Analysis of Price Volatility in Energy Commodities

by Sumeet Gupta & Manvinder Singh Pahwa

Abstract

After globalization, there has been a drastic increase in energy consumption of India, as the development aspect has picked up pace. India in the recent past has pioneered the economic growth and is just behind China in the race. In order to meet the galloping demand of energy, India is importing 76% of crude oil, 22.5 % of natural gas and 14.8% of coal. These energy commodities have a great role to play in growth and development of any country. The import of these commodities significantly contributes towards the continuously increasing fiscal deficit. The increasing demand and scarce supply of these energy generating commodities has given rise to the high volatility in the prices. The evolution of derivatives market is a step towards mitigation of the risk associated with the price fluctuation of these commodities but the same has lead to speculative practices which in turn has added a value in volatility.

This paper concentrates on the study of price volatility and fundamental factors influencing the price of energy generating commodities using ATR (Average True Range). It further attempts to study the inter-commodity price effect using multiple regression analysis.

Introduction

Crude Oil, Coal and Natural Gas have been the major sources for fulfilling the energy requirements of the entire world and therefore these commodities have been playing a vital role in industrial growth and economic development throughout the globe. The fluctuations in the prices of these commodities highly affect the economies of all the countries. The analysis shows that the prices of these commodities are affected by US inventory data, weather data, unemployment index and dollar index. For instance the market price shows stimuli to decrease in US oil inventories. Further if USD devaluates, crude oil prices show an upward trend and vice versa. Both the demand and supply of these natural energy resources play an important role in pricing of these commodities.

Coal is presently in demand as it is the base of power generation in several developing countries such as China, India and South Africa. These countries need to import coal because of their limited resources and the international price of coal plays an important role in power tariff fixation. At the same time the supply of coal is affected by weather conditions such as floods in Australia, which also influence its price in global markets and the direct impact can be seen on the price of power.

The environmental restriction, global warming, increasing air pollution has restricted the use of coal and has promoted the use of natural gas. Most of the nations can be seen shifting to natural gas. Some of the fundamental factors affecting the supply side of natural gas prices are weather conditions such as Katrina, Rita and the Richard in Gulf of Mexico. Besides, a drastic seasonal variation in US demand for natural gas has been notified in winters, where an increase of 1.5 times of normal consumption has been recorded.

This in turn leads to further price rise. The global market of natural gas in increasing due to economic development activities of which one of the prominent is establishment of gas based power plants.

The crude oil in past, present and in future will be in demand by the all the developing nations. But the factors affecting the price of crude oil may include the scope of economic growth of OECD countries, the prospective substitution of renewable fuels and natural gas for petroleum based products and the weather conditions.

India has been a significant consumer of energy resources. India is the fourth largest consumer of crude oil in the world after US, China and Japan. Despite global financial crises, India's energy demand continues to rise. (EIA Report). In order to meet its increasing energy requirements and insufficient domestic resources, India imports most of its coal, liquefied natural gas as well as crude oil. This increasing gap of demand and supply may adversely affect the price of energy commodities in future. Besides the above, certain macro economic factors such as GDP, trade deficit, national debt, inflation, interest rates etc have influence on the prices of these energy commodities.

All the above factors have created a feeling of uncertainty of future price of these energy commodities which has lead to the rationale and statement of problem of the present research paper.

Rationale of Study

Due to volatility in the energy commodity market, all the stakeholders viz producers, investors, government have to bear huge losses. This price risk can be mitigated by using the instruments of derivative markets but the selection of the strategies become irrelevant when the direction of the market trend cannot be predicted within the given time frame. So there is a need to find out the market forces and the factors deriving the energy commodity prices using fundamental and technical analysis. Further, on the basis of the outcomes, there is a need to develop a price forecasting model for energy generating commodities so that the risk arising out of the price volatility can be mitigated.

Problem Statement

In the light of increasing rate of energy consumption year on year, due to population growth and economic development against scarce supply, the price of energy generating commodities has been highly volatile. India, in order to meet its energy requirements imports 76%, 22.5% and 14.8% of its total requirements of crude

oil, natural gas and coal respectively. The increasing imports on one hand and the increasing prices of these energy commodities on other hand are continuously contributing to fiscal deficit of the country. Moreover, under recoveries of OMCs and subsidies on LPG, kerosene and diesel are giving catalytic effect to highly increasing trade and fiscal crisis. Against this backdrop there is a need to identify the factors affecting price of the energy commodities, analyze them and develop a price forecasting model to reduce the risk exposure so that the future losses can be reduced by applying appropriate risk management techniques.

Objectives of the Study

The above rationale and problem statement has given rise to the following specific objectives of this research paper:

1. To study and analyze price volatility and to identify the fundamental and technical factors affecting price of energy commodities;
2. To develop a price forecasting model for the energy generating commodities; and
3. To suggest relevant risk mitigating strategies for the stakeholders.

Research Methodology

The present research work is on the analysis of price volatility of crude oil, natural gas and coal. Besides doing an intense literature review, the secondary data i.e., prices of the selected energy commodities viz. crude oil, coal and natural gas has been collected and tabulated. For this purpose, data for a period from 1983 to 2011 has been considered. Other relevant information has been collected from various authentic sources like relevant books, national and international websites, reports of Petroleum and Natural Gas Regulatory Board. (PNGRB) etc. For the purpose of analysis, statistical tools like standard deviation, regression and correlation and technical analysis tools like Average True Range (ATR) has been used to accomplish the objectives mentioned above.

The proposed research papers makes an attempt to determine the price trend of energy commodities and at the same time analyze the inter commodity price relationship amongst crude oil, coal and natural gas to develop a model of price forecasting.

Price Volatility in Crude oil

The price volatility in the crude oil can be because of two factors one is the investor's sentiments

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and the other is known as fundamentals of crude oil. The first factor is investors sentiments which is the price effect when the investor is likely to invest or exit from the market. These investor's sentiments can be predicted by using the technical and statistical analysis. One of the tools is ATR (Average True Range).

ATR (Average True Range)

The average true range (ATR) determines Commodities volatility over a given period which is the tendency of a commodity to move, in either direction. More specifically, the average true range is the average of the true range for a given period. The true range is the greatest of the following:

- The difference betinvestorsen the current high and the current low
- The difference betinvestorsen the current high and the previous close
- The difference betinvestorsen the current low and the previous close

The ATR is mainly used to have stop loss or to exit from the trade while trading. Because investors expect that the commodity price will not move more than this level in a particular day. Other statistical method which can be of use is finding the Standard deviation from the expected price of the commodity.

Standard Deviation

Standard deviation is widely used in the measurement of variability or diversity preferred in statistics and probability theory. It shows how much variation is from the average. A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data are spread out over a large range of values. The second major factor is fundamentals of crude oil. The market players are sensitive about market news. Whenever there is a news in a market the market participants try to grab that opportunities and react accordingly but at the same time there are some big players who tried to trap the other players and move the market in a opposite direction and make their stop loss triggered and the others end up with the losses. So investors have to very careful while trading and finally market always moves in the way it should move. So investors have to analyze at what time and which side the market will move and accordingly investments can trade. For that purposes investors can actually see the market and past news as well as analyze how the market move in shorter duration and in the longer duration.

ATR calculation of the Crude oil

Time duration taken for long term is from March 1983 to March 2011.
The price data is on daily bases.
ATR from the **1983 to 2011** is = **0.8023385**

14 days ATR

Maximum ATR from **1983 to 2011** is= **3.74951683**

The 5 days ATR and 15 days ATR is commonly used ATR for trading activities. It is considered that the price in a particular day might move to this range and then will stop moving. But investors cannot assure that the price will not move more than that because the price is unpredictable and it can move further but chances of moving not more than this level is very less. The all time ATR or say ATR from 1983 to 2011 says that the average movement in a particular day is $0.8023385. But if there is adverse news then in that case the market may move more than this value so in this case investors can take more 5 days ATR or 15 days ATR to know the volatility in short term or can say current volatility in the market.
In this study there is calculation of 14 days ATR of all this time and it is possible to find that the max. Value of the ATR is $ 3.74951683. Means in the time duration of the 18 years the average movement of the crude was $ 3.74 and the average value is somewhere around the $ 3.5 In the calculation of the 5 days ATR investors find that the max Value is $ 5.738812. in this case investors can also take the 5 days ATR because it tells the current market volatility and if the volatility according to the 14 days and 5 days are approx. Same in this case it can be concluded that the market might move near to the ATR value but if both the ATR is not equal then investors can say that the market will move the higher value of the ATR.

Standard Deviation

Using excel sheets calculation of the Standard deviation of the same 18 years is being done and it is find that the values similar to the ATR which says the variables and the values which are calculated are somewhere correct. The term starts from January 2010 to March 2011. The analysis of the Standard Deviation says that in a particular year in a particular month the volatility is on an average is $ 2.45. It means the deviation in a month from the mean value is near about $2.5, in a particular trading day the commodity moves not more than this level. Further in a particular month the maximum volatility is $4.7 when there was adverse news in the market. On the bases of the analysis by ATR and Standard

deviation , the study concluded that in a particular trading day commodity did not move more than $ 2.5-$ 3.5. And if investors want to see the volatility in crude in a particular day than investors can calculate % day ATR, 14 day ATR and Standard Deviation and investors will get the value which will tell us that in that day what is the rage of the commodity and how much it may move.

Regression Analysis

It was found that crude oil prices exhibit a strong correlation with global oil demand with a correlation coefficient of 0.64 on a quarterly basis, while on an annual basis, it was found to be further higher at 0.83 indicating the long-term impact on prices taking into account the seasonal variation in demand.

The regression analysis indicates that global oil demand explains around 68.8 percent of the variation in crude oil prices. A one percent increase (decrease) in global oil demand shall result in an increase.

	Correlation	Coefficient	R^2	P-Value
Crude oil price as a function of global oil demand	0.829	1.498	0.688	0.0056

The regression analysis indicates that global oil throughput explains around 69.1 percent of the variation in crude oil prices. A one percent increase (decrease) in global oil throughput shall result in an increase (decrease) in crude oil prices by 11.556 percent.

	Correlation	Coefficient	R^2	P-Value
Crude oil price as a function of oil throughput	0.831	11.556	0.691	0.0021

	Correlation	Coefficient	R^2	P-Value
Crude oil price as a function of Dollar index	- 0.392	- 1.66	0.153	5.06 E-

The regression analysis indicates the Dollar index can explain 15.3 percent of variation in the Crude oil prices.

One percent increase (decrease) in dollar index shall result in a decrease (increase) in crude oil prices by 1.66 percent.

Volatility in Coal

Coal is another energy which is used from the past long time in the world for various purposes. Mainly Coal is used in Iron and Steel industry and Power generation. The change in the prices of coal affects the Industry which is actually backbone of the country as power sector.

ATR of COAL

Long term ATR for the Coal is = **$ 1.43655**
The 14 days ATR is = **$ 3.4563**
The 5 days ATR is = **$ 2.35646**

On the bases of the study it can be concluded that in the general condition of the market the price movement in a particular trading day is $ 1.5 which is the long term ATR. Further to know the current volatility, investors consider the 5 days ATR and 14 Days ATR which tells that now days the average movement in the coal prices are near about $ 2.6. So when investors trade in the coal investors can say that the expected movement will be near $ 2.5 - $ 3 after that the market will retrace or become side wave but if there is any news related to the Demand and Supply of the Coal then the prices will more than the ATR value.

Standard Deviation

SD is another tool to check the volatility in which investors can check the volatility and the price movement in a particular time duration investors are using the same for coal but as investors know that coal prices are mainly depend on the market fundamental factors so investors also have to consider the movement.
The long term 1 year standard deviation is = **$ 5.675741**

Month wise SD table

Month	Standard Deviation
April	1.89786
May	3.45644
June	2.45345
July	1.75532
August	3.372067
September	1.882181
October	1.438301
November	1.078546
December	2.139523
January	2.471605
February	3.152573
March	3.28046

On the bases of the analysis of the SD investors can say that volatility in the prices is from $ 2.1 to $ 3.1 which means in a particular month the movement of the commodity will be between these values. On the bases of the two of the analysis investors can consider the one day volatility of the coal could be $2.5, ATR and SD says that in a particular normal trading day when there is no news in the market the Coal prices will move up to the $ 2 to $ 3 and in case of the market news the Coal price can move up to $ 5 in a particular trading day.

Regression analysis of Coal and NG with Crude oil

Coal and Crude oil are highly correlated with 97% correlation. This means there is strong possibility that both the crude oil and coal will move in same direction and with same speed. R square and T statistics are very high which means that coal significantly represents the variation in the Crude oil prices. 1 unit move in the Coal will be followed by 0.68 unit move in the crude oil. Correlation of Natural gas and Crude oil is also very high (i.e. 89%). With high r square and t statistics which indicates strong association between the crude oil and natural gas.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.94							
R Square	0.88							
Adjusted R Square	0.88							
Standard Error	12.61							
Observations	251.00							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1.00	293864.61	293864.61	1846.63	0.00			
Residual	249.00	39624.71	159.14					
Total	250.00	333489.33						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-3.87	2.21	-1.75	0.08	-8.21	0.48	-8.21	0.48
Coal	0.68	0.02	42.97	0.00	0.65	0.71	0.65	0.71

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.92							
R Square	0.86							
Adjusted R Square	0.85							
Standard Error	13.93							
Observations	251.00							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1.00	285185.09	285185.09	1470.08	0.00			
Residual	249.00	48304.24	193.99					
Total	250.00	333489.33						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-10.42	2.63	-3.96	0.00	-15.61	-5.24	-15.61	-5.24
NG	11.86	0.31	38.34	0.00	11.25	12.47	11.25	12.47

Volatility in Coal:

The natural gas is less volatile then the Crude Oil because the Natural Gas market is not that much developed as the Crude Oil market. Natural Gas has correlation with Crude oil. If the prices of the crude oil will increase the prices of the Natural Gas will also increase.

ATR of NATURAL GAS:

All time average ATR is = **0.1498101**
Maximum value of the 14 days ATR = **0.64708**
Maximum value of the 5 days ATR = **1.0535879**

As the all time ATR is showing that the movement is around $ .15 which means in a general market the price of the Natural Gas moves either side of the market by $ .15. The 5 days ATR is showing the value of $ 1.06 that means according to the current market volatility and the time of the energy shocks the price of the Natural Gas may move up to the $ 1 so at the time of the important news in the market investors can expect the price will change up to $ 1 in one trading day. The 14 days ATR is showing the value of $ .65 that means in a particular trading day the maximum volatility was $.65. On the bases of the average of the last month 5 days and 14 days ATR the values are near about the $ .15.

Standard Deviation:

For the long term period, the daily prices from April 1990 to March 2011 and the SD of this period is $ 2.7. On the bases of the analysis it can be concluded that according to the SD the movement in the price or say volatility of the price of Natural Gas was $ 2.7 Now if investors look at the SD on month bases then investors find that the average SD for the Natural Gas is $ .25 so investors can say that the average movement in the Natural Gas in a particular trading day is $.25-$.30,

Now if analyze both the values ATR and the SD then investors will find that the volatility of the Natural Gas is $.15 - $.25, and in case of adverse condition or big market news the market can move up to $ 1.

Relation between Crude Oil and Natural Gas Prices:

The availability of natural gas supplies act as a demand dampener for crude oil in the form of competition for residual crude oil in electricity generation and with distillate crude's for space heating applications. Thus, there stands a relationship between the prices of natural gas and crude oil. Despite the substitution effect of natural gas prices on crude oil prices, prices are found to have a positive correlation to the tune of 82 percent on account of differences in seasonal demand patterns which govern both the commodities.

	Correlation	Coefficient	R^2	P-Value
Crude oil prices as a function of Daily natural gas prices	0.819	0.695	0.671	0
Crude oil prices as a function of Monthly natural gas prices	0.824	0.699	0.679	0.0291

The regression analysis indicates the impact of natural gas prices on crude oil prices to an extent of explaining 67 percent of the movement in crude oil prices. However, with the products being inter-dependent, it cannot be completely said that it is natural gas price that dictates crude oil prices rather both the product complement each other.

Conclusion

Energy commodities play an important role in the economy. Small change in the price of these commodities leads to big losses to the consumers and having large impact on economy. In the research, effort has been made to find the factors affecting the price and the movement of the price in a particular day. The study finds that in a particular trading day in normal condition the prices of crude oil moves between $ 2- $ 3.5 and if there is any news in the market which affect the market sentiments, it may become more volatile and move according to the news in the market. The factors which are affecting the crude oil prices are : US crude and product demand, crude and product inventories, crude oil and product imports, refinery production of crude oil and products etc, weather conditions, natural gas prices, trend in other global markets, currency movements and political/geopolitical issues . Natural Gas market is developing currently and the demand is increasing continuously. In the study it is found that in general conditions it moves between $.15- $ .25 and in adverse condition it can move up to $1. Natural gas has a very good correlation with crude oil. Crude oil and the demand in power sector and transportation sector influence the price of natural gas.

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Coal is another prominent commodity used mainly in the power generation so the industrial demand and the demand in the power sector influences the price of coal. Coal is not traded in exchanges , it is traded in OTC market. Analysis says that the movement in the price of coal is between $ 2- $ 3 and with the other market condition it can be reach up to $5.5.

Coal and Crude oil are highly correlated with 97% correlation. Correlation of Natural gas and Crude oil is 89% which is very high.

There are yet other factors which are affecting the prices such as the correlation between the commodities and the effect of the change in the price currency value in which the commodity trade.

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