<i>Variable</i>
BVSP	Stock index of Brazil
RTSI	Stock index of Russia
SENSEX	Stock index of India (BSE-30)
SSC	Stock index of China
FTSE-JSE	Stock index of South Africa
GOLD	Gold price in terms of dollar
OIL	Crude oil price in terms of dollar
BR-USD	Exchange rate (Brazilian Real/USD)
RUBBLE-USD	Exchange rate (Russian Rubble/USD)
INR-USD	Exchange rate (Indian Rupee/USD)
YUAN-USD	Exchange rate (Chinese Yuan/USD)
RAND-USD	Exchange rate (South African Rand/USD)

*Source:* From Researcher's Sample

To check the stationary property of all the variables used in our study, Augmented Dicky-Fuller unit root test (ADF) (Dickey and Fuller, 1979) and the Phillips-Perron unit root test (PP) (Phillips and Perron, 1988) both with intercept and with intercept and trend.

Johansen's cointegration test (Johansen 1988) has been applied to check the cointegration between all four variables in each group. Pair wise Granger causality test (Engle & Granger 1987), has been conducted to test the Unidirectional/Bidirectional causality between the variables for each group.

## RESULT AND ANALYSIS

### Result of unit root test

Table 3 carries the required statistics of ADF and PP test both with intercept and intercept and trend with level. Table 3.1 carries critical value for test. The calculated values of ADF and PP test are greater than the critical values of this test at 1%. It means there is no unit roots exist for any of these time series variables, in other words all these series are stationary at level.

### SELECTION OF OPTIMAL LAG

Selection of appropriate lag length is necessary before applying test for co-integration or causality. VAR model can be used to select the appropriate lag length. There are broadly two methods that could be used to arrive at the optimal lag length: cross-equation restrictions and information criteria, we have used multivariate information criteria. We have repeated VAR model by reducing lag length from a large lag term until 0 and the smallest value of Sequential modified LR test statistics (LR), Final prediction error (FPE), Akaike information criterion (AIC), Schwarz criterion (SC) and Hannan-Quinn information criterion (HQ) has been selected as optimal lag length.

**Table 3**  
Unit Root Test with Level Data

		ADF with Level		PP with level	
		Intercept	Intercept and Trend	Intercept	Intercept and Trend
<b>Brazil</b>	BVSP	-24.72166	-24.83524	-52.61189	-52.71713
	Gold	-24.82434	-24.82726	-53.77740	-53.77269
	BR-USD	-24.50424	-24.60161	-54.14296	-54.23694
	OIL	-24.82434	-24.82726	-53.77740	-53.77269
<b>Russia</b>	RTSI	-22.88008	-22.92301	-51.13938	-51.16421
	Gold	-22.84907	-22.88191	-50.81200	-50.83366
	RUBBLE-USD	-39.62386	-39.61698	-164.1070	-164.0742
	OIL	-24.83206	-24.83527	-53.68743	-53.68319
<b>INDIA</b>	SENSEX	-24.17970	-24.22437	-48.88042	-48.90481
	Gold	-22.72331	-22.75495	-51.13782	-51.15391
	INR-USD	-21.29230	-21.38478	-53.33807	-53.41146
	OIL	-24.06213	-24.06500	-52.57547	-52.57041
<b>China</b>	SSC	-22.48704	-22.50158	-52.69983	-52.70849
	Gold	-23.29898	-23.32791	-51.43521	-51.45346
	YUAN-USD	-22.93960	-22.99233	-59.72881	-59.78513
	OIL	-24.25726	-24.25976	-54.09396	-54.08888
<b>South Africa</b>	FTSE-JSE	-24.93931	-24.94124	-48.66616	-48.66054
	Gold	-22.40643	-22.44530	-49.88096	-49.90683
	RAND-USD	-22.81812	-22.84819	-48.78438	-48.79587
	OIL	-24.25953	-24.26668	-53.05791	-53.05680

Source: From Researcher's Sample result

**Table 3.1**  
Mckinnon critical values for ADF and PP test

	Mckinnon critical values for ADF and PP test	
	Intercept	Intercept and Trend
1% level	-3.432649	-3.961541
5% level	-2.862442	-3.411520
10% level	-2.567295	-3.127622

Source: From Researcher's Sample result

**Table 4**  
Lag Length Selected by Different Criteria

Model for lag length with I(1)	LR	FPE	AIC	SC	HQ	Lag selected for this study
Brazil Group	8	6	6	1	1	1
Russia Group	8	8	8	3	5	3
India Group	8	2	2	0	1	1
China Group	7	3	3	1	1	1
South Africa Group	8	6	6	0	1	1

Source: From Researcher's Sample result

Table 4 shows the result of lag length selection by using VAR model. Lag length 1 has been selected for the group of variable for India, China, Brazil, Russia and lag length 3 has been selected for the group of variable of Russia.

### Result of Johansen's co-integration test

Johansen's Co-integration test has been applied on the set of variables for each of the BRICS countries with the lag length selected above and the result of Johansen's Co-integration test with Trace statistics and Max-Eigen Statistic is mentioned in table 5. It is clear from the table 5 that the value of both Trace Statistic and Max-Eigen is greater than 0.05 critical values for all five countries and it indicates 4 co-integrating vectors for each set of countries.

So the Null hypothesis that there is no co-integration between stock prices, Crude oil prices, exchange rate and gold prices is rejected for all five countries and we can say that all these four variables are associated in long run.

**Table 5**  
Co-integration test results

	<i>Hypothesized No. of CE(s)</i>	<i>Trace Statistic</i>	<i>0.05 Critical Value</i>	<i>Max-Eigen Statistic</i>	<i>0.05 Critical Value</i>
<b>Brazil Group</b>	None *	2201.312	47.85613	631.1339	27.58434
	At most 1 *	1570.178	29.79707	585.9924	21.13162
	At most 2 *	984.1854	15.49471	528.5260	14.26460
	At most 3 *	455.6595	3.841466	455.6595	3.841466
<b>Russia Group</b>	None *	2732.493	47.85613	1235.425	27.58434
	At most 1 *	1497.068	29.79707	552.5664	21.13162
	At most 2 *	944.5014	15.49471	479.0129	14.26460
	At most 3 *	465.4885	3.841466	465.4885	3.841466
<b>India Group</b>	None *	1998.927	47.85613	592.7341	27.58434
	At most 1 *	1406.193	29.79707	521.5641	21.13162
	At most 2 *	884.6291	15.49471	467.4436	14.26460
	At most 3 *	417.1855	3.841466	417.1855	3.841466
<b>China Group</b>	None *	1979.583	47.85613	564.8366	27.58434
	At most 1 *	1414.746	29.79707	533.7504	21.13162
	At most 2 *	880.9959	15.49471	463.9754	14.26460
	At most 3 *	417.0205	3.841466	417.0205	3.841466
<b>South Africa Group</b>	None *	2017.942	47.85613	567.7169	27.58434
	At most 1 *	1450.225	29.79707s	530.3668	21.13162
	At most 2 *	919.8586	15.49471	483.9750	14.26460
	At most 3 *	435.8835	3.841466	435.8835	3.841466

Source: From Researcher's Sample result

### Results of granger causality test

To establish the causal relationship between stock prices, Crude oil prices, exchange rate and gold prices pair wise granger causality test has been applied. Table 6 illustrates



result of pairwise granger causality test for all the five countries. Results of granger causality differ country-wise

1. For India it shows bidirectional causality for exchange rate - stock market and Gold prices -Crude oil prices and unidirectional causality between gold and exchange rate,
2. For China it shows bidirectional causality between Crude oil -Gold and Unidirectional relationship for Gold prices -Exchange rate and Crude oil - Stock market,
3. For Brazil it shows Bi-directional relationship between Crude oil –Gold prices, Gold-stock market index(BVSP), Exchange rate- stock market index and unidirectional relationship between Exchange rate-GOLD prices, Crude oil-stock market index (BVSP),
4. For Russia it shows unidirectional relationship between Crude oil-Gold prices,
5. For South Africa it shows unidirectional relationship between Crude oil prices- stock market index(JSE), stock market index(JSE)-Exchange rate, stock market index(JSE)-Gold prices, Crude oil-Gold prices, Exchange rate- Gold prices.

**Table 6**  
**Pair-wise Granger Causality Tests**

	<i>Null Hypothesis</i>	<i>F-Statistic</i>	<i>Probability</i>	<i>Accept/Reject</i>
Brazil Group	OIL does not Granger Cause GOLD	26.0921	6.E-12	Reject
	GOLD does not Granger Cause OIL	5.23069	0.0054	Reject
	BVSP does not Granger Cause GOLD	22.8941	1.E-10	Reject
	GOLD does not Granger Cause BVSP	5.60940	0.0037	Reject
	BR-USD does not Granger Cause GOLD	6.06078	0.0024	Reject
	GOLD does not Granger Cause BR-USD	0.57094	0.5651	Accept
	BVSP does not Granger Cause OIL	6.81680	0.0011	Reject
	OIL does not Granger Cause BVSP	0.12045	0.8865	Accept
	BR-USD does not Granger Cause OIL	0.09860	0.9061	Accept
	OIL does not Granger Cause BR-USD	0.04157	0.9593	Accept
Russia Group	BR-USD does not Granger Cause BVSP	9.19334	0.0001	Reject
	BVSP does not Granger Cause BR-USD	45.7207	3.E-20	Reject
	OIL does not Granger Cause GOLD	13.1944	2.E-08	Reject
	GOLD does not Granger Cause OIL	1.53608	0.2031	Accept
	RUBBLE-USD does not Granger Cause GOLD	0.36404	0.7790	Accept
	GOLD does not Granger Cause RUBBLE-USD	0.67626	0.5665	Accept
	RTSI does not Granger Cause GOLD	0.40922	0.7464	Accept
	GOLD does not Granger Cause RTSI	0.40488	0.7495	Accept
RUBBLE-USD does not Granger Cause OIL	0.24205	0.8670	Accept	

*contd. table 6*

	<i>Null Hypothesis</i>	<i>F-Statistic</i>	<i>Probability</i>	<i>Accept/Reject</i>
India Group	OIL does not Granger Cause RUBBLE-USD	0.97784	0.4022	Accept
	RTSI does not Granger Cause OIL	0.06293	0.9794	Accept
	OIL does not Granger Cause RTSI	0.12497	0.9454	Accept
	RTSI does not Granger Cause RUBBLE-USD	0.02953	0.9932	Accept
	RUBBLE-USD does not Granger Cause RTSI	0.01581	0.9973	Accept
	OIL does not Granger Cause BSE30	0.33781	0.7134	Accept
	BSE30 does not Granger Cause OIL	1.37613	0.2527	Accept
	INR-USD does not Granger Cause BSE30	4.30128	0.0136	Reject
	BSE30 does not Granger Cause INR-USD	4.63069	0.0098	Reject
	GOLD does not Granger Cause BSE30	2.64884	0.0709	Accept
	BSE30 does not Granger Cause GOLD	2.03182	0.1313	Accept
	INR-USD does not Granger Cause OIL	1.61820	0.1985	Accept
	OIL does not Granger Cause INR-USD	0.50319	0.6047	Accept
	GOLD does not Granger Cause OIL	4.10614	0.0166	Reject
China Group	OIL does not Granger Cause GOLD	17.2339	4.E-08	Reject
	GOLD does not Granger Cause INR-USD	4.38135	0.0126	Reject
	INR-USD does not Granger Cause GOLD	1.48491	0.2267	Accept
	OIL does not Granger Cause GOLD	21.1905	7.E-10	Reject
	GOLD does not Granger Cause OIL	3.40196	0.0335	Reject
	YUAN-USD does not Granger Cause GOLD	0.21372	0.8076	Accept
	GOLD does not Granger Cause YUAN-USD	10.5383	3.E-05	Reject
	SSC does not Granger Cause GOLD	1.23121	0.2921	Accept
	GOLD does not Granger Cause SSC	2.60889	0.0738	Reject
	YUAN-USD does not Granger Cause OIL	0.50316	0.6047	Accept
	OIL does not Granger Cause YUAN-USD	2.98767	0.0506	Reject
	SSC does not Granger Cause OIL	1.51641	0.2197	Accept
	OIL does not Granger Cause SSC	3.52871	0.0295	Reject
	SSC does not Granger Cause YUAN-USD	0.07126	0.9312	Accept
South Africa group	YUAN-USD does not Granger Cause SSC	1.30885	0.2703	Accept
	RAND-USD does not Granger Cause OIL	0.23533	0.7903	Accept
	OIL does not Granger Cause RAND-USD	0.31228	0.7318	Accept
	GLD does not Granger Cause OIL	0.28967	0.7485	Accept
	OIL does not Granger Cause GOLD	15.2605	3.E-07	Reject
	SA does not Granger Cause OIL	0.77432	0.4611	Accept
	OIL does not Granger Cause SA	8.75578	0.0002	Reject
	GOLD does not Granger Cause RAND-USD	1.24324	0.2886	Accept
	RAND-USD does not Granger Cause GOLD	7.62817	0.0005	Reject
	SA does not Granger Cause RAND-USD	3.21792	0.0402	Reject
	RAND-USD does not Granger Cause SA	2.48567	0.0835	Accept
	SA does not Granger Cause GOLD	3.47987	0.0310	Reject
	GOLD does not Granger Cause SA	0.78434	0.4565	Accept

Source: From Researcher's Sample result

## FINDINGS AND CONCLUSION

This paper empirically investigate the long run relationship between national stock index, crude oil prices, gold prices and exchange rates for BRICS countries by using Johansen's co-integration test. To assess the causal relationship between the variables, granger causality test has been used. Result of this research paper shows each of the BRICS country has four co-integration vectors, which indicate that there exist long

term stable equilibrium relationships among the national stock index, crude oil prices, gold prices and exchange rates. Granger causality test shows different result for each country. It does not draw clear direction of causality between these variables.

It has been conclude that stock market, Forex market and commodity market (represented by oil and gold) are interrelated among each other. Investors that tried to stimulate stock market during stock market crisis could include Forex market and commodity market into their considerations.

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