Historical Fall in Crude Oil Prices and Volatility Spillover to Selected Asian Stock Markets

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Abstract

Oil industry recently faced the deepest downturn. This plunging price was first observed in June 2014 and it moved further down. This change affected the investment pattern of many companies and leads to a decline in corporate margins and influence investments in stock markets. Keeping in view this important relationship, here, we propose to study the movement of crude oil prices and volatility spill over to select major stock markets of Asia.

We have taken daily data for the period from June 01, 2014 to August 31, 2016 for the major Asian countries (China, Malaysia, Indonesia, South Korea, Singapore, Japan and India). One major stock index of each country has been taken to represent its stock market. We used GARCH (1,1) model to forecast volatility. Beside, doing descriptive statistics and correlation test, we put granger causality test to identify spill over of volatility.

Preliminary results suggested that apart from different degrees of correlations, return spill overs between India and its Asian counterparts are found to be significant and bi-directional. We found that there are some markets from where there is significant flow of volatility. Affect of historic crude price movement on stock markets is also significant.

Keywords: Crude Oil, Stock Market, Garch Model, Causality, Correlation

Introduction

Oil is the fuel that forces world economies. The sharp increase in the price of oil and other energy products were the most severe supply shocks hitting the world economies since World War II. An oil shock may have a different impact on each of the countries due to various factors such as their relative position as oil importers or exporters, different tax structures etc.

In context to Asian countries, changes in oil prices are one of the most important factors which impact the overall inflation of the countries. The major producers of oil are Saudi Arabia, United States, Russia, China, Canada, Iran, UAE, Iran whereas the major consumers are United States, China, Japan, India, South Korea, Germany, Italy, France, Netherland and Singapore. This mismatch between the producers and consumers drives international trade in oil. Due to the rising oil demand in countries like China and India, and production

cuts by OPEC countries, the price of oil rose significantly from 1999 to mid 2008 from $25 to $150 a barrel. In July 2008, it reached its peak of US $147.27 a barrel.

Conceptual Framework

The financial crises of 2007-2008 affected the oil price and underwent a significant decrease after July 11, 2008. On December 23,2008, it dropped below $30.28 per barrel which is lowest since financial crises. During the economic recovery, for about three and a half year the price remained from $90 to $120 a barrel. In mid of 2014, from a peak of $115 per barrel in June 2014 oil price started declining due to a significant increase in oil production in USA, and declining demand in other countries. By February 3, 2016 the price of oil was below $30 a barrel which is almost a drop 75% since mid-2014. This change affected the world economies to great extent. Many countries faced with the problem of unemployment. In USA 250,000 oil workers-roughly half of them lost their jobs. This change was also observed in stock market. The earnings are down for companies that made record profits in recent years whereas many companies have gone bankrupt. Thus it affected the investment in stock markets. This study is in the continuation of research based on the issue of fall in oil prices and its impact on stock market returns.

Review of Literature

S.No	Title of Paper	Authors	Year	Indexes and time period* considered	Data and Methodology Used	Conclusions-Comments
1	Oil Price Risk and the Australian Stock Market	Faff and Brailsford,	1999	24 Australian industry equity returns, 14 years	Arbitrage Pricing Theory(APT), Capital Asset Pricing Model (CAPM)	Findings were that the oil price factor effects the Australian industrial market
2	Autoregressive conditional heteroscedasticity in commodity spot prices	Beck	2001	20 commodities, Consumer Price Index, Producer Price Index, Wholesale Price Index, 171 years	GARCH	Results concluded that ARCH term was significant on storable commodities.
3	Modeling the conditional volatility of commodity index futures as a regime switching process.	Fong and See	2002	Future returns of Goldman Sachs Commodity Index(GSCI), 5 years	GARCH(1,1)	Regime shift in conditional mean and volatility
4	Oil Price Shocks and Emerging Stock Markets: A Generalized VAR Approach	Maghyereh,	2004	Weighted stock market indices of Argentina, Brazil, Chile, China, Czech Republic, Egypt, Greece, India, Indonesia, Jordan, Korea, Malaysia, Mexico, Morocco, Hungary, Pakistan, Philippines, Poland, South Africa, Taiwan, Thailand, and Turkey, 6 years	VAR model	With VAR model, it was found that the stock market in these economies do not effect crude oil markets
5	Oil Price Risk and Emerging Stock Markets	Basher and Sadorsky,	2006	Morgan Stanley Capital International (MSCI) World Index and Stock market returns of 21 countries, 11 years	Capital Asset Pricing Model (CAPM)	Evidences were found that shows the impact of oil price changes on stock price returns in emerging markets
6	Oil Prices and the Stock Prices of Alternative Energy Companies	Henriques and Sadorsky,	2007	WilderHill Clean Energy Index (ECO), the Arca Technology Index (PSE), and oil prices , 7 years	Vector Auto - regression (VAR)	It was observed that the prices of stock and oil Granger cause the stock prices of alternative energy companies
7	Commodity price cycles and heterogeneous speculators: A STAR GARCH model.	Reitz and Westerhoff	2007	US-dollar market prices of commodities-cotton, lead, rice, soybeans, sugar, and zinc, 30 yrs	STAR-GARCH	The model indicates that their influence positively depends on the distance between the price of commodity and its long- run equilibrium
8	Short-term Predictability of Crude Oil Markets: A Detrended Fluctuation Analysis Approach	Ramirez, Alvarez and Rodriguez,	2008	International crude oil prices, 20 years	Auto-regressive Fractionally Integrated Moving Average (ARFIMA)	In long run crude oil prices were efficient but in short run, inefficiency was found.

9	Crude Oil and Stock Markets: Stability, Instability, and Bubbles	Miller and Ratti,	2008	Returns of S&P 500, oil prices., 37 years	Vector Error Correction Model (VECM)	There was Long run relationship between the stock prices of OECD countries and world oil prices
10	Relationships between Oil Price Shocks and Stock Market: An Empirical Analysis from China	Cong, Wei, Jiao and Fan,	2008	Composite index of Shanghai stock market and Shenzhen stock market , 10 years	Multivariate Vector Auto - regression	It was observed that oil prices have not shown any effect on Chinese stock market
11	The Impact of Oil Price Shocks on the U.S. Stock Market	Kilian and Park,	2009	US stock market return, 34 years	VAR model	The results proved that the US stock market return effects the oil price changes
12	Dynamic correlation between stock market and oil prices: The case of oil -importing and oil-exporting countries	Filis, Degiannakis and Floros,	2009	S&P/TSX 60, MXICP 35, Bovespa Index, Dow Jones Industrial , DAX 30 and AEX General Index. 22 years	GARCH model	It was observed that Oil prices have significant impact on stock market prices, except 2008, year of global financial crisis, wherein oil prices showed positive correlation with stock markets
13	The Effects of Crude Oil Shocks on Stock Market Shifts Behav ior: A Regime Switching Approach	Aloui and Jammazi,	2009	Stock returns of Nikkei225, FTSE100 and CAC40, 19 years	Markov-switching EGARCH model	It was observed that rises in oil price had significant role in determining both ie in probability of transition across regimes and the volatility of stock returns.
14	Exploring Autocorrelation in NSE and NASDAQ during the Recent Financial Crisis Period	Siddiqui and Seth	2011	NSE and NASDAQ, 4 years	VAR Model	It was found that there is no long term integration between oil prices and exchange rate prices
15	Crude oil shocks and stock markets: A panel threshold co-integration approach	Zhu, Li and Yu,	2011	Norway, Sweden, Poland, Turkey, Brazil, India, Chile, China, Israel, Slovenia and South Africa, USA, UK, Mexico, 14 years	Threshold co - integration, threshold VAR and Granger Causality model	It was found that there was Co -integration, error correction and bidirectional causality between crude oil prices and stock returns
16	Does crude oil move stock markets in Europe? A sector investigation	Arouri,	2011	DJ Stoxx 600 and European sector indices- *Automobile & Parts, Financials, Food & Beverages, Oil & Gas, Health Care, Industrials, Basic Materials, Personal & Household Goods, Consumer Services, Technology, Telecommunications*, and *Utilities,12 years*	GARCH model and the quasi - maximum likelihood (QML) method	The results concluded that the strength of relationship between oil and stock prices varies across different sectors
17	Association between Crude Price and Stock Indices: Empirical Evidence from Bombay Stock Exchange	Bhunia,	2012	BSE 500, BSE 200, BSE 100, 10 years	Johansen's Co - integration test and VECM	It was observed that the three indexes from BSE and crude oil prices are co - integrated but having only one way causality from all indexes to crude oil prices.
18	Crude Oil Price Velocity and Stock Market Ripple: A Comparative Study Of BSE With NYSE and LSE	Sharma and Khanna,	2012	Sensex, DJIA and FTSE 100, spot prices of oil , 3 years	correlation, regression and coefficient of determination	It was found that the changes in oil price have significant effect on performance of stock returns.

19	How does oil price volatility affect non -energy commodity markets?	Ji and Fan	(2012)	US dollar index, crude oil prices, 2 yrs	Bivariate EGARCH	It was observed that significant volatility spillover effect was there of crude oil on non energy commodity market.
20	Nonlinear Analysis among Crude Oil Prices, Stock Markets' Return and Macroeconomic Variables	Naifar and Dohaiman,	2013	OPEC Oil spot markets and Gulf Cooperation Council (GCC),S&P 500, 7 Years	Markov Switching Models and Copula Models	The relationship between Gulf Corporation Council stock market returns and OPEC oil market volatility was found to be regime dependent. It was also observed that inflation rate and short term interest rates were also dependent on crude oil prices
21	On the links between stock and commodity markets' volatility.	Creti, Joëts and Mignon	(2013)	Aggregate commodity price index, Commodity Research Bureau (CRB) index. Regarding the equity market, S&P 500 index. 25 commodities divided into sectors - energy, precious metals, non-ferrous metals, food, oleaginous, exotic , agriculture and livestock,10 yrs	GARCH (DCC)	There exist a correlation between commodity market and stock market. It was observed Stock Market as highly volatile since the financial crises of 2007-2008
22	The Impact of Oil Price Shocks on the Stock Market Return and Volatility Relationship	Kang, Ratti and Yoon,	2014	Weighted average of NYSE, AMEX, and Nasdaq stocks and oil prices, 14 years	GARCH (1,1) model and structural VAR model	Oil prices were found to be associated with the stock market volatility and returns
23	Modelling dynamic dependence between crude oil prices and Asia-Pacific stock market returns.	Zhu, Li and Li,	2014	S&P/ASX 200, Shanghai composite,Hang Seng, BSE National, Jakarta SE composite,Nikkei 225, Kospi, Kuala Lumpur Composite, Strait Times, SE weighted, 12 years	AR(p)-GARCH (1, 1)-t model	It was concluded that there was a weak relation between crude oil prices and Asia - pacific stock markets
24	Co-movement of International Crude Oil Price and Indian Stock Market: Evidences from Nonlinear Cointegration Tests	Ghosh and Kanjilal,	2014	SENSEX, exchange rate and international crude oil price , 8 years	VAR model	It was observed that the movement of international crude oil prices had an impact on stock prices
25	Forecasting excess Stock Returns with Crude Oil Market Data	Liu, Ma and Wang,	2014	Return of S&P 500 and oil price, 37 years	Time-varying Parameter (TVP)	Apart from traditional predictors, oil prices effects the forecasting of stock market prices
26	The Impact of Oil Prices on the Exchange Rate in South Africa.	Kin and Courage	(2014)	Nominal exchange rate against the US dollar, Brent crude oil prices and South African interest rate, 10 yrs	GARCH, EGARCH, and CGARCH	The results concluded that there is a high persistence of volatility among the indices whereas Leverage Effect is there in Energy Spot, Agricultural Spot and Metal future.
27	Forecasting Volatility in Commodity Market: Application of Select GARCH Models.	Siddiqui and Siddiqui	2015	Indian Metal, Energy and Agriculture index, 10 years	GARCH, EGARCH, and CGARCH	It was observed that there was a high persistence of volatility among the indices. Leverage Effect was there in Energy Spot, Agricultural Spot and Metal future

Research Methodology

Research Methodology is presented as under:

Objectives

Objectives are put as follows:

1. To ascertain the correlation among oil price and other indices
2. To assess the direction of causality between oil price and other indices
3. To forecast volatility oil price and other indices

Data

We have taken daily data for the period from June 01, 2014 to August 31, 2016 for the major Asian countries (China, Malaysia, Indonesia, South Korea, Singapore, Japan and India). One major stock index of each country has been taken to represent its stock market i.e. for China(SSE COMPOSIE), Malaysia(FTSE),Indonesia (JKSE), South Korea(KOSPI), Singapore(STI index), Japan(NIKKI 225) and India (S&P BSE). This data were taken from Yahoo Finance. We have also taken historical crude oil prices from Investing.com.

Tools

We used GARCH (1,1) model to forecast volatility and to develop residual series. Beside, doing descriptive statistics and correlation test, we put granger causality test to identify spill over of volatility.

Hypotheses

In order to meet the objectives following Null Hypotheses are proposed:

H01: There is no correlation among oil price and other indices

H02: There is no causality between price and other indices.

H03: There is no volatility persistence in oil price and other indices

Analysis

Analysis is presented as under:

Descriptive Statistics

With the help of descriptive statistics we are describing the various features of the oil price and other indices. Here, we have taken indices of China(SSE COMPOSIE), Malaysia(FTSE),Indonesia(JKSE), South Korea(KOSPI), Singapore(STI index), Japan(NIKKI 225) and India (S&P BSE). It helps in summarizing a sample's detail. Following table shows the result of descriptive statistics of the variables.

TABLE 01
Descriptive Statistics

	CHINA	INDIA	INDONESIA	JAPAN	MALAYSIA	SINGAPORE	SOUTH KOREA	OIL
Mean	0.00077	0.00023	0.00020	0.00018	-0.00022	0.00023	2.31E-05	-0.00148
Std. Dev.	0.02026	0.00958	0.00934	0.01498	0.00639	0.00958	0.00757	0.029798
Skewness	-1.05922	-0.6612	-0.35327	-0.17323	-0.20914	-0.66116	-0.25359	-0.61007
Jarque-Bera	452.325	286.597	165.970	411.093	68.0276	286.597	74.1507	2261.178
Probability	0	0	0	0	0	0	0	0
Observation	555	555	555	555	555	555	555	555

Descriptive Statistics means describing the data in quantitative terms. It summaries about the sample and the observation we have made. Here there are 4440 observations (555*8) of China, India, Indonesia, Japan, Malaysia, Singapore, South Korea and crude oil prices. FTSE is least volatile as compared to other indices as the standard deviation is least with .639 per cent and crude oil price is considered to be highest volatile as its standard deviation is 2.979 per cent. As Skewness measures the asymmetry of the probability distribution of variables. Here all variables are negatively skewed. Jarque- bera test is used to check the normality of the distribution. Hypothesis of normality is rejected here, in all the cases.

Correlation Test

In statistical terms, correlation measures how two variables move in relation with each other. Table 3 provides summary of the correlation among China(SSE COMPOSIE), Malaysia (FTSE),Indonesia(JKSE), South Korea(KOSPI), Singapore(STI index), Japan(NIKKI 225) and India (S&P BSE).

TABLE 02
CORRELATION

	CHINA	INDIA	INDONESIA	JAPAN	MALAYSIA	OIL	SINGAPORE	SOUTH K0REA
CHINA	1.0000	0.0447	-0.0064	-0.0921	-0.0352	0.0334	0.0447	0.0501
INDIA	0.0447	1.0000	0.0145	0.2094	0.0710	-0.0623	1.0000	0.1415
INDONESIA	-0.0064	0.0145	1.0000	0.0857	0.0170	-0.0384	0.0145	-0.0492
JAPAN	-0.0921	0.2094	0.0857	1.0000	0.0544	0.0925	0.2094	0.0274
MALAYSIA	-0.0352	0.0710	0.0169	0.0544	1.0000	-0.0114	0.0710	0.2033
OIL	0.0334	-0.0623	-0.0384	0.0925	-0.0114	1.0000	-0.0623	-0.0089
SINGAPORE	0.0447	1.0000	0.0145	0.2094	0.0710	-0.0623	1.0000	0.1415
SOUTH KOREA	0.0501	0.1415	-0.0492	0.0274	0.2033	-0.0090	0.1415	1.0000

Correlation is a statistical tool which measures the fluctuations between two or more variables. The value of correlation can be positive or negative. There is a positive correlation when an increase in one variable, increases the other variable. Here, values of correlation are ranging from -0.0921 to 1 which means they are negatively and positively correlated with each other.

GARCH Model

Past variances are considered to explain the future variances under this model. The result of GARCH model reflected by mean and variance equation are presented in Table 3

TABLE 03
GARCH MODEL

	CHINA	INDIA	JAPAN	INDONESIA	SINGAPORE	MALAYSIA	SOUTH KORIA	OIL
GARCH								
C	0.001237 (0.0276)	0.000319 (0.4530)	0.000656 (0.2391)	0.000334 (0.3978)	0.000319 (0.4530)	-0.000158 (0.5047)	8.84E-05 (0.7810)	0.001410 (0.1299)
Variance Equation								
C	1.44E-06 (0.0784)	6.64E-06 (0.1439)	7.34E-06 (0.0006)	3.46E-06 (0.0049)	6.64E-06 (0.1439)	1.41E-06 (0.0037)	3.33E-06 (0.0169)	5.11E-06 0.0351
A	0.080304 (0.0000)	0.039828 (0.1126)	0.153157 (0.0000)	0.070067 (0.0001)	0.039828 (0.1126)	0.118201 (0.0003)	0.075258 (0.0052)	0.095205 (0.0000)
B	0.921710 (0.0000)	0.887800 (0.0000)	0.827264 (0.0000)	0.889909 (0.0000)	0.887800 (0.0000)	0.849882 (0.0000)	0.867303 (0.0000)	0.909729 (0.0000)

In the table 3 Alpha (α) indicates the ARCH affect and Beta (β) indicates the GARCH affect.

In all cases ie oil prices and other indices, the value of probability of GARCH coefficient (β) is 0.000, which is less than the critical value 0.05. Thus GARCH is significant for oil prices and other indices which mean that past deviation in values can affect the values in future.

Granger Causality Test

This test involves examining whether lagged values of one series have significant explanatory power for another series. They have null hypotheses of no granger causality. The results of this test are summarized in Table 4, and it indicates whether there exists significant Granger Causality and if it exists, then in which direction such causality exists between oil returns and stock returns

TABLE 4
Granger Causality Test

Basis	Null Hypothesis	Obs	F-Statistic	Prob.
CHINA	INDIA does not Granger Cause CHINA	555	0.06688	0.7960
	INDONESIA does not Granger Cause CHINA		1.85951	0.1733
	JAPAN does not Granger Cause CHINA		6.92928	0.0087
	MALAYSIA does not Granger Cause CHINA		0.03612	0.8493
	SINGAPORE does not Granger Cause CHINA		0.06688	0.7960
	SOUTH KOREA does not Granger Cause CHINA		0.08496	0.7708
	OIL does not Granger Cause CHINA		1.52164	0.2179
	CHINA does not Granger Cause INDIA		0.00058	0.9809
	INDONESIA does not Granger Cause INDIA		4.30056	0.0386

INDIA	JAPAN does not Granger Cause INDIA	2.89037	0.0897
	MALAYSIA does not Granger Cause INDIA	21.4221	5.E-06
	SINGAPORE does not Granger Cause INDIA	na	
	SOUTHK does not Granger Cause INDIA	4.11469	0.0430
	OIL does not Granger Cause INDIA	4.45484	0.0353
INDONESIA	CHINA does not Granger Cause INDONESIA	0.11557	0.7340
	INDIA does not Granger Cause INDONESIA	2.74654	0.0981
	JAPAN does not Granger Cause INDONESIA	1.88193	0.1707
	MALAYSIA does not Granger Cause INDONESIA	0.01860	0.8916
	SINGAPORE does not Granger Cause INDONESIA	2.74654	0.0981
	SOUTHK does not Granger Cause INDONESIA	1.03023	0.3106
	OIL does not Granger Cause INDONESIA	0.00161	0.9680
JAPAN	CHINA does not Granger Cause JAPAN	0.51011	0.4754
	INDIA does not Granger Cause JAPAN	11.9310	0.0006
	INDONESIA does not Granger Cause JAPAN	0.75902	0.3840
	MALAYSIA does not Granger Cause JAPAN	0.05684	0.8117
	SINGAPORE does not Granger Cause JAPAN	11.9310	0.0006
	SOUTHK does not Granger Cause JAPAN	5.49902	0.0194
	OIL does not Granger Cause JAPAN	4.33665	0.0378
MALAYSIA	CHINA does not Granger Cause MALAYSIA	1.07574	0.3001
	INDIA does not Granger Cause MALAYSIA	0.86460	0.3529
	INDONESIA does not Granger Cause MALAYSIA	1.99501	0.1584
	JAPAN does not Granger Cause MALAYSIA	0.27766	0.5985
	SINGAPORE does not Granger Cause MALAYSIA	0.86460	0.3529
	SOUTHK does not Granger Cause MALAYSIA	14.2092	0.0002
	OIL does not Granger Cause MALAYSIA	4.40239	0.0364
SINGAPORE	CHINA does not Granger Cause SINGAPORE	0.00058	0.9809
	INDIA does not Granger Cause SINGAPORE	Na	
	INDONESIA does not Granger Cause SINGAPORE	4.30056	0.0386
	JAPAN does not Granger Cause SINGAPORE	2.89037	0.0897
	MALAYSIA does not Granger Cause SINGAPORE	21.4221	5.E-06
	SOUTHK does not Granger Cause SINGAPORE	4.11469	0.0430
	OIL does not Granger Cause SINGAPORE	4.45484	0.0353
SOUTH KOREA	CHINA does not Granger Cause SOUTHK	0.32018	0.5717
	INDIA does not Granger Cause SOUTHK	0.48508	0.4864
	INDONESIA does not Granger Cause SOUTHK	1.00569	0.3164
	JAPAN does not Granger Cause SOUTHK	4.79247	0.0290
	MALAYSIA does not Granger Cause SOUTHK	14.8580	0.0001
	SINGAPORE does not Granger Cause SOUTHK	0.48508	0.4864
	OIL does not Granger Cause SOUTHK	2.01632	0.1562
OIL	CHINA does not Granger Cause OIL	0.17780	0.6734
	INDIA does not Granger Cause OIL	1.04198	0.3078
	INDONESIA does not Granger Cause OIL	3.75555	0.0532
	JAPAN does not Granger Cause OIL	0.10664	0.7441
	MALAYSIA does not Granger Cause OIL	5.22161	0.0227
	SINGAPORE does not Granger Cause OIL	1.04198	0.3078
	SOUTHK does not Granger Cause OIL	0.51781	0.4721

The results of tables 4 indicates that null hypothesis is rejected for oil and other indices as all indices and oil does not Granger Cause each other, that is even short-term causality does not exist between oil and index series.

Conclusion

This study is in the continuation of research based on the issue of fall in oil prices and its impact on stock market returns. For depicting the issue of interrelation and interdependency between the indices, we used Descriptive Statistics, Correlation Analysis. We used GARCH (1,1) model to forecast volatility and to develop residual series. We put granger causality test to identify spill over of volatility.

The key findings of the study are –

FTSE is least volatile as compared to other variables as the standard deviation is least with .639 per cent and crude oil price is considered to be highest volatile as its standard deviation is 2.979 per cent. As values of correlation are ranging from -0.0921 to 1 which means they are negatively and positively correlated with each other. GARCH is significant for oil prices and other indices which mean that past deviation in values can affect the values in future. The results of granger causality

This study is helpful to all individual/ institutional investors, portfolio managers, corporate executives, policy makers and practitioners may draw meaningful conclusions from the findings of this study while operating in stock markets. Our research may help stakeholders in management of their existing portfolios as their portfolio management strategies may be, up to some extent, dependent upon such research work.

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