A STUDY ON DYNAMIC RELATIONSHIP AMONG OIL PRICES, EXCHANGE RATE AND STOCK PRICES IN INDIA

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Abstract:

This paper examines the long run and short run dynamics among oil prices, exchange rates and stock prices in India (one of the fastest growing emerging markets in the world) over the most recent 15 year period 2000-2015. Using Johansen's Co integration test we find the existence of long run equilibrium relationship among oil market, foreign exchange market and stock market in India. The short term dynamics among the three markets are analyzed using Vector Auto regression (unrestricted as well as VECM), VAR causality/ Block Exogeneity Wald test and Impulse response analysis. We find unidirectional causality from stock market to oil market. An impulse originating in foreign exchange market results in a profound drop in stock as well as oil prices and is statistically significant for about three weeks in oil market and two weeks in stock market. The domino effect of up-waves in stock market is positive for oil market and remains statistically significant for few weeks, while being of opposite tendency in foreign exchange market. The optimism of oil market bulls up stock market in India while creating bearish trends in foreign exchange market. An assessment of impulse response graphs in pre crisis, during crisis and post crisis period exhibits that the riposte of all the variables to a shock generating from within stays for a relatively longer period during crisis as compared to pre and post crisis period. These results have wider implications for market integration, policy makers and investors at large. Since these markets are integrated rather than segmented, from the perspective of investments, risk reduction cannot be achieved in the long run by holding assets from these markets in the same portfolio. However diversification opportunities are not ruled out in the short run. Stock market turns out to be the leader in all the three markets especially after the recent financial crisis. Rapidly rising stock prices in India signal the expectation of higher economic growth ahead. If the stock prices get trapped in a bubble, however, oil prices will overshoot in relation to economic fundamentals.

Key Words: *Oil prices, exchange rate, stock prices, market integration, causal relationship, Co integration, Vector auto regression.*

1. Introduction:

The financial crisis instigating in early 2008, erupted like a volcano in mid of the year and shook up almost entire world instantly. The wave was not only a testimony of the mammoth significance of finance in today's world but also gave an atrocious demonstration of how strongly the economies are interwoven in the new world as a consequence of globalization. The volatilities pre observed and probably ignored were relooked by various agencies, academicians and government for the interest of all. The literature is full of studies related to various aspects diagnosing the roots, the impact, solutions and above all the preventive measures-how could it have been avoided. The gravity and intensity emphasizes the need to study the channels through which this crisis became contagious. The precariousness of oil prices, mounting stock prices and

strange behavior of exchange rates even before detonation of the crisis raises the eyebrows. This calls for a deeper understanding for the contagion relationship of real market, stock market and exchange rate movements.

The intensity, gravity and the direction of relationship among these three markets withholds invaluable information not only for the investors, but for the policy makers, multinational corporations and government at large. The implications are rigorous for one and all. For the multinationals, they can assess their exposure to foreign contracts. For the investor, it enables him assess his investment portfolio. For oil importers, fluctuations in oil price affect their trade balance and net foreign assets position. For the citizen, it could reduce their disposable income and corporate profitability. Policymakers have to take serious account of the developments in the oil market, as a rise in the world price of oil imposes macroeconomic costs in two ways. First, to the extent that oil is both an important input to production and consumer goods (i.e. petrol and heating oil), results in a reduction in economic activity as energy becomes more expensive. Second, rising oil prices contribute directly to the level of inflation, particularly in energy dependent countries. Over time, the impact on activity and inflation will also depend on policy responses and supply-side effects. **(**Masih et al., 2011).Paramount among the reasons is that such knowledge can aid in the prevention of an economic crisis. Strong relationship implies these as important factors to be considered for decision making for policymakers to minimize the contagious effect.

2. Review of Literature

Understanding the relationship between oil prices, exchange rates and emerging stock market prices is an important topic to study in context of India because as emerging economies continue to grow and prosper, they will exert a larger influence over the global economy (Basher et al, 2011:1). The growth trajectory of India has been impressive in the past decade. The crisis period too witnessed a remarkable above seven percent growth of GDP. The escalating stock market of India has been a favorite destination for investors worldwide. It ranks fourth in world's consumption of oil (3.1 million barrels per day) as per the estimates of EIA, thus contributing for pull of prices being an oil importing nations. The currency contribution of Indian rupee(INR) has increased from 0.1 percent in 2003 to 0.9 percent in global currency turnover (Bank of International Settlements) and transaction of Dollar vs. Indian Rupee remain even higher than Chinese Yen. The rising demand of oil, volatile stock performance and increasing role of Indian currency in global trading and transactions, accentuate the necessity to understand the relationship in context of India.

The direction of impact of changing oil prices on stock prices and exchange rates will differ from country to country depending on whether the country is an oil-exporter or oil-importer. In oil-exporting countries, a rise in world oil prices improves the trade balance, leading to a higher current account surplus and an improving net foreign asset position. At the same time, increase

in oil prices tends to increase private disposable income in oil-exporting countries. This increases corporate profitability, raises domestic demand and stock prices thereby causing exchange rate to appreciate. In oil-importing countries, the process works broadly in reverse: trade deficit are offset by weaker growth and, over time, real exchange rate depreciates and stock prices decrease.

While there exists some literature on the relationship between oil prices and stock prices, and a separate literature on the relationship between oil prices and exchange rates, the relationship between these two streams has, however, not been that closely studied, especially within the context of emerging market stock prices.

There is a fairly sizable literature showing that oil price movements affect stock prices. While most of the research investigating the relationship between oil prices and stock prices has been conducted for developed economies (see for example: Chen 2010, Park, & Ratti 2008, Elyasiani et al. 2011, Sadorsky 1999, Narayan & Sharma 2011, Oberndorfer 2009, Malik & Ewing 2009), there is some research looking into the relationship between oil prices and emerging stock markets (see for example Mohanty et.al 2011, Arouri et al 2011, C. Zhang and X. Chen 2011 ,S.A. Basher and P. Sadorsky 2006, Masih et al.2011) . The studies also compare the relationship for oil importing (Fayoumi 2009) and oil exporting countries and comparing both (Fayyad & Daly 2011, Filis et al.2011). On balance, these papers provide evidence that changes in oil prices affect do stock prices.

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 Krugman 1983). 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. Zhang, Fan, Tsai and Wei (2008) reported 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.

Golub (1983) and Krugman (1983) put forth compelling arguments as to why movements in oil prices should affect exchange rates. Golub reasons that since oil prices are denominated in U.S. dollars, an increase in oil prices will lead to an increase in demand for U.S. dollars. This analysis depends upon the crucial assumption that the demand for oil in oil-importing countries is price inelastic and if the price elasticity is greater than one (in absolute value) an increase in oil prices will lower total expenditure on oil and the demand for U.S. dollars would fall. Krugman's (1983) analysis is based on the relationship between the investment portfolio preferences of oil exporters and movements in exchange rates. Rising oil prices will increase the investment

portfolio possibilities of oil exporters. In this analysis, exchange rate movements are determined primarily by current account movements. If rising oil prices lead to a country's current account deterioration, then exchange rates will fall.

This discussion on the relationship between oil prices and exchange rates highlights that there are strong theoretical arguments for why exchange rates should affect oil prices as well as why oil prices should affect exchange rates.
There also exists some literature studying three variables (oil price, exchange rate and stock prices) simultaneously (see Basher et al.2011, Adebiyi et.al 2009,). Basher et al (2011) establishes a short term relationship among three as rising oil prices tend to depress emerging market stock prices and US dollar exchange rates in the short run.

The present paper aims at examining the dynamic relationship (long run as well as short run) among oil price, exchange rate and aggregate stock prices in India, one of the fastest growing emerging markets in the world. As already mentioned the results of the study have wider implications for market integration, market efficiency, policy makers, regulators and investing community at large.

The rest of the paper is organized as follows. Section 2 describes data and their sources while section 3 highlights the methodology followed. Empirical results are discussed in section 4. Finally section 5 provides conclusions and policy implications.

3. Methodology:

We begin with the descriptive statistics and Karl Pearson's coefficient of correlation analysis of all the six variables under study viz. Sensex, exchange rate, oil prices, sensex return, exchange rate return and oil return. For the purpose of comprehensive and meaningful analysis we divide the total study period (2000-2015)

3.1: Unit root tests

We test for unit roots for each series covering level variables (sensex, exchange rate and oil prices) and return variables (first difference of log values of level variables). We test the null hypothesis for the existence of a unit-root (non-stationary) against the alternative hypothesis of stationary variables using the Augmented Dickey–Fuller (ADF) statistic. We employ the Automatic selection of lags based on Schwarz Information Criterion (SIC). Augmented Dickey fuller test is the most frequently used test of unit root. It is based on simple logic. A non stationary process has infinite memory as it does not show decay in a shock that takes place in the process. Every random shock carries away the process from its earlier level not to return to its original value unless random shock pushes it towards its previous level. More specifically the ADF test equation is :

$$\Delta Y_t = \mu + \beta Y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + e_t$$

The Standard Dickey-Fuller model has been 'augmented' byΔY_{t-j}. In this case the regression model and the *t*- test are referred as the ADF test.

When the time series has a trend in it (either up or down) and is potentially slow-turning around a trend line we use the following test equation:

$$\Delta Y_t = \mu + \beta Y_{t-1} + \gamma t + \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + e_t$$

The null hypothesis of the Augmented Dickey-Fuller t-test is

$H_0: \beta = 0$

(i.e. the data needs to be differenced to make it stationary) versus the alternative hypothesis of

$H_A: \beta < 0$

(i.e. the data is trend stationary and needs to be analyzed by means of using a time trend in the regression model instead of differencing the data)

3.2: Johansen's co-integration test:

Next we test for the presence of long run equilibrium relationship among the three markets using Johansen's Co integration Test.

Johansen's methodology takes its starting point in the vector auto-regression (VAR) of order *p* given by:

$$y_t = c + \sum_{i=0}^{p} Ai\, y_{t-1} + e_t$$

This VAR can be re-written as

$$\Delta Y_t = \mu + \prod Y_{t-1} + \sum_{i=1}^{p-1} \mathbf{\Gamma_i} \Delta Y_{t-1} + e_t$$

Where: $\Pi = \sum_{i=0}^{p} Ai - I$ and $\mathbf{\Gamma_i} = -\sum_{j=i+1}^{p} Aj$

If the coefficient matrix **Π** has reduced rank $r<n$, then there exist $n \times r$ matrices **α** and **β** each with rank r such that $\mathbf{\Pi} = \boldsymbol{\alpha}\boldsymbol{\beta}'$ and t $\boldsymbol{\beta}'\mathbf{y}$ is stationary. r is the number of cointegrating relationships, the elements of **α** is known as the adjustment parameters in the vector error correction model and each column of **β** is a cointegrating vector. It can be shown that for a given r, the maximum likelihood estimator of **β** defines the combination of $\mathbf{y_{t-1}}$ that yields the r largest canonical correlations of Δ **Y** t with Y $t-1$ after correcting for lagged differences and deterministic variables when present.

Johansen proposes two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the **Π** matrix: the trace test and maximum eigenvalue test, shown in equations below:

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln (1 - \hat{\lambda_i})$$

$$J_{max} = -T ln(1 - \hat{\lambda_{r+1}})$$

Here T is the sample size and $\hat{\lambda}_i$ is the i^{th} largest canonical correlation. The trace test tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. The maximum eigenvalue test, on the other hand, tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of r +1 cointegrating vectors.

4. Data

The study uses weekly data from Jan,3 2000 to Oct,28 2015 i.e. for about 15 years. Weekly OPEC Countries Spot Price FOB Weighted by Estimated Export Volume (Dollars per Barrel), which is applicable for Indian economy, is used as oil prices and have been downloaded from website eia.com (U.S. Energy Information Administration). The weekly Exchange rate (INR/USD) data has been collected from website ONADA.com. A higher exchange rate here implies a stronger US dollar and a weaker INR (i.e. Indian rupee). Sensex, the oldest and most widely used index comprising thirty representative stocks which account for nearly sixty percent of total market capitalization on Bombay stock exchange, has been used as a proxy for aggregate stock prices in India. The data for Sensex has been downloaded from website yahoofinance.com.

The raw data regarding Sensex values, exchange rates and oil prices are then converted into their return counterparts by taking first difference of their log values. Specifically

$$Sensex\ Return\ (or\ Dlog(Sensex)) = in\ (SNX_t / SNX_{t-1})$$

$$For\ t = 1,2,3 \ldots 772$$

Where

SNX_t refer to Sensex index value at time t.

SNX_{t-1} refers to SNX index value at time t-1

$$Exchange\ rate\ Return\ (or\ Dlog\ (exchange\ \_\ rate)) = in\ (ER_t / ER_{t-1})$$

Where

ER_t refer to INR/USD rate at time t.

ER_{t-1} refers to INR/USD rate at time t-1

$$Oil\ Return\ (\ or\ Dlog(Oil)) = \ ln\ (OIL_t / OIL_{t-1})$$

Where

OIL_t refer to OPEC Countries Spot Price FOB Weighted by Estimated Export Volume (Dollars per Barrel) at time t.

OIL_{t-1} refers to OPEC Countries Spot Price FOB Weighted by Estimated Export Volume (Dollars per Barrel) at time t-1.

In total there are 772 observations for price variables and 771 observations for return variables.

5.0 Empirical Results:

5.1 Descriptive Statistics:

Table 1: Descriptive Statistics

Descriptive statistics(Total Period)						
	Level Variables			Return Variables		
	Exchange rate	Oil	Sensex	Exchange Returns	Stock Returns	Oil Returns
Mean	44.5208	46.3913	8619.9990	0.0004	0.0022	0.0020
Median	45.1283	33.1850	5670.9250	0.0000	0.0052	0.0036
Maximum	52.6286	137.1800	21004.9600	0.0428	0.1317	0.2098
Minimum	35.6995	9.4100	2600.1200	-0.0644	-0.1738	-0.1645
Std. Dev.	3.4202	30.3988	5746.4780	0.0084	0.0366	0.0421
Skewness	-0.7700	0.8612	0.6741	-0.2768	-0.3586	-0.2761
Kurtosis	3.4350	2.7841	1.8805	13.8363	4.8598	4.6631
Jarque-Bera	82.3756	96.9243	98.7747	3782.1670	127.6302	98.6488
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 1 presents the summary statistics for all the six variables for the total study period as well as all the five sub periods. The average oil price during the period is USD 46.39 with a maximum of 137.18 and a minimum of 9.41. The average value of Sensex is about 8620 with a maximum of 21004 and a minimum of 2600 over the same period, while the average INR/USD exchange rate is 44.52 with a maximum of 52.62 and a minimum of 35.70. The mean weekly returns of Sensex, Exchange rate and oil have been found to be 0.22percent, 0.04percent and 0.20percent respectively. The standard deviation is highest in oil market followed by stock market and foreign exchange market. As expected the volatility is highest in all the three markets during the crisis period (2008-09). However volatility in post crisis period does not appear to be significantly different from that of pre crisis period.

5.2 Correlation analysis:

Table 2: Cross Correlation Matrix

	2000-2015		**2000-2003**		**2004-06**		**2008-10**		**2013-14**		**2014-15**	
	Ex rate	**oil**	**Ex rate**	**oil**	**Ex rate**	**oil**	**Ex rate**	**oil**	**Ex rate**	**oil**	**Ex rate**	**oil**
Sensex	0.05	0.91*	0.27*	0.68*	-0.86*	0.72*	-0.60*	0.82*	-0.72*	0.59*	-0.51*	0.09
Ex rate		0.10		0.39*		-0.63*		-0.56*		-0.81*		-0.04
	Ex ret	**oil ret**	**Ex ret**	**oil ret**	**Ex ret**	**oil ret**	**Ex ret**	**oil ret**	**Ex ret**	**oil ret**	**Ex ret**	**oil ret**
Sensex ret	-0.36*	0.05	-0.21*	-0.05	-0.33*	-0.01	-0.25*	-0.05	-0.53*	0.22*	-0.50*	0.23*
Ex ret		-0.16*		-0.07		0.09		-0.09		-0.28*		-0.40*

**significant at 5% level.*

Table 2 shows cross correlations (Karl Pearson's Correlation coefficients) matrix for the level and return variables. As expected there is very high and positive correlation between oil prices and stock prices for the total period (0.91) and pre crisis period (0.82) in India. However it is relatively lower during crisis period (0.529) and is drastically low in post crisis period (0.08). It shows that the relationship between the stock market and oil market has reduced significantly post financial crisis. However in terms of returns, the correlation coefficients between both these markets have actually increased.

Stock prices and Exchange rates are positively related while stock returns and exchange rate returns show negative correlation for the total period. This negative correlation has become relatively higher in post crisis period.

Regarding oil prices and exchange rates we find a positive relationship in terms of level variables but negative correlation in terms of return variables. Hence the returns in stock market and oil market on one hand and returns in foreign exchange market on the other hand are negatively correlated suggesting diversification benefits for investors who hold assets in either stock market and foreign exchange market or oil market and foreign exchange market.

5.3 **Unit Root Tests Results**

Table 3: **Augmented Dickey Fuller Unit root test results**

		Sensex	Exchange Rate	Oil	Sensex Returns	Exchange Rate Returns	Oil Returns
Total Period	t-Statistic	-0.578	-2.230	-0.549	-26.874	-25.915	-12.991
	Prob.*	0.873	0.196	0.879	0.000	0.000	0.000
Period I: 2000-2004	t-Statistic	-1.921	-0.544	-1.402	-13.638	-14.232	-10.865
	Prob.*	0.322	0.879	0.581	0.000	0.000	0.000
Period II: 2005-2007	t-Statistic	0.854	-0.026	-1.690	-13.399	-11.910	-11.806
	Prob.*	0.995	0.954	0.435	0.000	0.000	0.000
Period III: Pre Crisis(2008-10)	t-Statistic	0.763	0.431	-0.647	-12.836	-10.875	-9.510
	Prob.*	0.993	0.984	0.855	0.000	0.000	0.000
Period IV: Crisis period(2011-13)	t-Statistic	-1.869	-1.781	-1.047	-5.246	-9.857	-3.575
	Prob.*	0.346	0.388	0.734	0.000	0.000	0.008
Period V: Post Crisis(2014-15)	t-Statistic	-1.883	-0.895	-0.800	-9.265	-8.804	-7.864
	Prob.*	0.339	0.786	0.814	0.000	0.000	0.000
Note: Lag length is chosen based on SIC. The maximum lag length is 20 for the whole period, 14 for period I&II, 13 for pre crisis, 12 for crisis and 11 for post crisis period. *							

shows MacKinnon (1996) one-sided p-values. The Durbin Watson statistics reveal no auto correlation for all the variables in all periods under consideration.

Table 3 presents the results of Augmented Dickey Fuller Unit root tests for the level as well return variables. All the three level variables (sensex, exchange rate and oil pieces) are non stationary while their first difference in log terms i.e. all the three return variables are stationary. Hence the three level variables are I(1).

6. Conclusion

Realizing the vibrant relationship of aggregate stock prices, exchange rates and oil prices, the study is a contribution to the existing literature in many aspects. One, it studies the liaison of three variables taken together, in reference to an emerging economy of India. The implications are crucial in context of emerging contribution of India to global economy and investment avenues it offers for multinationals, global institutions and investors. Two, it studies the long term relationship as well as during different periods covering pre, during and post crisis period, which of course would offer great lessons for all concerned.

The examination of relationship is achieved via a formal empirical framework. Johansen cointegration technique (bi-variate as well as multi-variate) is applied to observe the long term relationship. The empirical findings suggest existence of long term relationship among three variables. Further we find that in times of any destabilization, the stock market pulls the oil market towards a new equilibrium position. Hence stock market leads the oil market in India. The contribution of foreign exchange market in correcting any disequilibrium is rather low but statistically significant. The variables were modeled in VAR (unrestricted as well as error correction mechanism) in order to analyze the short term dynamics. VAR results show that in the short run oil returns are affected significantly by their lagged values, lagged sensex returns and lagged exchange rate returns in case of total period.

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