AN EMPIRICAL STUDY ON RELATIONSHIP BETWEEN CRUDE OIL PRICES, GOLD PRICES AND EXCHANGE RATE IN INDIA

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Abstract:

This study using the monthly data spanning 1995:01-2012:07 to investigate the relationship between the prices of two strategic commodities: crude oil prices and Gold prices and Exchange rate in India. The aim of this study is to analyse and determine the character of the co-movement between price levels. This study used methods of analysis and synthesis of theoretical knowledge from literature, research articles and other publications and for this purpose we have used such as Correlation, Regression, ADF test ,ADF (GLS) test, KPSS test ,Granger causality,VAR Log Order selection Criteria, Johansen co-integration test and vector error correction model. Further, Results shows that there is a short run and long-run relationship existing between the prices of crude oil and gold and exchange rate.

Key Words: Crude Oil Prices, Gold Prices, Exchange rate, ADF test ,ADF (GLS) test, KPSS test,VAR Log Order selection Criteria ,Johanson Co- integration Test, vector Error Correction Model

INTRODUCTION

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Trend of market inter connectivity in the world economy is noticeable also in the commodity field, with its most important representatives – Gold and Crude oil with Exchange rate. Gold, the precious metal and Crude oil, the most traded raw material land its play a vital role in shaping the Economy. The first connection between gold and oil has begun in history, when producers of the Middle East required Gold in exchange of Crude oil important milestone was in 1933. In 1993 the original oil concession in Saudi Arabia could be traded in Gold only. As result of many historical events, Gold and oil markets went through huge development and significant relationship between these two commodities was no longer determined at the level of payment only.

The high oil prices in 2005 and 2006 reflect the booming demand from Asia, especially china and India are two principal players on the global scene in 1990 ,consumption in these two countries amounted to not less than 3.5 billion barrels per day approximately 5% of global petroleum use . in 2003,13 years later ,these two countries account for more than 10%of global oil consumption (BP statistical review of World energy markets2004)

There are numerous evidences, particularly over the post- Bretton Woods era, pointing to the crucial role of oil price fluctuations in the determination of the path of the exchange rate1. Theoretical contributions, by Golub (1983), Krugman (1983) and Corden (1984) among a few others, are suggestive of exchange rate appreciation2 in response to soaring oil prices and attendant depreciation with falling oil prices in oil exporting countries, while the obverse is expected to be the case in oil-importing economies.

Understanding the relationship between oil prices, exchange rates and gold prices is an important topic to study because as emerging economies continue to grow and prosper, they will exert a larger influence over the global economy

For this purpose, various statistical and Econometric techniques like unit root test have been done to check out the stationary and finally granger causality between them and results that have come out i.e. ,there is causal and bilateral relationship . The processes have confirmed the long-term equilibrium between oil and gold prices with exchange rate using Johansen co integration test and vector error correction model.

LITERATURE REVIEW:

Some existing studies look into movement, co-integration, and lead lag relationship between crude oil and gold but almost every study does it different way. Some researchers choose to investigate potential long run relationship between spot price and some financial instruments with gold or crude oil other researchers look for relationship between gold, crude oil and Macro economic factors. Most of the analysis use traditional time series model.

Cashin et al (1999) test the correlation between seven commodities with the time period from April 1960 to November 1985. Empirical results from this study demonstrate that there is existing significant correlation between oil and gold.

Pindick and Rotemberg (1990)j test systematic co-movement of oil and gold price levels confirm Pindick and Rotemberg(1990). Ewing et al. (2006) and Fattouh (2010) examine the asymmetry in the spread adjustment process for oil and metal commodities.

There are several studies (Hunt, 2006, Hooker, 2002) have established this link empirically. When oil prices rise, almost every price rises (Furlong et al., 1996). It follows that when inflation rises, the price of gold (as a good) goes up as well. Different channel was researched by Melvin and Sultan (1990). Their main thesis is the impact on gold prices through the export revenue channel. Gold is basic part of the international reserve portfolio of most countries, including the oil producing countries. When oil price rises, oil exporter's revenues from oil rise and this may have implications for the gold price level, if gold consists of a significant share of the assets portfolio of oil exporters and oil exporters purchase gold in proportion to their property. In that case, an oil price rise leads to a rise in gold price.

The idea that there is a relationship between oil prices and exchange rates has been around for some time (early papers, for example, include, Golub, 1983 and Krugman1983a,b). Bloomberg and Harris (1995) provide a good description, based on the law of one price, of how exchange rate movements can affect oil prices. Commodities like oil are fairly homogeneous and internationally traded. The law of one price asserts that as the

US dollar weakens relative to other currencies, ceteris paribus, international buyers of oil are willing to pay more US dollars for oil.

Bloomberg and Harris (1995) find that, empirically the negative correlation between commodity prices and the US dollar increased after 1986. In addition to the theoretical and empirical work by Bloomberg andHarris (1995), empirical papers by Pindyck and Rotemberg (1990) and Sadorsky (2000) find that changes in exchange rates impact oil prices.

Zhang, Fan, Tsai and Wei (2008)find a significant influence of the US dollar exchange rate on international oil prices in the long run, but short run effects are limited.

Akram (2009) also finds that a weaker dollar leads to higher commodity prices. Current observations suggest that oil prices and exchange rates do move together. This analysis is implemented using a longer period, from January 1995 to July 2012 . In this paper are partly replicated the previous researches, but with newer data including recession years.

STATEMENT OF THE PROBLEM

To study the movement and the Relationship between Crude Oil Prices and Gold Prices with exchange rate in India

OBJECTIVES

1. To examine the trend of gold prices, crude oil prices and Exchange rate in India
2. To examine the correlation and unit root test between gold, crude oil prices and Exchange rate.
3 .To study the short run and long run relationship between crude oil, gold prices and exchange rate

HYPOTHESIS

1. There is no significant relationship between gold, crude oil prices, and exchange rate.
2. There is a presence of unit root for the time series of data(a=1)
3. There is no significant short run and long run relationship between on crude oil prices , gold prices and Exchange rate

DATA AND VARIABLES IN THE STUDY

In this study monthly data from January 1995 to July 2012 has been used such as crude oil prices and gold prices . The major source of Data of these variables are obtained from Hand book of Indian statistics on Indian Economy published by Reserve Bank of India and international Financial statistics published by International Monetary Fund

SYMBOL	VARIABLE	DEFINITION
V1	Crude oil	**Crude Oil (petroleum) Price Indian Rupee per Barrel**
V2	Gold price	**Gold Price (Indian Rupee per Troy ounce)**
V3	Exchange Rate	**Monthly averages of Rupee/ dollar**

V4	Rate of change Crude Oil Price	**Crude Oil ROC(difference between previous month with current month price/100)**
V5	Rate Of Change Gold price	**Gold ROC (difference between previous month with current month price/100)**
V6	Rate Of Change of Exchange rate	**Exchange rate ROC(difference between previous month with current month price/100)**

The majorvariables are used in this study was briefly explained below

Gold:

In India, gold has immense value from the perspective of religion, economic reserve, wealth creation, ornaments, and financial securities

According to IMF, about 58% of the countries hold Gold as a reserve. Even gold is the best commodity used for hedging against inflation.

The Global Supply of gold approximately as follows.

61.4% Mine production

37% Recycled gold

1.5% forward sales and options

The global demand of gold approximately as follows:

32.7% Investment

12% Technology

55.3% Jewellery

Price developments in the years January 1995 to July 2012 can be seen in graph 1

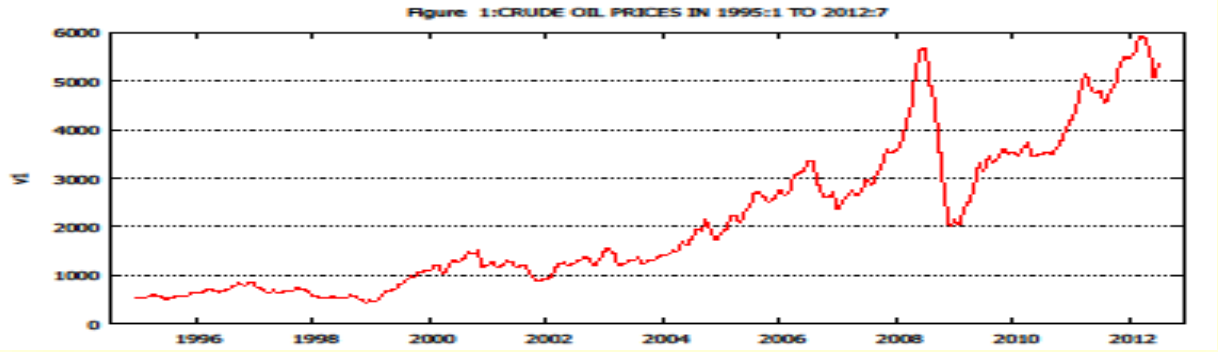
GRAPH: 1MOVEMENT OF GOLD PRICE IN JANUARY 1995-JULY 2012

CRUDE OIL:

India imports 70% of its crude oil requirement from OPEC countries. So the oil price fluctuation affects the economy. The payment made for import is in foreign currency, hence, the appreciation or deprecation of rupee value affects the prices of oil. The Reserve bank of India had reportedly estimated that every one dollar rise in the International price per barrel of crude oil adds $600 million (around Rs.2800 Crores) to the Country's oil Import bill.

Price developments in the years 1995 to 2012 July can be seen in graph 2

GRAPH : 2 MOVEMENT OF CRUDE OIL PRICES IN JANUARY 1995 TO JULY2012

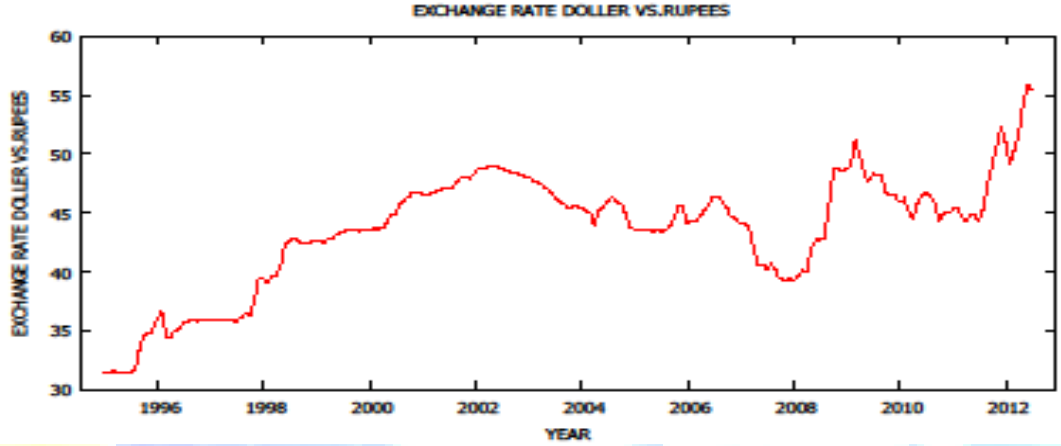


EXCHANGE RATE RUPEE VS.DOLLAR

The US Dollar is widely accepted as a means of both international and domestic payments. The availability of US Dollar plays a very important role in economic transactions and the safety of the economy. The general observations - like a weak dollar makes Crude oil cheaper, which turns, increases the demand from buyers with stronger currencies. Thus escalating the prices of crude oil or fall in the Rupee primarily being attributed to the high crude oil prices ,which

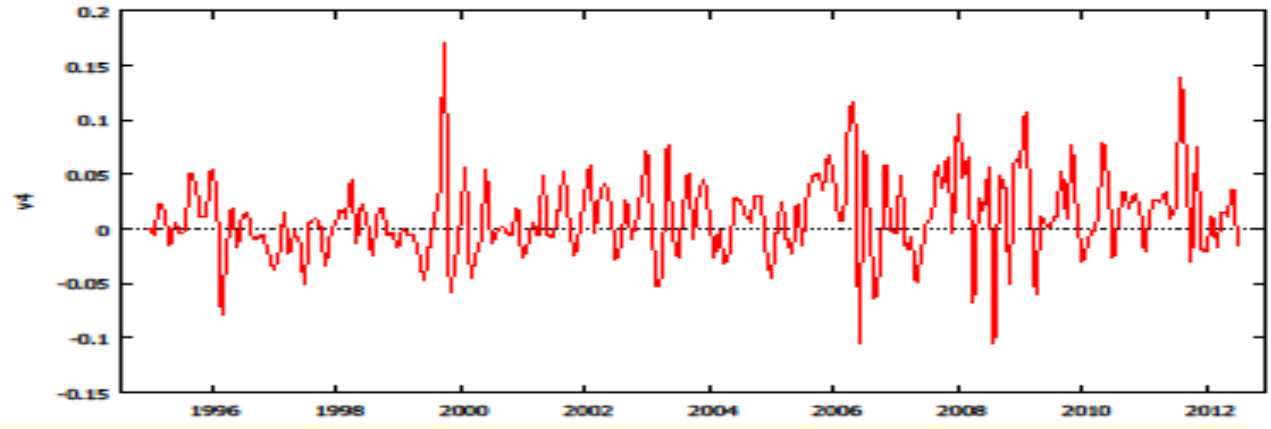
touched an all time high of over $135 per barrel on May 22,2008.The Importance of US Dollar as a common currency for trade and its affect the prices of crude oil and Gold . Exchange rate is decided by the market driven forces after the LERMS.(Liberalized Exchange Rate Management System. Due to global crisis, the Rupee Dollar Exchange rate has depreciated conspicuously.

GRAPH: 3 MOVEMENT OF EXCHANGE RATE RUPEE VS.DOLLAR IN JANAUARY 1995 TO JULY 2012



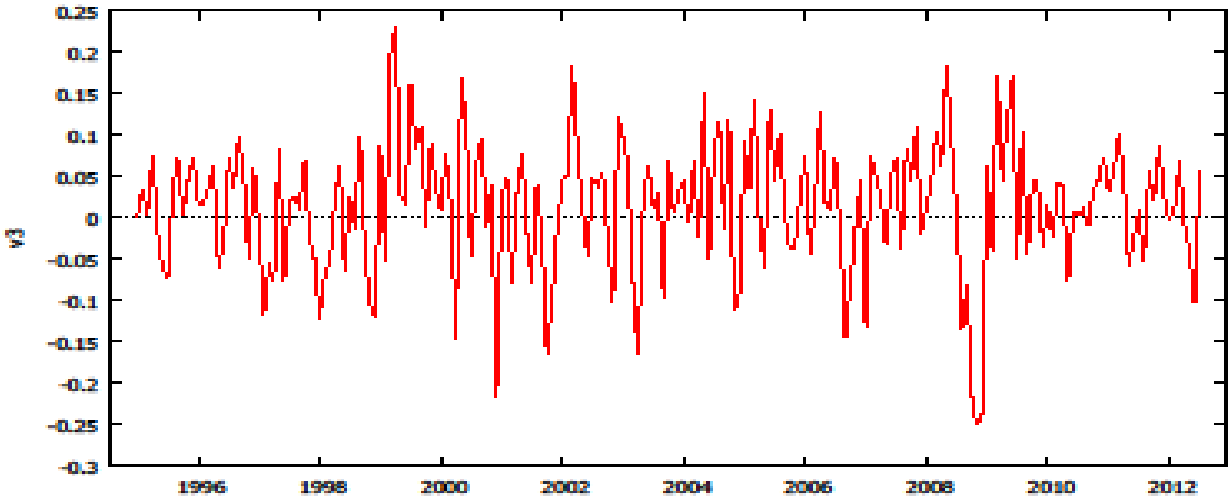
GRAPH :4 RATE OF CHANGES OF GOLD PRICES

RATE OF CHANGE OF GOLD PRICES from 1995:1 -2012:7

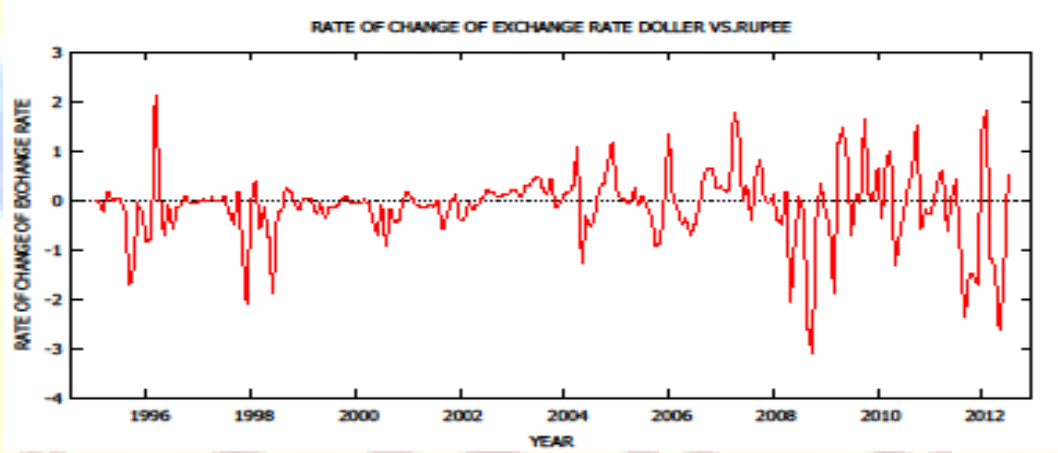


GRAPH5: RATE OF CHANGE OF OIL PRICES

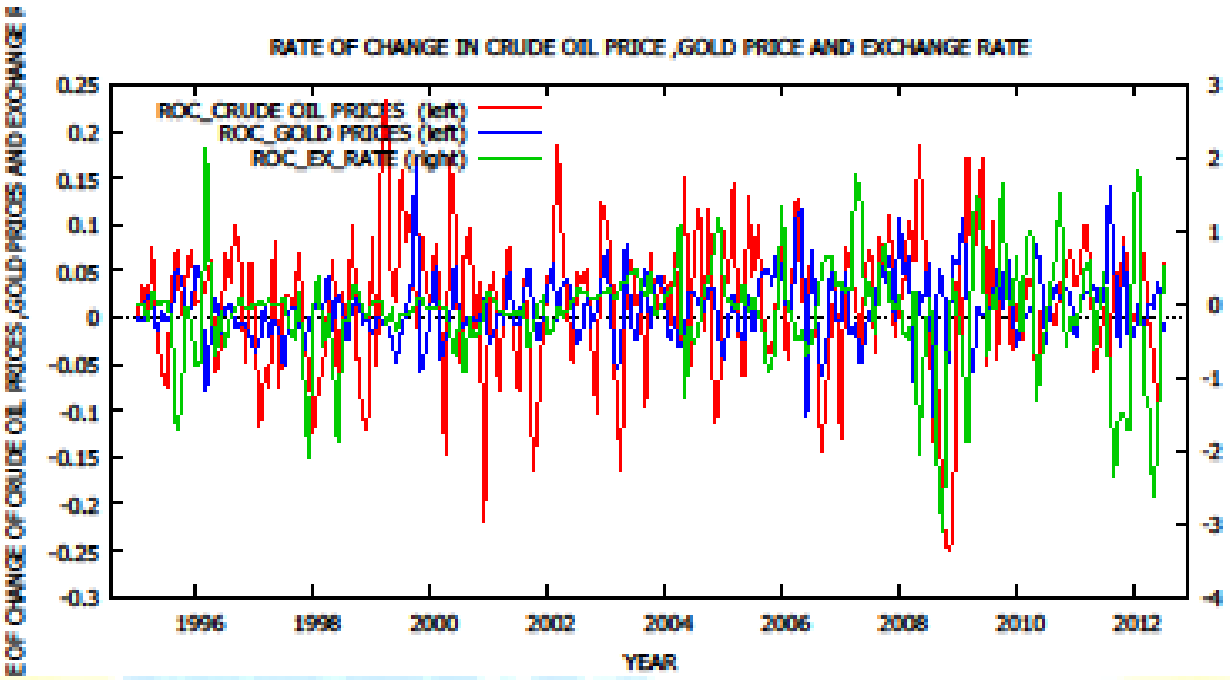
RATE OF CHANGE OF OIL PRICES FROM 1995:1 to 2012:7



GRAPH 6: RATE OF CHANGE OF EXCHANGE RATE



GRAPH:7 RATE OF CHANGE OF CRUDE OIL AND GOLD PRICES AND EXCHANGE RATE



RESULT ANALYSIS:

Since the purpose of this research article is to study the relationship that exists between the crude oil prices and gold prices with the help of various statistical and econometric tools .They are 211 available observations. The time series properties of variables used in this analysis using Augmented Dickey Fuller unit root test. The long run relationship between the variables used is examined using Johansen Juselius co -integration test ,vector error correction modeling used to capture the long run equilibrium between the variables.

DESCRIPTIVE STATISTICS

Table -1 Summary Statistics, using the observations 1995:01 - 2012:07

Variable	Mean	Median	Minimum	Maximum	Std. Dev	C.V.	Skewness	Ex. kurtosis
Crude oil	2105.12	1455.51	442.990	5927.55	1490.86	0.708205	0.860954	-0.318870
Gold	27208.1	17363.0	11084.8	89578.5	20748.9	0.762601	0.54310	1.42151
Exchange Rate	43.5937	44.7575	31.3736	55.9424	4.95117	0.113575	-0.67504	0.158383

Roc of crude oil	0.0142531	0.022400	-0.251000	0.231500	0.079504	5.57806	0.472180	0.869726
Roc of gold	0.0102678	0.006600	-0.105100	0.171400	0.038368	3.73676	0.521475	1.97006
ROC of Exchange rate	-0.1139	-0.02900	-3.08550	2.10930	0.079504	5.57806	-0.47218	0.869726

From the table above in which descriptive values of all the variables was calculated shows that

1. The coefficient of variation is to measure of relative variation .the Crude oil prices and gold prices are high volatility in its values by 70% and 76% respectively and changes only 11%

2. The Mean value of crude oil 2105.12 and its Std Deviation has a value 1490.86 it shows that significant fluctuations from this mean value can be observed

3 Std.deviation of crude oil and gold prices are it's away from mean value it shows that the prices of both variables are highly volatility.

4. The Skewness measure we found that crude oil is more positively skewed than gold prices . The crude oil prices shows 86% and gold prices are 54% and exchange rate shows skewed negatively by -0.67504.

4.kurtosis of distribution crude oil prices are shows 31% negatively skewed its shows that the curve is platykurtic and gold prices of distribution shows the calculated valve is less than 3 then the curve is less peaked than the normal curve i.e. ., platykurtic and exchange rate shows 0.86

CORRELATION OF GOLD , OIL PRICES AND EXCHANGE RATE:

TABLE-2CORRELATION BETWEEN GOLD PRICE AND OIL PRICE

Correlations				
		Crude oil prices	**Gold prices**	**Exchange rate**
Crude oil prices	**Pearson Correlation**	**1**	**.899****	**.474****
	Sig. (2-tailed)		**.000**	**.000**

	N	211	211	211
Gold prices	Pearson Correlation	.899**	1	.480**
	Sig. (2-tailed)	.000		.000
	N	211	211	211
Exchange rate	Pearson Correlation	.474**	.480**	1
	Sig. (2-tailed)	.000	.000	
	N	211	211	211

****. Correlation is significant at the 0.01 level (2-tailed).**

Correlation is a statistical technique which shows whether and how strongly two variables are related as visible from table-2 the degree of correlation between Gold and Oil is strongly positive. For the whole period, the value of correlation coefficient is .899.and this leads to a positive correlation, and correlation between exchange rate and Crude oil prices .474 .the correlation between Exchange rate and gold prices shows .480 which means Exchange rate, Gold prices and crude oil variables are move in a same direction and have linear relationship

Regression Analysis

Regression analysis is the statistical technique that identifies the relationship between two or more variables: a dependent variable, whose value is predicted and an independent variable about knowledge is available

Regression Analysis - Independent variable – Exchange rate9(v3), Dependent variable – Gold prices(v2),Crude oil prices(v1)

Table 3

Model Summary[b]

Model	Change Statistics				
	R Square Change	F Change	df1	df2	Sig. F Change
1	.225[a]	60.576	1	209	.000

a. Predictors: (Constant), Exchange rate(v3)

Model Summary[b]

Model	Change Statistics				
	R Square Change	F Change	df1	df2	Sig. F Change
1	.225[a]	60.576	1	209	.000

b. Dependent Variable: Crude oil prices(V1),Gold prices(v2)

Table 4

Model Summary

Model	Change Statistics				
	R Square Change	F Change	df1	df2	Sig. F Change
1	.230[a]	62.588	1	209	.000

a. Predictors: (Constant), V3

By observing table 3 indicates positive correlation found between crude oil prices we can say that 1%change in gold price and crude oil price which leads to .230 increase in Exchange rate. So **the null hypothesis i.e. "there is no significant relationship between crude oil prices , gold prices and exchange rate" is rejected**

TRANSFORMING OF GOLD AND CRUDE OIL PRICESAND EXCHANGE RATE IN TIME SERIES:

Before conducting other test, the first step is to know whether the data are stationary or not and for that, the augmented Dicky fuller unit root test The standard dicky fuller test estimates the following equation

Test with constant model:

(1-L)y = b0 + (a-1)*y(-1) + ... + e

with constant and trend model:

(1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e

Unit root test for stationary

Table – 5 ADF TEST

variables	With constant			With constant and trend			Order of integration
	F-value	tau statistic	p-value	F-value	tau statistic	p-value	
Crude oil prices	1.990 [0.0060]	-3.1615	0.02	2.114 [0.0030]	-3.6065	0.0292	I(1)
Gold prices	2.255 [0.0014]	0.514074	0.0223	1.860 [0.0120]	-1.6497	0.7733	I(1)
Exchange rate	3.060 [0.0001]	-4.0793	0.001046	3.052 [0.0001]	-4.014	0.008303	I(0)

Asymptotic critical values(t-statistics)

1%	5%	10%
-3.48	-2.88	-2.57

Table 6 Augmented Dickey-Fuller (GLS) test with constant and trend model:

(1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e

variables	Co-efficent of e	F-value (25, 158)	estimated value of (a – 1)	test statistic: tau	Order of integration
Crude oil prices	-0.007	1.868 [0.0114]	-0.940537	-2.5534	I(1)
Gold prices	-0.003	1.951 [0.0073]	0.0658343	0.154544	I(1)
Exchange rate	0.010	3.044 [0.0001]	-0.928075	3.94429	I(0)

Asymptotic critical values (t-statistics)

1%	5%	10%
-3.46	-2.93	-2.64

Table- 7KPSS test result (including trend)

variable	T	Lag truncation parameter	Test statistic	Interpolated p-value
Crude oil	210	27	0.0548624	0.0206
Gold price	210	27	0.162478	0.042
Exchange rate	210	27	0.153317	0.047

Asymptotic critical values (t-statistics)

1%	5%	10%
0.217	0.148	0.120

To check the stationarity of the underlying data series, we follow the standard procedure of unit root test by employing the AugumentedDicky fuller test. However, the ADF test was often criticized for low power. Thus we complement this test with Phillips-Perron(PP)test and Kwiatkowski-Philips-Schmidit-Shin (KPSS) test.The results are presented in table .

On the basis of these three test ,all the series except exchange rate are found to be Non-stationary with constant and trend.however ,after talking the first difference these series are found to be stationary at 1%,5% and 10% level.Thus all the three stationarity test indicate that crude oil prices and gold prices are individually integrated of the order I(1)except exchange rate which is I(0).

Table-8 VAR Log Order selection Criteria

Endogenous variables: crude oil ,gold prices and exchange rate

Lags	Log lik	p (LR)	AIC	BIC	HQC
1	3255.47147	NA	32.869060	33.117299	32.969529
2	3224.00084	0.00000	32.643225	**33.040407***	**32.803975***
3	3209.05138	0.00046	32.583431	33.129557	32.804462
4	3196.95514	0.00401	32.552313	33.247382	32.833625
5	3187.72412	0.03018	32.549991	33.394004	

32.891585				
6	3177.02874	0.01102	32.532952	33.525908
32.934827				
7	3168.12641	0.03751	32.533934	33.675833
32.996090				
8	3159.42880	0.04287	32.536973	33.827816
33.059410				
9	3137.01121	0.00000	**32.402123***	33.841909
32.984842				
10	3130.70853	0.18129	32.429231	34.017961
33.072232				
11	3125.69473	0.34826	32.469294	34.206967
33.172575				
12	3115.19642	0.01267	32.454235	34.340852
33.217798				

The asterisks * above indicate the best (that is, minimized) log order values of the respective information criteria,

P(LR)=sequential modified LR test statistic (each at 5% level)

AIC = Akaike information criterion,

BIC = Schwarz Bayesian criterion

HQC = Hannan-Quinn criterion.

The presence of co –integrating relationship among the variables are tested through a vector error correction model applying the Johanson procedure i.e., JohansonJuselious (1990) and Johanson(1991).Specifically ,trace statistics and maximum eigenvalue test statistics are presented in table no. both the trace statistics and the maximum eigenvalue statistics identify one co- integrating vector.

Table-9 Multivariate (Johansen) co integration test result (Unrestricted trend and constant)

Hypothesized No. of CE(s)	Eigen statistics	Trace stasistics	0.05 critical value	Probability**	Max – Eigen statistics	0.05 critical value	Probability**

0*	0.19080	50.067	95.753	0.0005	37.684	40.077	0.0002
1	**0.063783**	**12.382**	**69.818**	**0.2867**	**11.732**	**33.876**	**0.2620**
2	0.0036481	0.65055	47.856	0.4199	0.65055	27.584	0.4199

*denotes rejection of hypothesis at 0.05 level.

**Mackinnon –Haug-Michelis(1990) p- values

VECM system, lag order 33

Maximum likelihood estimates, observations 1997:10-2012:07 (T = 178)

Cointegration rank = 1

Case 5: Unrestricted trend and constant

	coefficient	std. error	t-ratio	p-value
Equation 1: d_v1 EC1	-0.0696831	0.0782660	-0.8903	0.3760
Equation 2: d_v2 EC1	1.80516	0.566835	3.185	0.0021
Equation 3: d_v 3 EC1	0.000914476	0.000280919	3.255	0.0017

Cross-equation covariance matrix:

	v1	v2	v3
v1	10403.	5820.4	-2.5559
v2	5820.4	5.4564	44.814
v3	-2.5559	44.814	0.13402

determinant = 7.30361e+008

Equation 1: d_v1(crude oil price)

Mean dependent var	26.34904	S.D. dependent var	218.2089
Sum squared resid	1851661	S.E. of regression	153.0972
R-squared	0.780293	Adjusted R-squared	0.507746
rho	0.062925	Durbin-Watson	1.848336

Equation 2: d_v2 (gold price)

Mean dependent var	429.9211	S.D. dependent var	1509.069
Sum squared resid	97124385	S.E. of regression	1108.793
R-squared	0.759045	Adjusted R-squared	0.460138
rho	-0.098848	Durbin-Watson	2.173492

Equation 3: d_v3(exchange rate)

Mean dependent var	0.106456	S.D. dependent var	0.768299
Sum squared resid	23.85491	S.E. of regression	0.549510
R-squared	0.771680	Adjusted R-squared	0.488447
rho	0.006253	Durbin-Watson	1.985408

The co-integration results indicate that causality exists between the co-integrated variables but it fails to show us the direction of the causal relationship. According to Engel and Granger (1987), if the variables are found to be co-integrated then there always exists an error correction representation in which the short run dynamics of the variables can be tested that are influenced by the deviation from equilibrium. Engel and Granger suggest that if co-integration exist between the variables in the long run, then, there must be either unidirectional or bidirectional relationship between variables. The short run and long run causal relationship between the variables should be examined in a vector error correction (VECM) frame work.

The VECM can capture the short run dynamics as well as the long run equilibrium relations between time series variables and therefore can distinguish between short run and long run Granger causality. The significant coefficient for lagged error correction term provides the long run Granger causality which can be observed through the t-statistics.

On the other hand, the short run Granger causality is tested by the joint significance of the coefficients of the differenced explanatory variables. The short run causality for other variables can be tested in similar way. The Granger causality analyses based on the VECM with 1 lag are conducted between the exchange rate and gold prices ,crude oil prices . The results are summarized qualitatively in Table 7.

Table 7. Long-run and Short-run Granger causality based on VECM

Variables			Long-run causality	Short-run causality
Crude oil	⇒	Gold	YES	NO
Gold price	⇒	Crude oil	YES	YES
Crude oil	⇒	Exchange rate	NO	NO
Exchange Rate	⇒	Crude oil	NO	NO
Gold prices	⇒	Exchange Rate	YES	YES
Exchange rate	⇒	Gold	NO	YES

Notes: The causality test is based on the VECM with 1 lag. X ⇒Y means X Granger cause Y.

Table- 10

Long-run matrix (alpha * beta')

variables	Crude oil	Gold prices	Exchange rate
Crude oil	-0.26997	-0.0032067	-17.799
Gold prices	0.79952	0.28010	92.885
Exchange rate	0.0011842	0.00011026	0.075561

The results indicate that, there is bidirectional causality exists between gold price with crude oil price and exchange rate both long-run and short-run. There is no short-run causality found crude oil price with gold price. However long-run causal relationship is found between crude oil with gold price. Results also reveals that exchange rate do not cause crude oil price either in short-run or in long-run, but exchange rate do granger cause on gold only in the short run

SUMMERY OF RESULTS

1 The crude oil prices from perusal of graph 1, one can notice that in the years 1995,1996,1998,1999,2002,2004,2006,2008,2011 had touched more than 10% the growth in its become explosives (529.58in the year 1995 and it had touched 2012 January 5,475.69 per barrel)

2. Gold rates are grown steadily over the years up to 2004 later shown an upward trend in year 2006 on words and 2008, and 2009 and 2011 highly sensitive due to economic slowdown globally its play traditional role as a safe-haven and stores of value.

3.The rate of change exchange rate in Dollar vs. Rupee value moderately till the year 2006 later it shows decreasing trend due depreciating our rupee value and slowly recovered in year 2009 onwards.

4. From the correlation and regression analysis shows high degree of correlation between gold and crude oil prices i.e. ,1% change in crude oil price leads to change gold price by .89% and exchange rate with crude oil.474and with gold price .480

5. On the basis of these three unit root test, all the series except exchange rate are found to be Non-stationary with constant and trend. However, after talking the first difference these series are found to be stationary at 1%, 5% and 10% level. Thus all the three stationarity test indicate that crude oil prices and gold prices are individually integrated of the order I(1)except exchange rate which is I(0).

6. ., JohansonJuselioustest show that the variables are co integrated and short run relationship existed between gold with crude oil and exchange rate with gold

7. Vector Error correction model (VCEM) test shows that there is existence of long run relationship between gold price with crude oil and exchange rate.

CONCLUSION

This research tries to find out the relationship between crude oil prices, gold prices with exchange rate .In this study, monthly data of exchange rate (Rupee vs. Dollar), crude oil prices, and gold prices are used. The statistical techniques used are correlation, unit root test and vector error correction model .The result found that, inverse relationship found between crude oil and exchange rate in the long run. Gold and crude oil prices shows high positive relationship in short run as well as long run but exchange rare with crude oil and gold rate not having significant relationship existed between the long run .

SCOPE FOR FURTHER RESEARCH

The study concentrates on the movements of crude oil prices, gold prices, exchange rate in Indian context .The study further enhanced by specific factors affects the price to understand the reasons for change, and the model can be enhanced by adding micro factors to give a better model, which explains the price volatility.

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