ISSN (Print Version) 0975-3931
ISSN (On Line Version) 2278-1277

Development of Optimum Portfolio for Investment in Oil & Gas Sector (Investor's View)

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Introduction

Energy is the primary requirement to sustain development. With rapid development activities concentrated in China, India and Asian countries the demand for energy is also growing faster in these countries compared to the average growth of energy demand of the world. 80% of the growth of global output is concentrated in developing economies, with China and India has accounted for half of the growth. Arising trade dispute of China and other nations (specially US) there may be a shift of growth of industrial production towards India. Rising prosperity and improving living standard in China and India is acting as a support to growth of per capita energy consumption in these countries. According to BP's Energy Outlook 2019 by mid-20s India will surpass China as the largest growth driver of energy in the world with whooping more than quarter of the total growth of energy demand. LNG import is also highest in Asia. Shifts in the pattern of import in Asia has put India and China clear of more established markets in Japan and Korea. Asian countries have also driven most of the growth in Renewable sector with more than 50% share of the total renewable energy growth across the globe. In a country like India there is huge potential in the energy sector as the country is still not fully penetrated with energy. India is the 3rd largest oil and energy consumer. Oil and gas had a share of approx. 35% of the total energy consumption in the country in the year 2017. In India the demand for petroleum product is expected to grow as high as 244,960 MT by 2021-22.

Selecting good companies to invest and earn more than average return by considering the trade-off between risk and return is a critical task. A rational investor always looks to maximize return and minimize risk while constructing portfolio. To maximize return and minimize risk investors generally pool assets and invest on them. These pools of assets are called portfolio. An investment portfolio consists of divisions of varying size representing variety of asset classes of investment to obtain

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optimum/expected risk -return portfolio allocation. A portfolio can be constructed by using different types of securities, but cash, bonds and securities are generally the building blocks of portfolio. Transaction of shares are done and monitored by stock exchange. India is the home of the first(oldest) stock exchange in Asia (Bombay Stock Exchange, ESTD:1875).

Creating a portfolio of investment restricts the damage of well-being in case if one of the assets goes for a tailspin. In today's global financial conditions, a well-maintained portfolio is vital for success of any investor. Advantages of investing in share are: (a) capital growth, (b) dividends, (c) liquidity, (d) limited liability, (e) better control on finance, (f) miscellaneous benefits. All of these advantages also comes with some associated baggage of disadvantages. Some of the disadvantages are: (a) High risk, (b) fluctuation in market price.

Problem Statement

With establishment of International Solar Alliance in New Delhi and due to the push given to renewable energy by the current government India has opened new dimension for innovation, investment and industry. This government has made a significant effort to push India's renewable energy ambition. Due to this push India is now the 4th largest wind power producer in the world only behind of China, USA & Germany. India has made record addition to the solar power capacity in last 5 years. Although the recently concluded Financial Year (FY19) has shown a dip in installation of solar power with only 6500MW installed in the year. With this trend in the country the researchers are focusing on the scenario of renewable energy in India. So, the papers which are recently made available in the public domain are concerned with the current scenario. The surge in renewable energy is a good sign for the nation as renewable is the future. Though the rising demand of the fastest growing economy of the world can't be satisfied with this growth in renewable energy. In simply words, the growth of the renewable energy is not enough to sustain the growth of the Indian economy. This statement is supported by the growing dependence of India on imported crude oil. Dependence of imported crude oil has gone up to 83.7% in Financial Year 19 from 82% in FY18. Hence, it can be said that the oil and gas sector is not getting the deserved focus.

There is no such buzz with the oil and gas sector in India. Though in recent months there was a news of a proposed biggest refinery of the world in Ratnagiri in India. ADNOC and all the big refiners (PSUs) has shown their interest to invest. Development of the 2nd strategic reserve was also in news in recent months. ADNOC is also investing in this project. These means there is huge opportunity in the oil and gas sector. Hence the problem statement for this paper;

To find out a single combination of stocks in oil and gas sector with lowest volatility in returns.

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Literature Review

Asset valuation models are used to describing the relationship between risk & return for a given investment is generally used to support investment decision making. Fluctuation of price is one of the most common characteristics in Energy commodities and derivatives. Commodity and Derivatives Markets of energy commodities is important for financial market and investors. These markets play a crucial role in related risk-sharing processes. Therefore, a new asset class consisting of energy commodities has emerged. This asset class is used for diversification, hedging or speculation of prospects (de Roon, 2000). Stock markets across the world feel the heat of fluctuation of prices of crude oil and natural gas. Energy market dynamics has effects on these stock markets. As a result, crude oil and natural gas assets are becoming vital assets to play a diversifying role in portfolios.

Three-dimensional dependence structure in US among stock, crude and natural gas markets from January 1997 to January 2013 is studied by the author (Gatfaoui, 2016). Three markets depict structural changes over time is highlighted in her findings. So that Crude oil, natural gas and US stock markets returns display alternating periods of high, medium and low variance. As a result of this multiple variation in returns the multivariate structure is time varying in nature and exhibits regime switches. So, this three-dimensional dependency nature of US crude oil, natural gas and stocks is explained by various copula functions across variance regimes. Thus, representative copula functions exhibit numerous tail dependences (i.e. switching of negative and positive correlation over time). Tail dependency is of high relevance to portfolio risk managers because it explains the dependence between the extreme returns of portfolio assets. For example, experts have shown that when "the three-dimensional dependence structure exhibits positive lower tail dependence, the extreme negative returns of all asset components are positively correlated". Hence, the risk mitigation measures can become ineffective and risk of loss is substantial.

Integration of stock and commodity markets is favoured by index commodity trading (Domanski, 2007); (Financialization, 2013); (commodities., 2012). It also imposes co-movement of commodity prices and stock prices. This pattern assists the reported price/return correlation between stock prices and commodity prices within the commodity asset class (Eckaus, 2008) (Falkowski, 2011.); (Karolyi, 2012); (Kilian, 2009). Though this reported relationship varies with time (Aloui, 2014.); (Brigida, 2014).

Prices of crude oil and natural gas are cointegrated, so, they exhibit equilibrium in long run though they depart in short term (Brigida, 2014); (Hartley, 2014); (Miller, 2009). In short term prices of these two do decouple whereas the couple in long term (Gatfaoui, 2016), (Brown, 2008) (Hartley, 2014). Hence, shocks which are oil specific need more time to influence gas prices. This feature creates room for potential market strategies on the commodity market. Therefore, involvement of crude oil and natural gas in portfolio investment makes sense. In this manner commodities can help to mitigate portfolio's risk.

Further benefits can be realized with involvement of commodities in investment portfolios, specifically when equity market depicts resilience and inflation is large. Commodity futures shows positive correlation with changes in both expected and unexpected inflation, whereas it portrays negative correlation with equity/bond returns (Zvi, 1980) (Gorton, 2006). Hence, commodities offer an edge while hedging against unexpected inflation (at least in longer period) because they are real asset (Greer, 2006) (Hensel, 1993). However, the benefits of diversification vary over time as mentioned previously. Effectiveness of the diversification is sensitive to disturbances of financial markets (i.e. stressed market times; (Büyükşahin, 2010). Business cycle also impacts such relationship (Chevallier J. I., 2013) (Chevallier J. G., 2014). For example, when the correlation between stocks and commodity markets are strong the diversification power disappears.

Financial crisis and the fall in commodity prices of 2008 has changed the economic outlook of the world. In this regard, India is expected to grow at least at 6.5% (CAGR) over the next 25 years and it has already surpassed the growth rate of china. This will increase demand and consumption of crude oil to support the growth. Report of IEA states that demand of oil in India is expected to grow at 4% per annum for upcoming 25 years compared to China's 1.2% growth per annum. Since India is putting efforts to transform itself to a manufacturing sector (Make in India campaign) from its service dominated nature, it is expected to become the biggest consumer of oil in the group of fastest growing economies replacing China. Adding to it, India depends 83% to imports of crude oil to meet its energy demand. The country spends USD 1.36 billion (INR 9126 crore) more per annum for every USD 1 increase in crude oil prices.

Furthermore, studies on oil prices so far have concentrated on economies as importers or exporters of crude oil. However, the impact of oil price changes on the economy in general, and stock markets in particular, depends on the economic policy initiatives related to oil price changes. As a result, fluctuation in oil prices is expected to impact the equity market and sectoral equity through the interest rate and inflation, that are the focus of the monetary policy of a country.

Adding to it, the features of the impact of oil price fluctuation changes on stock market return relies on the underlying cause of the price shock, such as demand or supply related shocks (Hamilton, 2009a) (Hamilton J. , 2009b) (Kilian, 2009). Shocks in demand or supply of oil translates in to the price of crude oil. For example, Decision by OPEC to cut production influenced oil price to jump by 10% (The Economic Times, 02/12/2016). This is an example of supply shock with a positive impact on prices. Further, these shocks are not regular in nature. Hence, this characteristics of oil prices may be described as tail risk of oil price fluctuation, which is also empirically confirmed in the case of the four regional developed country stock markets (Mensi, 2017a) (Mensi W. H., 2017b). Positive shocks in oil price results in decrease in supply side of oil or increase in demand. Similarly, negative oil price shocks mean oversupply of oil or shrinking demand of oil. The resulting magnitude of impact on stock markets depend

on the magnitude of fluctuation in the oil price (Gogineni, 2010). Supply and demand side shocks are negatively related to stock market whereas impact of demand on these shocks is positive in totality (Kilian, 2009) (Lippi, 2012).

The equity market is considered as the marker/barometer of the economy as stock price portrays all type of risks, including oil price risks related to fluctuations (Aloui C. N., 2012.). This is the reason for studies focusing on the impact of oil price changes on equity market.

Most of the studies found, has tried to study to identify the causes of the impact of oil prices on stock markets. All of them attributed the impact to one of the two factors. First, whether the particular country under scanner is a net exporter or importer of oil. Second, whether the price shocks are supply driven or demand driven. As a result of the first factor, adverse impacts of oil shocks are expected to reflected in countries which are net importer of oil (Arouri, 2010) (Park, 2008.) (Sadorsky, 1999.). However, (Aloui C. N., 2012.) has studied emerging nations, including India and was unable to find any substantial of conditional or unconditional impacts on equity market returns of countries which are net importer of oil.

Furthermore, countries exporting oil reported experiencing significant positive impacts of oil changes on equity markets (Aloui C. N., 2012.) (Jammazi, 2012b.) (Jiménez-Rodríguez, 2005.). The studies of second set focuses on whether oil price shocks are demand or supply driven as it is the characteristics of the oil price shocks that have effects stock markets (Jammazi, 2012b.) (Kilian, 2009) (Filis, 2011.). Precautionary demand shocks, that reflect a scarcity of future oil supply, have a negative impact on stock markets. Aggregate demand shocks reflect the unexpected fluctuation in demand of oil, corresponding to a change in future economic activities that have a positive effect on equity markets. However, shocks on supply side results in increase or decrease in the supply of oil don't have any significant impact on equity markets. In a recent news article in The Economic Times, it was reported that "the Indian stock market reacted quite negatively to decisions by OPEC countries and Russia to cut crude oil supply". However, opposing to the literature described above, the oil price impact on equity markets is not fixed; it varies with time (Filis, 2011.) (Jammazi, 2012b.) (Jammazi R. A., 2010.). Further, (Martín-Barragán, 2015.) study also shows that no correlation between equity market returns and oil price in stable conditions. But, this correlation between oil price and stock market changes during both financial and oil shocks.

Studies concerned with Indian context, some of them examine the relationship between equity markets at the aggregate level and the fluctuation of oil price. did not find any correlation between Indian stock market and international oil prices, but they observed effects of crude oil price fluctuation in to the equity market. (Singhal, 2016.) did not find any notable volatility spillovers from the international crude oil price to Indian equity market. Although in sectoral equity they reported spillovers in 3 sectors namely, automotive, power and financial sector out of the 10 studied sectors. Adding to

it, persistent co movement is observed between fluctuation of oil price and all the 10 sectoral equity index. During normal market conditions, fluctuation in oil price does not show any affect the following sectors: FMCG, Energy, CD. This is obtained through the aggregate impact of oil price fluctuations, as well as for both positive and negative fluctuation of oil price (Faff, 1999.).

Periods in which oil prices influence sectoral equity returns are important for portfolio managers, risk managers and investors. Reason is the time period of fluctuation of oil price decides that whether the impact of oil price will result in permanent shift or temporary shifts in the link with sectoral equity. The permanent (low frequency) components are the components of inter dependency, and the temporary shifts in the link is characterized as contagion effect of causality in short duration(high frequency) (Bodart, 2009.) (Gallegati, 2012.) (Martín-Barragán, 2015.).

Report by (The Economist, 2016. Oil Companies: In the Dark Ages., February 6, 2016.)The suggests that oil and gas companies experienced "dark ages" recently with significant cuts in cost of capital spending and job cuts. Adding to it, the recent downtrend in oil prices also caused a spillover impact on countries and sectors relying on oil and commodities related to oil (Husain, 2015.) (IMF, 2015. Spillover Report., 2015). To that end, the study has investigated the volatility spillovers and co-movement of volatile oil prices and major oil and gas companies stock prices over the period of 18th June 2001 to 1st February 2016.

(Nikolaos Antonakakis a, 2018) 501studies concentrated on the US equity market has found notable spillover effects between oil price ant equity market fluctuations.

In particular, (Ewing, 2016.) analyzed the dynamics of volatility of oil prices and S&P500 index from July 1, 1996 to June 30, 2013. They used daily returns of the mentioned time period and had taken account of endogenously determined structural breaks. Result of their study has suggested presence of significant direct & indirect volatilities between US equity market and oil price. In addition, (Phan, 2016.) has investigated the price volatility interaction between US equity market & crude oil (i.e., the E-mini S&P500 index futures and the E-mini NASDAQ index futures) using 5 minutes data from 2 January 2009 to 31st December 2012. There results have shown a positive contemporaneous relation between spread of bid-ask rate, price volatility & trade volume. Other studies have considered multiple major equity markets. For instance, (Khalfaoui, 2015.), has examined spillovers of oil and equity prices of the G7 equity market using daily data from June 2 2003 to February 7, 2012. Their result has shown significant evidence of strong volatility spill overs between oil prices and equity market volatility. In a recent study, (Maghyereh, 2017.) has investigated the connectedness between volatility related to oil and equity indices' in eleven major stock markets (i.e., Germany, Switzerland, South Africa, US, India, Japan, UK, Mexico, South Africa, Russia and Sweden) using daily observations from 3rd March 2008 to 3rd February 2015.

(Boldanov, 2016.) has also found that the relationship between oil and equity market volatilities varies upon time, although have reported intensified correlations during the final crisis, 2007-09. More importantly they have reported heterogeneity in the correlations between oil importing & oil exporting nations. For instance, (Malik, 2009.), has examined transmission of volatility and shocks between oil prices and five major sectors of US economy (i.e., industrials, financials, health care, technology and consumer behavior) using weekly data from January 1, 1992 to April 30, 2008. Their findings have provided presence of significant transmission between oil market and some of the mentioned sectors.

(Sadorsky P. , 2012), has analyzed the volatility spillovers between US equity prices of clean energy companies, technology companies and oil price by using daily data from 1st January 2001 to 31st December 2010. He has employed various GARCH models (I.e., Constant Conditional Correlation (CCC), DCC and BEKK) and shown that the equity prices of clean energy companies have more high correlation with technology stock price volatility has with oil price fluctuations.

Research Gap

Sl No.	Title	Author	Findings	Gap in Literature
1.	How can upstream oil and gas companies build a fit-for-the-future portfolio?	Deloitte (2018)	After the down turn of oil prices (2014-17) oil and gas companies has tried to protect and transform their portfolios but they are yet to receive any significant reward for that. 73% of the upstream company's stock price has failed to grow with the rise in price since January 2017. Lake of in line growth of equity price shows the weakness in financial results. This indicates that oil and gas companies need to revisit their portfolio.	Report provides insights only on top notch upstream oil and gas companies.
2.	Value of investment: Evidence from the oil and gas industry	Amir H. Sabet, Mahmoud Agha, Richard Heaney (December 2017)	Market reacts positively in both in investment and divesture announcements on an average. There is also an evidence of greater returns to smaller firms. Market reaction to divesture in non-conventional oil and gas resources is much greater compared to conventional resources	Paper concentrates on small oil and gas companies of US. The study considers US market only.

3.	Impact of oil price risk on sectoral equity markets: Implications on portfolio management	Aviral Kumar Tiwari, Sangram Keshari Jena, Amarnath Mitra, Seong-Min Yoon	Energy and IT industries react positively to decline in oil prices in a bull market.	
4.	Risk factors in oil and gas industry returns: International evidence	Sofia B. Ramos, Helena Veiga (November 2010)	Oil price hikes impacts the industry return more compared to price drops. This effect is stronger for developed countries.	Study is focused on developed countries and does not take developing countries in consideration.
5.	What determines investment in Oil & Gas Sector	Lyudmyla Hvozdyk, Valerie Mercer-Blackman (August 2010)	Increased tax rate reduces the eagerness to invest in oil and gas. International oil companies invest heavily with political and financial support from the government and are less sensitive to higher cost.	Study focuses on those National Oil companies which have international presence. Study is Gulf country centric most of the time.
6.	Hedging pressures effects in futures markets. Variable metric method for minimization.	F. de Roon, T. Nijman, Veld (2000)	Asset valuation models are used to describing the relationship between risk & return for a given investment is generally used to support investment decision making. Fluctuation of price is one of the most common characteristics in Energy commodities and derivatives. Commodity and Derivatives Markets of energy commodities is important for financial market and investors. These markets play a crucial role in related risk-sharing processes. Therefore, a new asset class consisting of energy commodities has emerged. This asset class is used for diversification, hedging or speculation of prospects. Stock markets across the world feel the heat of fluctuation of prices of crude oil and natural gas. Energy market dynamics has effects on these stock markets. As a result, crude oil	This paper does not consider Indian stock market and has no information specific to India.

			and natural gas assets are becoming vital assets to play a diversifying role in portfolios.	
7.	Linking of the oil and gas markets with the stock market: investigating the US relationship.	H. Gatfaoui (2016).	Three-dimensional dependence structure in US among stock, crude and natural gas markets from January 1997 to January 2013 is studied by the author. Three markets depict structural changes over time is highlighted in her findings. So that Crude oil, natural gas and US stock markets returns display alternating periods of high, medium and low variance. As a result of this multiple variation in returns the multivariate structure is time varying in nature and exhibits regime switches. So, this three-dimensional dependency nature of US crude oil, natural gas and stocks is explained by various copula functions across variance regimes.	US centric study. Hardly provides information about any other country.
8.	Assesing the impacts of oil price fluctuations on stock returns in emerging markets.	C. N. Aloui, D.K Nguyen, H. Njeh, (2012.)	Other than the magnitude of impacts of oil shocks across market conditions, it is also required for stakeholders to understand the nature and characteristics of the impact at different time horizon. The spontaneous impact of oil price shocks on stock prices happens via the cash flows of the organizations related to oil and gas. Although, the hit on stock market prices is felt in long run through economic variables, such as interest rates and inflation because higher price of oil tends worsen inflationary condition in the economy. Inflation positively effects nominal interest rates; the interest rate is a discounting factor in	Study discusses time varying effect of oil shocks but does not give any insights to invest in oil and gas investment.

			stock price determination; this is how oil price changes impact stock price in long run. The equity market is considered as the marker/barometer of the economy as stock price portrays all type of risks, including oil price risks related to fluctuations. This is the reason for studies focusing on the impact of oil price changes on equity market.	
9.	Assesing the effects of crude oil shocks on stock market returns	R. A. Jammazi (2010.)	Countries exporting oil reported experiencing significant positive impacts of oil changes on equity markets. The studies of second set focuses on whether oil price shocks are demand or supply driven as it is the characteristics of the oil price shocks that have effects stock markets. Precautionary demand shocks, that reflect a scarcity of future oil supply, have a negative impact on stock markets. Aggregate demand shocks reflect the unexpected fluctuation in demand of oil, corresponding to a change in future economic activities that have a positive effect on equity markets. However, shocks on supply side results in increase or decrease in the supply of oil don't have any significant impact on equity markets.	Paper gives information on effects of demand shock on economies and stock market as well. No further scope for investment in the industry is discussed.
10.	Oil price shock and real GDP growth: Emperical evidence for some OECD countries.	R. Jiménez-Rodríguez, M .Sánchez (2005).	Oil price impact on equity markets is not fixed; it varies with time study also shows that no correlation between equity market returns and oil price in stable conditions. But, this correlation between oil price and stock market	Study is focused on OECD countries only. Relation of market equity returns with oil price has been analysed in the study.

			changes during both financial and oil shocks.	
11.	Returns and volatility linkage between international crude oil price, metal and other indices in India: evidence from VAR-DC-GARCH	S. G. Singhal, S. Ghosh, (2016.).	In Indian context the author did not find any correlation between Indian stock market and international oil prices, but they observed effects of crude oil price fluctuation in to the equity market. did not find any notable volatility spillovers from the international crude oil price to Indian equity market. Although in sectoral equity they reported spillovers in 3 sectors namely, automotive, power and financial sector out of the 10 studied sectors. Adding to it, persistent co movement is observed between fluctuation of oil price and all the 10 sectoral equity indices. During normal market conditions, fluctuation in oil price does not show any affect the following sectors: FMCG, Energy, CD. This is obtained through the aggregate impact of oil price fluctuations, as well as for both positive and negative fluctuation of oil price.	Study is concentrated on Oil, metal and other industries combinedly.
12.	Evidence of interdependence and contagion using a frequency domain framework	V. C. Bodart, B. Candelon, (2009.)	Periods in which oil prices influence sectoral equity returns are important for portfolio managers, risk managers and investors. Reason is the time period of fluctuation of oil price decides that whether the impact of oil price will result in permanent shift or temporary shifts in the link with sectoral equity. The permanent (low frequency) components are the components of inter dependency, and the temporary shifts in the link is characterized as contagion	No framework for investment is suggested in the study.

			effect of causality in short duration (high frequency).	
13.	Time varying correlation between oil and stock market volatilities: evidence from oil-importing and oil-exporting countries.	R. Boldanov, S. Degiannakis, G. Fills (2016.)	Author has also found that the relationship between oil and equity market volatilities varies upon time, although have reported intensified correlations during the final crisis, 2007-09. More importantly they have reported heterogeneity in the correlations between oil importing & oil exporting nations.	Study focuses only on time varying relation of the stock market and volatilities.
14.	Oil volatility, oil and gas firms and portfolio diversification.	Nikolaos Antonakakis, Juncal Cunado, George Fillis, David Gabauera (2018)	Findings indicate an increasing pattern of volatility spillover index since 2005, before it had reached a peak towards the end of the financial crisis, 2007-09. The study also suggested that the spillover effects did not fade out instantaneously after end of the financial crisis, it raised until mid- 2010 instead. A reasonable causal explanation of such continuation has been found in the successive events that followed the 2007-09 financial crisis which created uncertainty in the oil market. The biggest event of all the events that had occurred was Deepwater Horizon oil spill in Gulf of Mexico in April 2010, caused by a BP's oil rig. In addition, high spillover effects of 75% has also been noticed during the period between mid-2011 to until 2014, before it had collapsed below 40% at the end of 2014. These effects have reflected the uncertainty in the market due to the Arab Spring in 2011, turbulence in Bahrain and unrest in Libyan politics, Yemen and Egypt, Syrian civil war in the post	The study focuses on big accidents and shocks of oil industry and effects of these events on equity market. The study is type of crude oil specific (WTI).

			2011 period as well. Furthermore, since 2015, when oil prices remain around $50, a third phase of increased spillover effects were inevitable. Study also has found that the collapse of the oil price in 2014-15, volatility spillover reached very low. The study also has found significant net increase in transmission of volatility spillovers towards WTI during the post financial crisis period. This is an indication of the fact that the firm level volatility is not dictated by oil price volatility, but the reverse. Such finding was not in accordance with the majority of the papers that mainly suggests that oil market influences and has an impact on equity market. Authors have also detected that the volatility transmission from the France Equity market to WTI oil market is bidirectional at both mid and long term horizons.	
15.	The directional volatility connectedness between crude oil and equity markets: new evidence from implied volatility indexes.	A.I. Maghyereh, B. Awartani, E.Bouri (2017)	Authors has shown that transmission of between equity implied volatilities and oil implied volatilities is bi-directional and asymmetric.	Paper does not give any insights on investment framework. It only discusses about the volatility.

All the reports and the papers reviewed describes diversification of portfolio across various sector. None of the reports or papers suggest any method or model to invest particularly in oil and gas sector. Available reports or research paper on the public domain mainly focuses on companies of Russia, US and China. There are also papers

on countries of OPEC. Papers on these countries discuss about their political powers and history that has affected the oil and gas market on a global scale. Very few available papers on India and Indian companies generally talk of Indian energy mix.

With establishment of International Solar Alliance in New Delhi and due to the push given to renewable energy by the current government India has opened new dimension for innovation, investment and industry. This government has made a significant effort to push India's renewable energy ambition. Due to this push India is now the 4th largest wind power producer in the world only behind of China, USA & Germany. India has made record addition to the solar power capacity in last 5 years. Although the recently concluded Financial Year (FY19) has shown a dip in installation of solar power with only 6500MW installed in the year. With this trend in the country the researchers are focusing on the scenario of renewable energy in India. So, the papers which are recently made available in the public domain are concerned with the current scenario. The surge in renewable energy is a good sign for the nation as renewable is the future. Though the rising demand of the fastest growing economy of the world can't be satisfied with this growth in renewable energy. In simply words, the growth of the renewable energy is not enough to sustain the growth of the Indian economy. This statement is supported by the growing dependence of India on imported crude oil. Dependence of imported crude oil has gone up to 83.7% in Financial Year 19 from 82% in FY18. Hence, it can be said that the oil and gas sector is not getting the required focus.

Statistics discussed above ascertains that there is still a huge role to play for the oil and gas companies in India. With expected role in the energy mix of India the industry will see much investment in future. Hence, there is a gap in both studies related to investment by the oil and gas companies in India and investment in sectoral equity in oil and gas in India.

Research Question

How to design a portfolio for investment in oil and gas sector in India using Markowitz Model?

Research Objective

The study has been conducted to construct an optimum portfolio of oil and gas companies using Markowitz Model. The study has been conducted on individual securities listed in Bombay Stock Exchange (BSE). The objectives of this study are:

a) Risk and return analysis of individual securities of oil and gas companies in India listed with BSE.
b) To identify the opportunities of investment in oil and gas companies and development of an optimum portfolio for investment in these companies.
c) To construct optimal portfolio using Markowitz Model.
d) Whether Markowitz Model performs well in Oil and gas companies well in BSE or not.

ISSN (Print Version) 0975-3931
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Research Methodology

The research conducted in the study is exploratory research. This type of research is used to investigate a problem which is not defined clearly. Though exploratory research is conducted to have a better understanding of a prevailing problem. It is conducted to have a better understanding of the existing problem it does not give any conclusive results. In case of an exploratory research, a researcher starts with a general idea and uses this research to identify problems. These problems may turn out to be topics of further research in future. This research methodology can be used in both primary and secondary research. In this study the research type is exploratory secondary research.

Data analysis:

Data collected for this research were taken from internet. Data of equity prices of 10 companies related to oil and gas in India is taken from the official website of Bombay stock exchange. The index data is also taken from the same website. Time period for which the data is taken is January 1, 2014 to January 31, 2019. The 11 companies considered for this study are: Indian Oil Corporation Limited, Oil and Natural Gas Corporation, Hindustan Petroleum Corporation Limited, Bharat Petroleum Corporation Limited, Gas Authority of India Limited, Oil India Limited, PETRONETLNG, Gujrat State Petronet Limited, Indaprastha Gas Limited, Hindustan Oil exploration Company Limited, Jindal Drilling Industries.

Systematic risk, unsystematic risk and total risk for all the 11 companies are calculated. Once risks are calculated then weightages for investments are assigned to 5 companies according to their risk for application of Markowitz model of portfolio development. The result obtained from the application of Markowitz portfolio theory is discussed in the later stages of this report.

Summary Table

All the data regarding the stock market of IOCL, HPCL, BPCL, Jindal Drilling, ONGC, PETRONETLNG, GSPL, IGL, Oil India, GAIL, Hindustan Oil exploration Company Limited is taken and their risk and return is calculated thoroughly. After that all the companies were ranked according to their respective risks.

Systematic Risk = β^2 * Variance of the market

Unsystematic Risk = Variance of Security - Systematic Risk

Security Return= [Security market value at $(n+1)_{th}$ day – Security market value of n_{th} day]

÷ (Security market value of n_{th} day)

Market Return= [Market Index value at $(n+1)_{th}$ day – Market Index value of n_{th} day]

÷ (Security market value of n_{th} day)

Markowitz Model:

ISSN (Print Version) 0975-3931
ISSN (On Line Version) 2278-1277

Dr. Harry M.Markowitz is credited with developing the first modern portfolio analysis model since the basic elements of portfolio theory emanate from a series of propositions concerning rational investor behaviour set forth by Markowitz, then of the Rand Corporation, in 1952, and later in a more complete monograph sponsored by Cowles Foundation. A portfolio is efficient when it is expected to yield the highest return for the level of risk accepted or, alternatively, the smallest portfolio risk for a specified level of expected return. To build an efficient portfolio an expected return level is chosen, and assets are substituted until the portfolio combination with the smallest variation variance at the return level is found. As this process is repeated for the other expected returns, set of efficient portfolios is generated.

Company	Beta(β)	Alpha(α)	Deviation of Security	Variance of BSE	Systematic Risk	Unsystematic Risk	Total Risk	Rank	Weight
IGL	0.750	0.114	1.814	0.697	0.392	2.897	3.289	1	0.30
PETRONETLNG	0.734	0.087	1.859	0.697	0.376	3.081	3.457	2	0.25
GSPL	0.608	0.077	2.000	0.697	0.258	3.743	4.001	3	0.20
ONGC	1.085	-0.085	2.039	0.697	0.820	3.338	4.158	4	0.15
BPCL	1.010	0.062	2.093	0.697	0.711	3.671	4.382	5	0.10
GAIL	0.892	0.024	2.136	0.697	0.555	4.006	4.561	6	0
OIL INDIA	0.611	0.032	2.325	0.697	0.260	5.143	5.403	7	0
HPCL	1.179	0.096	2.525	0.697	0.970	5.406	6.375	8	0
Jindal Drilling	1.195	-0.065	2.993	0.697	0.995	7.961	8.957	9	0
HOECL	1.626	0.059	3.363	0.697	1.844	9.469	11.313	10	0
IOCL	0.851	0.098	3.729	0.697	0.504	13.400	13.904	11	0

Table: Systematic risk, unsystematic risk, deviation of securities and variance of BSE

Formulae:

Let us consider a portfolio P consisting of n number of securities (i.e. $S_1,S_2\ldots\ldots\ldots\ldots S_n$). In this porfolio all the securities are weighted in a percentage basis (i.e. $x_1,x_2\ldots\ldots\ldots\ldots x_n$) such some of the weightage equals to 1. In addition, let μ_i be the expected return on investment investment on a percentage basis of i^{th} security. Then μ_p is the expected return of a portfolio, is equal to the weighted sum of expected return of each security, given by the following equation:

$$\mu_p = \sum_{i=1}^{n} x_i \mu_i .$$

The measure of the risk associated with i^{th} security is the variance of the return of the security, σ_i^2. The variance of the portfolio is

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$$\sigma^2 = \sum_{i=1}^{n} x_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j<i} x_i x_j \mathrm{Cov}(i,j)$$

Where Cov(i,j) is the measure of correlation, is the covariance between the i^{th} and j^{th} securities.

In this case we are constructing a portfolio of the best 5 companies in oil and gas sector of India.

In this case, $\boldsymbol{\sigma_P^2 = [}W_a^2\,\sigma_a^2 + W_b^2\,\sigma_b^2 + W_c^2\,\sigma_c^2 + W_d^2\,\sigma_d^2 + W_e^2\,\sigma_e^2 + 2W_aW_b\sigma_a\sigma_b\mathrm{Cov}(a,b) + 2W_aW_c\sigma_a\sigma_c\mathrm{Cov}(a,c) + 2W_aW_d\sigma_a\sigma_d\mathrm{Cov}(a,d) + 2W_aW_e\sigma_a\sigma_e\mathrm{Cov}(a,e) + 2W_bW_c\sigma_b\sigma_c\mathrm{Cov}(b,c) + 2W_bW_d\sigma_b\sigma_d\mathrm{Cov}(b,d) + 2W_bW_e\sigma_b\sigma_e\mathrm{Cov}(b,e) + 2W_cW_d\sigma_c\sigma_d\mathrm{Cov}(c,d) + 2W_cW_e\sigma_c\sigma_e\mathrm{Cov}(c,e) + 2W_dW_e\sigma_d\sigma_e\mathrm{Cov}(d,e)\boldsymbol{]^{(1/2)}}$

Where,

a= Securities of **IGL**

b= Securities of **PETRONETLNG**

c= Securities of **GSPL**

d= Securities of **ONGC**

e= Securities of **BPCL**

$\boldsymbol{W_a}$**=** Weightage **(30%)** assigned to the security with **lowest risk (IGL)**

$\boldsymbol{W_b}$**=** Weightage **(25%)** assigned to the security with **2nd lowest risk (PETRONETLNG)**

$\boldsymbol{W_c}$**=** Weightage **(20%)** assigned to the security with **3rd lowest risk (GSPL)**

$\boldsymbol{W_d}$**=** Weightage **(15%)** assigned to the security with **4th lowest risk (ONGC)**

$\boldsymbol{W_e}$**=** Weightage **(10%)** assigned to the security with **5thlowest risk (BPCL)**

$\boldsymbol{\sigma_a}$**=** Standard deviation of return of the security with **lowest risk (IGL)**

$\boldsymbol{\sigma_b}$**=** Standard deviation of return of the security with **2nd lowest risk (PETRONETLNG)**

$\boldsymbol{\sigma_c}$**=** Standard deviation of return of the security with **3rd lowest risk (GSPL)**

$\boldsymbol{\sigma_d}$**=** Standard deviation of return of the security with **4th lowest risk (ONGC)**

$\boldsymbol{\sigma_e}$**=** Standard deviation of return of the security with **5th lowest risk (BPCL)**

Cov(a,b)= Covariance of returns of security **a** & **b (IGL & PETRONETLNG)**

Cov(a,c)= Covariance of returns of security **a** & **c (IGL & GSPL)**

Cov(a,d)= Covariance of returns of security **a** & **d (IGL & ONGC)**

Cov(a,e)= Covariance of returns of security **a** & **e (IGL & BPCL)**

Cov(b,c)= Covariance of returns of security **b** & **c (PETRONETLNG & GSPL)**

Cov(b,d)= Covariance of returns of security **b** & **d (PETRONETLNG & ONGC)**

Cov(b,e)= Covariance of returns of security **b** & **e (PETRONETLNG & BPCL)**

Cov(c,d)= Covariance of returns of security **c** & **d (GSPL & ONGC)**

Cov(c,e)= Covariance of returns of security **c** & **e (GSPL & BPCL)**

Cov(d,e)= Covariance of returns of security **d** & **e (ONGC & BPCL)**

Covariance	IGL	PETRONETLNG	GSPL	ONGC	BPCL
IGL	0.032889041				
PETRONETLNG	0.011869062	0.034570033			
GSPL	0.009598456	0.009052204	0.040011006		
ONGC	0.006208919	0.007697447	0.006945331	0.04158403	
BPCL	0.009544188	0.009576699	0.007412655	0.013955535	0.043820117

Table: Covariance table of the top 5 companies

Company	Returns	Std. Deviation	Weightage
IGL (a)	0.149086675	1.813533592	0.3
PETRONETLNG (b)	0.121650392	1.859301832	0.25
GSPL (c)	0.106102828	2.000275133	0.2
ONGC (d)	-0.03462261	2.039216278	0.15

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BPCL (e)	0.109402179	2.093325511	0.1

Table : Company wise returns, standard deviation & weightage of investment

$\mathbf{W_a^2\,\sigma_a^2 = 2*(0.3)^2*(1.813533592)^2 = 0.296001}$

Similarly, $\mathbf{W_b^2\,\sigma_b^2 = 0.216063}$, $W_c^2\,\sigma_c^2 = \mathbf{0.160044}$, $\mathbf{W_d^2\,\sigma_d^2 = 0.093564}$, $\mathbf{W_e^2\,\sigma_e^2 = 0.04382}$

$\mathbf{2W_aW_b\sigma_a\sigma_bCov(a,b)}$=2*(0.3)*(0.5)*(1.813533592)*(1.859301832)*(0.011869062)

= 0**.006003205**

Similarly,

$\mathbf{2W_aW_c\sigma_a\sigma_cCov(a,c)=0.004283731}$, $\mathbf{2W_aW_d\sigma_a\sigma_dCov(a,d)=0.002279353}$,

$\mathbf{2W_aW_e\sigma_a\sigma_eCov(a,e)= 0.002444501}$, $\mathbf{2W_bW_c\sigma_b\sigma_cCov(b,c)= 0.003366619}$,

$\mathbf{2W_bW_d\sigma_b\sigma_dCov(b,d)= 0.002188876}$, $\mathbf{2W_bW_e\sigma_b\sigma_eCov(b,e)= 0.001863685}$,

$\mathbf{2W_cW_d\sigma_c\sigma_dCov(c,d)= 0.001699798}$, $\mathbf{2W_cW_e\sigma_c\sigma_eCov(c,e)=0.001241539}$,

$\mathbf{2W_dW_e\sigma_d\sigma_eCov(d,e)= 0.001787178}$

Variance of the portfolio, σ_P^2= [0.296001 + 0.216063 + 0.160044 + 0.093564 + 0.04382 + 0.006003205 + 0.004283731 + 0.002279353 + 0.002444501 + 0.003366619 + 0.002188876 + 0.001863685 + 0.001699798 + 0.001241539 + 0.001787178**]**

= (0.836650769)

Standard Deviation of the Portfolio (σ_P) =(0.836650769**)** $^{(1/2)}$

=0.914686159

Hence, the return from the portfolio will vary up to **91.47%.**

Expected Return on portfolio, $\mu_p = W_a*\mu_a + W_b*\mu_b + W_c*\mu_c + W_d*\mu_d + W_e*\mu_e$

Where,

μ_a**=** Expected return from security **a (IGL)**.

μ_b**=** Expected return from security **b (PETRONETLNG)**.

μ_c**=** Expected return from security **c (GSPL)**.

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μ_d= Expected return from security **d (ONGC)**.

μ_e= Expected return from security **e (BPCL)**.

$W_a*\mu_a$= (0.3* 0.149086675) = 0.044726003

Similarly, $W_b*\mu_b$=0.030412598, $W_c*\mu_c$=0.021220566, $W_d*\mu_d$=(-0.005193392)

$W_e*\mu_e$= 0.010940218

Hence, μ_p=0.044726003 + 0.030412598 + 0.021220566 + (-0.005193392) + 0.010940218

=0.102105993

Hence, Expected return from the portfolio is **10.21%.**

Findings:

Findings of the work related to oil and gas sector of India is very much common to the oil and gas industry across the globe. The findings are;

- The rate of return of oil and gas sectoral equity investment is moderate and not very high. It is only 10.21%
- The standard deviation of returns of the portfolio is 91.47%. This means this portfolio is under severe risk.
- Oil & Gas industry is too much volatile.
- Investing on a portfolio that consists only oil & gas companies is very risky.

Recommendation:

The study has found that oil & gas industry is highly volatile in India. The return is also not very high. It is moderate only. The recommendations will be;

- Severe risk is associated with moderate return which is to be considered before investment.
- In case, Investors are willing to invest in oil and gas sector, then investor should design a portfolio of few oil and gas companies and consider more companies from other industries. This will lessen the deviation of return on the portfolio. It will also help to gain higher return from the portfolio.

Limitations:

Every study has its own limitations. This study is not an exception to that. The limitations of the study are;

1. Companies taken in consideration for the analysis are from Bombay Stock Exchange (BSE).
2. The study is focused with investment in equity markets only.
3. Investment in derivatives market is not considered in this study.

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