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ABSTRACT

The concern about crude oil and gasoline prices accentuates the link between energy and the economy. The sensitivity of stock prices to oil prices is of continuing interest, particularly when oil prices are high. Changes in crude oil prices affect national economies at large and impact certain sectors of these economies more than the others. The most affected sectors include the oil-related industries (oil exploration, production, refining, etc.), the highly oil sensitive transportation industries (airlines, trucking, railroads, etc.) and the highly oil intensive manufacturing industries (aluminum, steel, polymer, etc.).

It was noted from the literatures that the studies relating the oil price and the stock prices of the oil companies are very few in number and those which do are concentrated only to US. The objective of this paper is to examine the effects of oil prices on the oil stocks in three different markets (US, India ad UK) using daily data; the dynamic interaction between oil prices and stock prices is investigated in the presence of economic variables like interest rates and industrial productions. This paper will also concentrate on the effects of volatility of crude oil prices on the oil stocks using daily data.

The empirical investigation employs unit root tests, cointegration tests, variance auto regression, error-correction models with variance decomposition and impulse response, and ARCH/GARCH models. The results suggest that there exists significant short run and long run relationship between oil price and the oil stocks including the

effect of the other variables such as interest rate and the stock index. The oil price volatility transmission has a persistent effect on the volatility of the stocks of the oil companies in all the countries that were studied.

CHAPTER 1 : Introduction

The concern about crude oil and gasoline prices accentuates the link between energy and the economy. Most energy analysts agree that sustaining even modest economic growth worldwide for the next several decades will require massive new investments in oil and natural gas. Recent forecasts by the U.S. Department of Energy's Energy Information Administration (EIA) estimate that sustaining a 4.1 percent rate of annual growth in the global economy to 2030 will require an expansion of 35 million barrels per day in global oil supplies. That is an increase of 42 percent. Throughout modern history, oil has played a prominent role in shaping the economic and political developments of world economies. The sensitivity of stock prices to oil prices is of continuing interest, particularly when oil prices are high

1.1 Oil Prices

According to the economists, oil prices are the complete effects of supply and demand fundamentals. The important factor is the Organization of Petroleum Exporting Countries (OPEC). The countries of OPEC, posses about 80 percent of world oil reserves and can control the oil market to expand capacity to keep pace with the growth in demand. Demand growth has accelerated in the last few years, even as production has dropped from mature fields in many countries. The means by which consumers and producers will fill that ever-growing wedge between oil demand and supply will be the dominant energy investment theme of this decade.

But there are many factors affecting the tried-and-true laws of economics – and those factors have contributed to today's high-demand, tight-supply world energy market.

- Demand is very strong, coming from mature economies like the United States and Europe plus the developing economies of countries like China and India. And as per capita income rises in the developing countries, the demand for energy is expected to continue growing.
- Political instability in key oil exporting countries, including Venezuela, Nigeria, Indonesia, and Iraq.
- The failure of oil consuming nations, especially the US, to develop a rational energy demand policy. The US accounts for just five percent of global population but 25 percent of world oil consumption.
- Lengthening oil supply chains stemming from the US's growing reliance on distant oil supplies from Russia, the Middle East, and central Asia.

"The time when we could count on cheap oil and even cheaper natural gas is clearly ending" was said at a conference in Houston, where hundreds of oilmen gathered. Oil prices climbed to record highs above $147 a barrel in the month of July 2008. And unlike the more gradual increases earlier in the decade, the price shot up in 2008. In April and the first three weeks of May, the average real oil price in pounds was nearly double that in early 2007, and stood within a hair's breadth of the previous quarterly record in late 1979.

1.2 Impacts of Higher Oil Price

Changes in crude oil prices affect national economies at large and impact certain sectors of these economies more than the others. The most affected sectors include the oil-related industries (oil exploration, production, refining, etc.), the highly oil sensitive transportation industries (airlines, trucking, railroads, etc.) and the highly oil intensive manufacturing industries (aluminum, steel, polymer, etc.). Just about the only stocks that have done well this year are those that profit from the global boom in energy and other commodities. Jumping on board those kinds of winners is a bet -- which might pay off -- that prices will stay high or go higher. But given the steep rise in energy and commodities shares, many professionals fret they could fall equally dramatically. But in 2008, it increasingly appears that the energy price rise will slice a meaningful amount off the already weak pace of economic growth and further batter corporate profits -- bad news for stock prices. The stock market has certainly taken a hit from the latest surge in oil prices; oil prices affect the companies' earnings and their bottom lines, which in turn affect their dividends, retained earnings, and the prices of their stocks.

Not surprisingly, a large literature is devoted to the study of energy and its effects on macro-economic variables such as economic stability, economic growth, and international debt. For example, Hamilton (1983) concludes that increases in oil prices are responsible for declines in real GNP. Gilbert and Mork (1984) model the macro effects of an oil supply disruption and survey alternative policy options for dealing with the problem. Mork, Olsen, and Mysen (1994) assert that "the negative correlation between oil prices and real output seems, by now, to have been accepted as an empirical fact." In addition to the extensive investigation of the macroeconomics of energy issues, large research has been devoted to the repercussions of energy shocks on financial markets. Investigations by Charles Jones and Gautam Kaul (1996) using on reaction of the US and Canadian stock market to oil shocks show that stock prices rationally reflect the impact of news on current and future cash flows and there are no evidences of overreaction, while stock market in Japan and United Kingdom are different.

However, there are very few studies that examine the relationship between oil price and the stock prices of the oil industries. One among them is a study by Huang, Masulis and Stoll (1996) who examined the link between daily oil future returns and daily United States stock returns. Also, Al-Mudhaf and Goodwin (1993) examined the returns from 29 oil companies listed on the New York Stock Exchange. Not surprisingly, most of them are limited only to United States.

1.3 Problem Statement, Purpose and Significance

The problem statement is: "Does the performance and volatility of oil stocks vary with respect to the changes in oil prices?" It was noted from the literatures that the studies relating the oil price and the stock prices of the oil companies are very few in number and those which do are concentrated only to US. The purpose of this paper is to study the relationship between the oil prices and the stocks of oil companies in three different countries.

The results of the study should be useful to the various oil companies who are engaged in different phases of this industry and whose shares are traded on those stock exchanges. They should be of interest to the individual investors, policy makers, hedgers, arbitrageurs who buy the shares of these companies and analysts who wish to understand how the stocks of the different companies react to changes in the level and volatility of the oil prices.

1.4 Objective

The objective of this paper is to examine the effects of oil prices on the oil stocks in different countries, whether there are long-run relationships or co-movements among the oil prices and oil industry's stock. Specifically, the dynamic interaction between oil prices and stock prices is investigated in the presence of economic variables like interest rates and industrial productions. This paper will also concentrate on the effects of volatility of crude oil prices on the oil stocks using daily data.

1.5 Scope

The scope of this study extends to six oil companies from three different countries that are geographically apart and have different economic conditions; two each listed on New York Stock Exchange, London Stock Exchange and National Stock Exchange of India respectively.

1.6 Limitations

Initially the study was intended to analyze thirty oil companies listed on all the major stock exchanges across the world. But due to time constraint and feasibility of required methods pertaining to the scope of research at the MBA level, the number of companies were reduced to six (two each from the three stock exchanges mentioned above).

In addition, only two macro-economic factors, industrial productions and interest rates were considered as controlling variables but there might be other factors that could influence the findings that might have a smaller or greater effect. Future research is necessary to determine other potential macro-economic variables.

1.7 Organization of the paper

The remainder of the paper is organized as follows. The next chapter contains the literature review and the hypothesis development variables. It also gives the theoretical frame work. In Chapter 3 the data and the methodology adopted is discussed along with the framework for the empirical analysis. Chapter 4 present results of the impacts of oil price and on the oil stock. Finally, in Chapter 5 the conclusions are presented.

CHAPTER 2 : Literature Review and Hypothesis Development

Oil prices are flirting with all time highs, and oil company stocks, which generally move with oil prices, have outperformed the market this year (2008). Oil is a fundamental driver of modern economic activity, and there is a general market perception that stock markets react to oil price shocks. Higher oil prices might affect the global economy through a variety of channels, which include transfer of wealth from oil consumers to oil producers, a rise in the cost of production of goods and services, and impact on inflation, consumer confidence and financial markets. Literatures have proved that oil price changes are important in explaining stock price movements. A positive oil price shock depresses a real stock price return. At the same time past evidences have proved that with the crude prices riding high, most of the world's energy titans (Exxon Mobil, Royal Dutch/Shell, BP and others) report profits.

2.1 Effect of Oil Prices on the Economy

The impact of oil price changes on the world economy is large. There are several theoretical justifications to expect a relationship to exist between macroeconomic variables and stock returns (e.g., Boudoukh & Richardson, 1993; Mandelker & Tendon, 1985). Many empirical studies have analyzed the relationship between real stock returns and growth rates of industrial production (see Barro, 1990; Fama, 1981, 1990; Schwert,1990; Chen, 1991; Lee, 1992, Choi et al., 1999; Binswanger, 2000; Hassapis and Kalyvitis, 2002). The results of the above mentioned studies, mainly coming from univariate or multivariate time series approaches, indicate that real stock returns have a predictive power over real economic activity, that is they tend to lead real output, and that the degree of correlation tends to increase over longer production growth rate horizons (i.e. from monthly, to quarterly and to annual growth rates). According to Adelman (1993, p. 537), "Oil is so significant in the international economy that forecasts of economic growth are routinely qualified with the caveat: 'Provided there is no oil shock.'" Numerous studies focus on the effect of oil prices on the economy. Hamilton (1983), Gilbert and Mork (1984), Mork, Olsen, and Mysen (1994), said that oil plays an important role in US economy. Hamilton (1983) and Gisser and Goodwin (1986) indicate that oil price shocks have an adverse impact on the macro economy, and might even be a cause of economic recession. Hamilton (1983) using Granger causality examined the impact of oil price shocks and the US economy in 1949-1972. Hamilton found that changes in oil prices Granger-caused changes in GNP and unemployment where oil prices were determined exogenously. Burbridge and Harrison (1984) examined the impact of oil price shocks on some macroeconomic variables in the USA, Canada, UK, Japan and Germany. Using VAR models they show that the 1973-1974 oil embargoes explain a substantial part of the behavior of industrial production in each of the countries examined. They reached the same conclusions as in Hamilton's work. However, for the oil changes in 1979-1980 they find little evidence that the changes in oil prices had an effect on industrial production. Gisser and Goodwin (1986) found that oil price shocks affect a set of macrovariables. Using Hamilton's data they detect a relationship between the crude oil price and employment. Furthermore, they examine whether oil shocks have a different impact on the macro economy before 1973 than after. However, they could not provide support for that hypothesis. Their results are similar to those of Hamilton (1983) and Burbridge and Harrison (1984). Several economists (Tatom, 1988, 1982;

Bernanke et al., 1997) indicate the monetary authority behavior as a possible explanation for the economic effects of oil price shocks. Chen et al. (1986) provided a test of a multi-factor asset pricing model using innovations in a set of macroeconomic variables. This analysis included the possibility that a return series derived from oil prices could constitute an economic pricing factor. Generally, Chen et al. found no evidence to suggest that such a factor exists in their sample of U.S. equities. Hamao (1989) re-applied the Chen et al. approach to a set of Japanese equity data and confirmed the result for the oil price change factor. In contrast, Kaneko and Lee (1995) found that the oil price change factor was important in a more recent sample of Japanese equity data. Kaneko and Lee attribute this divergence in results to method and data differences between studies. In a study concerning predictability and time-varying risk across world equity markets, Ferson and Harvey (1995) reject the hypothesis that a risk variable based on oil price changes is equal across their sample of 18 countries. On the basis of rejecting this inequality hypothesis, they include the oil price risk variable as a separate factor in their asset pricing analysis. Jones, Leiby and Paik (2004) have reported that oil price shocks appear to be major contributors to post-oil–price shock recessions, and that the magnitude of the effect that an oil price shock has on GDP is approximately −0.06 in terms of elasticity. International Monetary Fund research also supports the view that higher oil prices have a detrimental impact on the global economy. For example, results reported by Mussa (2000) indicate that an increase of $5 per barrel in the oil price is likely to reduce the level of global output by approximately 0.25 percentage points over the first 4 years. A similar view is also supported by an International Energy Agency report (IEA 2004, p. 3), which suggests that 'World GDP would be at least half of 1% lower —

equivalent to $255 billion — in the year following a $10 oil price increase. This is because the economic stimulus provided by higher oil-export earnings in OPEC and other exporting countries would be more than outweighed by the depressive effect of higher prices on economic activity in the importing countries'.

Number of authors, such as Mork (1989), Mork et al. (1994), and Hamilton (1996, 2000); argue that there is a nonlinear relationship between the oil and economy. The failure of the 1986 oil price collapse to produce an economic boom leads several authors to hypothesize the existence of an asymmetric relationship between oil prices changes and economic activity: while oil price increases have clear negative effects, the impact of oil price declines is not always positive; indeed it may slow output growth down. In particular, Mork (1989) verifies that, if Hamilton's analysis is extended to include the oil price collapse of 1986, the oil price–macroeconomy relationship breaks down. Hence, he decided to test the symmetry hypothesis on U.S. data by allowing real increases and decreases in oil price to have different coefficients in a regression equation with real GNP growth as the dependent variable. The coefficients on oil price increases now turn out to be negative and highly significant; the coefficients on price declines tend to be positive, but small and not statistically significant. Moreover, coefficients on oil price increases and oil price decreases are significantly different from each other, demonstrating that the effects of oil price increases and decreases are indeed asymmetric. In an extension of this analysis to other countries, Mork et al. (1994) find that all countries except Norway experience a negative relationship between oil price increases and GDP growth. However, for most of these countries, the coefficients of oil price decreases and increases tend to have the opposite sign, which indicates that oil price decreases may adversely affect the business cycle. Specifically, these studies show that oil price increases are much more influential than oil price decreases, creating an asymmetric relationship between oil prices and economic activity. Cologni and Manera (2007) specified and estimated a structural vector autoregressive model for the G-7 countries aimed at verifying if the oil price changes of the last twenty years have affected monetary variables and have been transmitted by monetary policies to the economic system. They investigated long-run as well as short-run relationships among the macroeconomic variables output, money demand, oil prices, inflation, exchange rates and interest rates. Their results showed that the total impact of the 1990 oil price shock indicate that for some countries (U.S.) a significant part of the effects of the oil price shock is due to the monetary policy reaction function. For other countries (Canada, France and Italy), however, the total impact is offset, at least in part, by an easing of monetary conditions. Furthermore, Bansal et al. (1993) demonstrate the economic significance of nonlinearities in asset pricing. Also, Hiemstra and Kramer (1997) argue that linear asset pricing models omit potentially useful aspects of the relationship between macroeconomic variables and stock returns. Cunado and de Gracia (2003, 2005) used non-linear relationship to investigate the oil-growth relationship in some European and Asian economies. A more recent work by Hamilton (2003) uses a simple simulated example to show that a misspecified linear estimation of a true nonlinear model cannot provide a consistent estimate of the parameter and thus causes instability in the estimation results. Hamilton then developed a flexible approach to capture the relationship of oil price shocks and economic growth in post-war US data. A method of testing nonlinearity was also proposed. On the other hand, Lardic and

Mignon (2006) have studied the long-run relationship between oil price and economic activity, or GDP in particular, using an asymmetric cointegration approach. They studied the effects of oil prices on GDP in the G7 and some European countries and found evidence of the asymmetric long-run cointegration while the standard cointegration test is rejected. Zhang (2008) used the non-linear approach in studying the effects of oil shocks on the Japanese economy. The empirical evidence confirmed the existence of nonlinearity between these two variables and a flexible nonlinear model was estimated. The linkage between economic growth (hence, the oil price) and financial markets appears to be quite natural.

In the energy industry literature Kavussanos and Marcoulis (1997) study the impact of the market return and the Fama and French (1992) factors on the profitability of oil refining firms. Their main conclusion is that the market return (S&P 500) has the largest impact on the share price of refineries. The market value of equity (ME) and the assets value relative to the market value of equity (A/ME) have small positive influence, while the assets value relative to the book value (A/BE) has a small impact. Abugri (2006) investigated whether dynamics in key macroeconomic indicators like exchange rates, interest rates, industrial production and money supply in four Latin American countries significantly explain market returns. He reported that the response of market returns to shocks in macroeconomic variables cannot be determined a priori, since it tends to vary from country to country. He also added that the global variables are consistently more important than the domestic variables in explaining returns across markets. The production growth rate exhibits stationary long memory dynamics, while stock returns show stationary short memory dynamics; stock returns lead aggregate economic activity at scales corresponding to periods of 16 months and longer (Gallegati, 2007).

Recent contributions finding significant effects of oil price shocks on macroeconomic activity for most countries in their samples include Cologni and Manera (2008) and Kilian (2008) on the G-7, Jimenez-Rodriguez and Sanchez (2005) for G-7 and Norway, and Cunado and Perez de Garcia (2005) for Asian countries. In the most recent paper, Jimenez Rodriguez (2008) studied the effects of oil price shocks on the output of the main manufacturing industries in six industrialized OECD countries using disaggregate data at the industry level. She reports that the pattern of responses to oil price shocks by industrial output is diverse across the four EMU countries under study (France, Germany, Italy, and Spain), but highly similar in the UK and the US. Cross-country differences within the EMU can be partially explained by differences in the industrial structure. Moreover, the effects of an oil price shock seem to be unevenly distributed across the manufacturing industries in three of the four EMU countries under consideration (France, Germany, and Spain), while response homogeneity is the general norm in the remaining countries.

2.2 Effect of Oil Prices on Stock Markets

As oil price shocks have effects on the real economy through consumer and firm behavior, so do the effects of oil price shocks on world stock markets. Many studies analyze the relationship between oil prices and stock market prices as well as stock returns. Jones and Kaul (1992) examined the effect of oil prices on stock prices in the USA. They find an effect of oil prices on aggregate real stock returns, including a lagged effect, in the period 1947 to 1991. In a more recent study, Jones and Kaul (1996) tested whether the reaction of international stock markets to oil prices can be justified by current and future changes in real cash flows and/or changes in expected returns. They find that in the postwar period, the reaction of US and Canadian stock prices to oil shocks can be completely accounted for by the impact of these shocks on real cash flows. In contrast in case of Japan and UK, Jones and Kaul (1996) concluded that oil price shocks impact the expected stock return in a way that were not captured by their proxies for expected return or that the stock market in UK and Japan over react to the oil price shocks using post war data. Huang, Masulis and Stoll (1996) examined the link between daily oil future returns and daily United States stock returns. If oil plays an important role in an economy, one would expect changes in oil price to be correlated with changes in stock prices (Huang et al. 1996). They examined the contemporaneous and lead-lag correlations between daily returns of oil futures contracts and stock returns. In the period of the 1980s, there is virtually no correlation between oil futures returns and the returns of various stock indexes. In the case of specific oil stocks, there was contemporaneous correlation and a statistically significant one day lead of oil futures returns. However the economic significance of the lead is small. A simple bivariate correlation of raw returns produced the same conclusions as a more sophisticated multivariate vector autoregressive approach. They also investigated the association between oil volatility and stock market volatility and found no clear relation was found as it is with stock returns. Oil futures returns do lead some individual oil company stock returns but oil future returns do not have much impact on general market indices. Conrad, Gultekin and Kaul (1991) find that the stock price volatility of large firms leads that of small firms. Mussa (2000) argues that by affecting economic activity, corporate earnings, inflation and monetary policy, an increase in the oil price has implications for asset prices and financial markets. While summing up contemporary research relating to oil prices and capital markets, Jones et al. (2004 p. 24) comment that: ‘Ideally, stock values reflect the market's best estimate of the future profitability of firms, so the effect of oil price shocks on the stock market is a meaningful and useful measure of their economic impact. Since asset prices are the present discounted value of the future net earnings of firms, both the current and expected future impacts of an oil price shock should be absorbed fairly quickly into stock prices and returns without having to wait for those impacts to actually occur’. Empirical studies for the Greek economy have focused attention on energy demand and its association to output and prices (Samouilidis and Mitropoulos, 1984; Donatos and Mergos, 1989; Lolos and Zonzilos, 1996; Calogirou et al., 1997; Christopoulos, 2000). Hondroyiannis and Papapetrou (2001) studied the dynamic interactions among the economic indicators like interest rate, exchange rate and industrial productions foreign stock returns, oil price and stock returns for Greece. Applying impulse response functions, they show that oil price is an important factor in explaining the stock price movements in Greece, and that a positive oil price shock tends to depress real stock returns. Also, individually Papapetrou (2001) studied the dynamic relationship among oil prices, real stock prices, interest rates, real economic activity and employment for Greece using a multivariate vector-autoregression VAR approach. The empirical evidence suggests that oil price changes affect real economic activity and employment. Oil prices are important in explaining stock price movements, while the stock returns do not lead to changes in real activity and employment. Gjerde and Saettem (1999), using Norwegian data, demonstrated that stock returns have positive and delayed response to changes in industrial production and stock market responds rationally to oil price shocks. Maghyereh (2004) uses a vector autoregression model to study the relationship between oil prices changes and stock returns in 22 emerging markets. He finds that oil price changes have no significant role in affecting stock returns. Hammoudeh and Eleisa (2004) used the vector error-correction model to study the relationship between oil prices and stock prices for five members (Bahrain, Kuwait, Oman, Suadi Arabia, and the United Arab Emirates) of the Gulf Cooperation Council (GCC). They find that only the Saudi Arabia stock market has a relationship between oil prices and stock prices. There has been a continuing interest by researchers over recent years in the role and impact that oil and other energy sources have on financial markets and stock prices of modern corporations.

Ciner (2001) examined the dynamic linkages between oil prices and the stock market. Relying on nonlinear causality tests, Ciner's study provides evidence that oil shocks affect stock index returns, which is consistent with the documented influence of oil on economic output and stresses that the linkage between oil prices and the stock market was stronger in the 1990s. The above studies thus said that oil prices and the GCC stock markets were not related. This conclusion could be due to the fact that only linear linkages have been examined. Hence, Maghyereh and Al-Kandari (2007) examined the non-linear linkages between oil prices and stock market in Gulf Cooperation Council (GCC) countries. The empirical analysis of the paper supported that oil price impact the stock price indices in GCC countries in a nonlinear fashion. Thus, the statistical analysis in the paper obviously supports a nonlinear modeling of the relationship between oil and the economy. For many European countries, but not for the U.S., increased volatility of oil prices significantly depresses real stock returns. The contribution of oil price shocks to variability in real stock returns in the U.S. and most other countries is greater than that of interest rate. An increase in real oil price is associated with a significant increase in the short-term interest rate in the U.S. and eight out of 13 European countries within one or two months. Counter to findings for the U.S. and for Norway, there is little evidence of asymmetric effects on real stock returns of positive and negative oil price shocks for oil importing European countries. This result is consistent with the finding by Sadorsky (1999) for the U.S. after 1986 that the contribution of oil price shock is greater than that of interest rates on real stock returns. It is also consistent with finding by Davis and Haltiwanger (2001) that oil price shocks account for about twice the variation in plant level employment as interest rates.

Few authors (Bohi, 1989; Lee and Ni, 2002; Kilian and Park, 2007; and Herrera, 2007) have paid attention to the impact of oil price shocks at the industry level, and they all have focused on the US, with the only exception being Bohi (1989) who also explored such industry level effects on economies other than the US (specifically, Germany, Japan and the UK). While Bohi (1989) and Lee and Ni (2002) analyzed the impact of oil price shocks on output in manufacturing industries, Kilian and Park (2007) and Herrera (2007) investigated the effects on industry-level stock returns and on industry-level inventory-sales, respectively. Henriques and Sadorsky (2007) developed a four variable vector autoregression model and investigated the empirical relationship between alternative energy stock prices, technology stock prices, oil prices, and interest rates. Their results showed that technology stock prices and oil prices each individually Granger cause the stock prices of alternative energy companies. Their simulation results showed that a shock to technology stock prices has a larger impact on alternative energy stock prices than does a shock to oil prices. Oil price shocks have a statistically significant impact on real stock returns contemporaneously and/or within the following month in the U.S. and 13 European countries over 1986:1–2005:12 (Park and Ratti, 2008). Norway as an oil exporter shows a statistically significantly positive response of real stock returns to an oil price increase.

2.3 Effect of Oil Prices on Oil and Oil related Industry Stocks

Researchers in International Finance have focused on the sensitivity of the world's oil industry stocks and oil-sensitive industries stock to the oil price growth. Some researchers (e.g., Strong, 1991) have examined how well investors are able to hedge oil price risk using oil equity portfolios. Others, such as Miller and Upton (1985a, 1985b) and Crain and Jamal (1991), have investigated how well Hotelling's valuation principle applies to oil and gas companies. Other research has analyzed forward and futures prices on oil-related contracts (see Bopp & Lady, 1991; Farmer, 1993; Moosa & Al-Loughani, 1994; Foster, 1996). Huang et al. (1996) conclude that oil price shocks do not influence the aggregate economy. However, Ciner (2001) contests the findings of Huang et al., and argues for further research to produce evidence from international equity markets to support the robustness of results. Furthermore, Malliaris and Urrutia (1995) provide evidence of a negative reaction of share prices to the Persian Gulf crisis. Some researchers, including Bopp and Lady (1991), Farmer

(1993), Moosa and AI-Loughani (1994) and Foster (1996), analyse forward and futures prices on oil-related contracts. Other papers test the role of an oil price factor in explaining the systematic influence on prices in the equity markets (e.g. Hamao, 1989; Kaneko and Lee, 1995; Faff and Brailsford, 2000). Nandha and Faff (2007) examined whether and to what extent the adverse effect of oil price shocks impacts stock market returns. They analysed 35 DataStream global industry indices for the period from April 1983 to September 2005. Their results show that oil price rises have a negative impact on equity returns for all sectors except mining, and oil and gas industries.

Hamilton (1983, 1986) conducted detailed analysis on oil price changes in US and concluded that particular timing of changes in the nominal crude oil prices reflects largely exogenous developments specifically to petroleum sector. Jimmy and Albert (1984) studied the economic performance of 4 major oil (Exxon, Mobil, Texaco, Standard Oil of California) and 4 major automobile companies in the US for the period 1970-1979, when oil prices were rising rapidly. Compound yields and risk-adjusted yields on common stock were the measures of equity performance. Cross-spectral and regression analysis are used to investigate the attribution of the yields to fundamental economic factors (such as world oil prices). Their results showed that Oil firms' compound yields were higher than auto firms' and world oil prices were significantly related to changes in shareholders' wealth. US gasoline prices, the indicator of which most consumers are aware, did not satisfactorily explain the yields of either oil or auto firms. The impact of world oil spot prices was not significantly impounded in general yield proxies such as value weighted stock market or Treasury bill yields. Mudaf and Goodwin (1993) examined the stock returns of 29 oil companies listed on the New York Stock Exchange (NYSE) during the period surrounding the oil shocks of 1973. The reason they chose this period was because during this period the profits of oil companies jumped with oil prices and it became popular that oil prices and oil equity are positively related. Their results reinforced the 'refiner benefit' hypothesis. Their results matched to that of Smith et al. (1986). In another industry focused study, Faff and Brailsford (1999) investigated the sensitivity of Australian industry equity returns to an oil price factor over the period 1983–1996. They report significant positive oil price sensitivity of Australian oil and gas, and diversified resources industries. In contrast, industries like paper and packaging, banks and transport appear to demonstrate significant negative sensitivity to oil price hikes. A firm-specific study by Al-Mudhaf and Goodwin (1993) examines the returns from 29 oil companies listed on the New York Stock Exchange. Their findings suggest a positive impact of oil price shocks on ex post returns for firms with significant assets in domestic oil production. Hammoudeh and Li (2004) compared the oil sensitivity of equity returns of Mexico and Norway (non Gulf and oil based countries) with that of two major oil-sensitive industries (US oil and transportation industries). In addition, they also examined and compared the oil sensitivity of those returns with their sensitivity to systematic risk with respect to the world capital market. Their findings suggest that the oil price growth leads the stock returns of the oil-exporting countries and the US oil-sensitive industries, with the US oil industry showing the greatest sensitivity. The results also indicated that investors view the systematic risk more importantly than the oil sensitivity in pricing those oil-sensitive returns, regardless of the direction of the world capital market. El-Sharif et al. (2005)

demonstrate how oil price has a significantly positive impact on oil and gas returns in the UK. However, the UK evidence of the oil price sensitivity of non-oil and gas sectors is weak. In contrast, Chen et al. (1986) argue that there is no special reward for oil price risk in the stock market. Huang et al. (1996) conclude that the returns of the petroleum stock index and the three oil stocks (Chevron, Exxon and Mobil) are significantly correlated with current and lag one oil futures returns.

Faff and Brailsford (2000) find that in a study of the Australian equity market, both the market risk premium and oil factor were statistically significant in the Australian equity market. Kaneko and Lee (1995) also extracted a significant oil factor for the Japanese equity market and Hammoudeh and Li (2004a) determined that in a study of oil-based economies, Indonesia, Mexico and Norway, the oil price is a more significant risk factor than systematic risk, skewness or kurtosis. The finding that oil is a significant risk factor in national stock markets has led to comparative international studies. In a study across eighteen countries, Ferson and Harvey (1995) show that the oil-price sensitivity was not the same across those countries. Jones and Kaul (1996), who use an APT-type model with oil as a risk factor, conclude that oil is a priced risk factor. A number of studies consider oil sensitive stock markets.

Sardosky (2001) used a multifactor market model to estimate the expected returns to Canadian oil and gas industry stock prices. Results show that exchange rates, crude oil prices and interest rates each have large and significant impacts on stock price returns in the Canadian oil and gas industry. In particular, an increase in the market or oil price factor increases the return to Canadian oil and gas stock prices while an increase in exchange rates or the term premium decreases the return to Canadian oil and gas stock prices. Furthermore, the oil and gas sector is less risky than the market and its moves are pro-cyclical. Hammoudeh, Dibooglu and Aleisa (2002) studied the relationships among U.S. oil prices and oil industry equity indices. Their study reports that oil price systems have a few numbers of common trends, suggesting little potential for long-run portfolio diversification. On a daily basis, none of the oil industry stock indices explains the future movements of the NYMEX oil futures prices, while these prices can explain the movements of independent oil companies engaged in exploration, refining, and marketing, confirming our results that the oil exploration companies and refiners take their cues from the oil market. With the autoregressive conditional heteroskedasticity (ARCH)/GARCH analysis they suggested that the oil futures market's volatility has a matching resonant or volatility-echoing effect on the stocks of the oil exploration, production, and domestic integrated companies, and a volatility-dampening effect on the stocks of oil international integrated and oil and gas refining and marketing companies. Boyer and Filion (2007) use a multifactor framework to analyse the determinants of Canadian oil and gas stock returns. They find a positive association between energy stock returns and appreciation of oil and gas prices, with growth in internal cash flows and proven reserves, and negatively with interest rates. However, production volume and a weakening of the Canadian dollar against the US dollar have a negative impact. Finally, they found that the influence of the exchange rate, the market return and prices of natural gas on Canadian oil and gas stocks changes significantly over the years 1995–1998 and 2000–2002.

Further, Hammoudeh and Eleisa (2004) consider five oil-exporting countries, Bahrain, Kuwait, Saudi Arabia, and the UAE. Surprisingly, only the Saudi Arabian stock market exhibits some dependence on oil prices; the smaller Gulf stock markets are apparently invariant to oil price changes. In some studies, oil price sensitivity is investigated at the sector or industry level. Hammoudeh and Li (2004), using an international factor model, conclude that both world market integration and oil prices are significant determinants of stock prices at country and industry levels.

Scholtens and Wang (2008) assessed the oil price sensitivities and oil risk premiums of oil and gas firms listed on the NYSE by using two-step regression analysis using two different arbitrage pricing models. They found that the returns of oil stocks are positively associated with the returns of the stock market, the increase of spot crude oil prices and negatively with the firm's book-to-market ratio.

Thus, based on the above studies, the first hypothesis for study is given as follows:

H_1: Oil prices influence the oil stocks

2.4 Interest Rates

The VAR model takes account of the simultaneous interaction of the time series of oil futures returns, stock returns, and t-bill returns. T-bill returns are incorporated into the VAR system to control for the effect of interest rate changes on the variables of interest -- stock returns and oil futures returns. For example, stock prices depend on expected earnings discounted to the present.

Oil price changes might affect stock prices by affecting expected earnings, but it is important to control for interest rate changes that could also affect stock prices which directly affect the discount rate on expected earnings. Also, interest rates can affect futures prices relative to cash prices through the cost-of-carry model. Earlier studies of stock returns have shown that stock returns exhibit a number of important seasonalities. These seasonalities are accounted for in the analysis by introducing dummy variables in the VAR model. Huang et al. (1996) say “Interest rate variability is probably not as important over the one-day intervals we examine as it is for the analysis in Sims (1982), where the importance of including interest rates is stressed.”

Shiller (1981) concludes that degree of volatility represents irrationality in the stock market, because implied variance in the dividend discount rate was greater than could be justified. Spiro (1990) reports that a significant movement in stock prices is explained by two fundamental economic variables, GNP and the interest rates. He also adds that interest rate is most responsible for the short term volatility of stock price indices. Ferson and Harvey (1991) state that real interest rates and market return are the most important determinants in explaining the return of American petroleum shares. Sadorsky (2001) also observes that crude oil prices and market return have a positive effect on stock prices whereas a depreciation of the Canadian dollar and an increase of interest rates have a negative effect on Canadian oil and gas stocks. Sadorsky (2001) deepens the analysis of the Canadian oil and gas industry by using a model where the TSE Oil and Gas Index is explained by the Canadian market return, crude oil prices, the Canada–US exchange rate and the short term Canadian interest rates. He finds that the four factors have an influence on Canadian energy stocks, although the first two have a much larger impact. Hondroyiannis and Papapetrou (2001) showed that real stock returns are negatively related to interest rate shocks.

The second hypothesis can be written as:

H_2: Interest rates have an influence on the on the oil stocks

2.5 Stock Index

A stock market index is a method of measuring a section of the stock market and a broad-base index represents the performance of a whole stock market. The time series of composite stock price index is one of the best data reflecting economic conditions. The index data is used to analyze and predict the perspective of markets. Jensen and Meckling (1976), page 485 argue that "the existence of a well-organized market in which corporate claims are continuously assessed is perhaps the single most important control mechanism affecting managerial behavior in modem industrial economies."

Morck et al. (1990) examine whether the stock market has an influence on investment beyond forecasting future fundamentals and they find that there is a statistically significant relation. Okyu Kwon and Jae-Suk Yang (2007) investigated the strength and the direction of information transfer in the US stock market between the composite stock price index of stock market and prices of individual stocks using the transfer entropy. The results of their study indicate that there is a stronger flow of information from the stock index to the individual stocks.

Thus, the third hypothesis is stated as:

H_3: The Stock Index influences the oil stocks

2.6 Industrial Production

Jones and Kaul (1992) find an effect of fuel prices on stock prices but that effect disappears when future industrial production is included in the analysis. Serletis and Shahmoradi (2005) examined the dynamic comovements of natural gas prices, industrial production, and consumer prices. Ewing and Thompson (2007) examined the empirical relationship between oil prices and several key macroeconomic variables. In particular, they investigate the cyclical comovements of crude oil prices with output, consumer prices, unemployment, and stock prices. They have reported a number of important cyclical relationships using three different time series filtering methods and their results suggest that crude oil prices are procyclical and lag industrial production. Also, that oil prices lead consumer prices. The crude oil prices lag industrial production and lead consumer prices are consistent with those reported by Serletis and Shahmoradi (2005) for natural gas prices.

Koutoulas and Kryzanowski (1994) find that the pure domestic components of the interest rate structure, lagged industrial production, pure international components of the differential in the Canada/US leading indicators, and the interest rate of Euro deposits have a significant influence on Canadian oil and gas assets. On the other hand, Mittoo (1992) notes that only the 3-month T-bill interest rate explains these returns.

Results reported in the abovementioned literatures suggest that higher oil prices are generally bad news for economic growth and for the stock market returns. As a consequence of the negative impact of oil price shocks on the economy and oil being a direct or indirect input for many industries, one might expect a negative impact on most of the industries except a few like oil producers and explorers. In addition, interest rates and industrial production also have and impact on the stock returns of any company.

The third hypothesis is:

H_4: Industrial production index has an influence on the oil stocks.

2.7 Volatility

Ross (1989) argues that the volatility of price changes can be an accurate measure of the rate of information flow in a financial market. It is possible that no significant lead or lag cross-correlations are observable in the returns but that price volatility - the rate of information flow - in one market leads volatility in the others. Evidence that volatility is correlated across markets would imply dependence in the information processes. The expected market risk premium (the expected return on a stock portfolio minus the Treasury bill yield) is positively related to the predictable volatility of stock returns. There is also evidence that unexpected stock market returns are negatively related to the unexpected change in the volatility of stock returns. This negative relation provides indirect evidence of a positive relation between expected risk premiums and volatility (Schwert and Stambaugh, 1987).

Malik and Hammoudeh (2005) examined the volatility and shock transmission mechanism among US equity, global crude oil market, and equity markets of Saudi Arabia, Kuwait, and Bahrain. Their results show significant transmission among second moments. They showed that in all cases, Gulf equity markets receives volatility from the oil market but only in the case of Saudi Arabia a significant volatility spillover from the Saudi market to the oil market.

H_5: Volatility in the crude oil prices effect the oils stocks.

2.8 Theoretical Framework

From the hypothesis developed, the theoretical framework is as shown below:

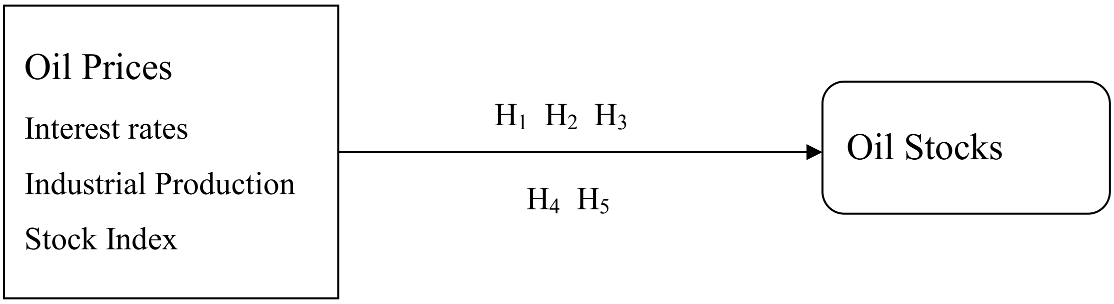

Figure 2-1 Theoretical Framework

CHAPTER 3 : Methodology

The paper was initially intended to look at all the major oil companies in different country categorized by stock markets. Accordingly daily data for 30 companies across 9 stock exchanges was collected. But due to limitations of time and methods the number of companies is limited to six.

3.1 Data

Three stock markets were selected: New York Stock Exchange, London Stock Exchange and the National Stock Exchange (India). The New York Stock Exchange (NYSE) is a stock exchange based in New York City. It is the largest stock exchange in the world by dollar volume and, with 2,764 listed securities, has the second most securities of all stock exchanges. It ranks third in the world in terms of company listings with 3,200 companies. The London Stock Exchange or LSE is a stock exchange located in London, United Kingdom. Founded in 1801, it is one of the largest stock exchanges in the world, with many overseas listings as well as British companies. The LSE is part of the London Stock Exchange Group plc. The National Stock Exchange of India Limited (NSE) is a Mumbai-based stock exchange. It is the largest stock exchange in India in terms of daily turnover and number of trades, for both equities and derivative trading. Though a number of other exchanges exist, NSE and the Bombay Stock Exchange are the two most significant stock exchanges in India and between them are responsible for the vast majority of share transactions.

The six stocks of oil companies two each from the above three stock exchanges was chosen. The selection of the oil companies was based on the performance and thus those having the height ROE based on 5 years average ROE were selected. Thus, Exxon Mobil and Valero from the New York Stock Exchange, Royal Dutch Shell and Gazprom from the London Stock Exchange and Reliance Industries and Indian Oil Corporation Limited from the National Stock Exchange of India were chosen for study.

The Oil prices are based on the London Brent Crude Oil Index. Brent Crude is the biggest of the many major classifications of oil consisting of Brent Crude, Brent Sweet Light Crude, Oseberg and Forties. Brent Crude is sourced from the North Sea. The Brent Crude oil marker is also known as Brent Blend, London Brent and Brent petroleum. It is used to price two thirds of the world´s internationally traded crude oil supplies.

The daily interest rates and industrial productions are used as control variables in the analysis. The interest rates are based on the three month Treasury bill with respect to each stock exchange. Industrial production is an economic report that measures changes in output for the industrial sector of the economy. The industrial sector includes manufacturing, mining, and utilities. Although these sectors contribute only a small portion of GDP (Gross Domestic Product), they are highly sensitive to interest rates and consumer demand. This makes Industrial Production an important tool for forecasting future GDP and economic performance.

All the data was obtained from DataStream, Thomson Datastream being the world's largest most respected financial statistical database. The empirical analysis has been carried out using the daily data for the period of August 08, 2003 to August 08, 2008.

3.2 Tests

3.2.1 Test for Integration

Initially the order of integration of all the variables is tested. The order of integration has significant relation to the stationarity of the time series data in the study. If the data is not stationary, it is said to have a unit root problem and in such a case the results are not reliable. The test of presence of unit root is based on the work of Dickey and Fuller (1979, 1981). The Augmented Dickey-Fuller (ADF) (Dickey, Fuller 1981) test is used to check the unit root and investigate the degree of integration of the variables used in the empirical analysis.

This requires regressing Δy_1 on a constant, a time trend Δy_{t-1} and several lags of dependent terms as follows:

$$\Delta X_t = \gamma_0 + \gamma_1 X_{t-1} + \beta_i \sum X_{t-I} + \varepsilon_t$$

Where

Δ = first difference operator

γ_0, γ_1 and β_i = coefficients to be estimated

X_t = non stationary time series

ε_t = error term at time t

The unit root analysis based on the Augmented Dickey – Fuller test for all the data series leads to the construction of the null hypothesis as shown below:

H_0: γ_1=0 versus H_0: $\gamma_1 \neq 0$

The above hypothesis statement indicates that the null hypothesis of a non-stationary data series (X_t) is represented by H_0: γ_1=0.

The decision in determining the stationarity of the data is with reference to the estimated ADF values as compared to the ADF critical values. If the estimated τ is smaller than the ADF critical values, the series is said to be stationary and vise-versa. This also decides the order of integration. If the series is stationary before the first difference, the series is said to be integrated at I(0) , if the first difference of the series is stationary, then it is of the order I(1) and so on.

3.2.2 Cointegration of variables

Cointegration refers to linear combination of non-stationary time series that result in stationary time series in the presence of cointegration mong the variables (Granger, 1986). Cointegration is a method of defining long run relationship amongst a group of time series variables (Hamilton, 1987). To check for cointegration between the variables (stationary time series) the OLS regression is run. The residuals of this regression equation are saved and test for unit root. The time series are said to be cointegrated if the residual is stationary.

(a) Vector Autoregressive

A vector autoregressive (VAR) approach is used to investigate possible effects of oil prices and the other macro-economic variables on the stocks of oil companies. This procedure was popularized by Sims (1972) and is based on earlier work by Granger

(1969). Analyzing and modeling the series jointly enables understand the dynamic relationships over time among the series and to improve the accuracy of forecasts for individual series by utilizing the additional information available from the related series and their forecasts. The VAR representation provides a highly flexible framework for examining dynamic interactions among price changes of different financial instruments.

The mathematical representation of a VAR is

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + \varepsilon_t$$

where

y_t = k vector of endogenous variables,

x_t = d vector of exogenous variables,

$A_1 \ldots A_p$, B = matrices of coefficients to be estimated

ε_t = vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

Since only lagged values of the endogenous variables appear on the right-hand side of the equations, simultaneity is not an issue and OLS yields consistent estimates. Moreover, even though the innovations may be contemporaneously correlated, OLS is efficient and equivalent to GLS since all equations have identical regressors.

(b) Error Correction Method

Error correction term were used by Sargan (1964), Hendry and Anderson (1977) and Davidson et. al. (1978) is a way of capturing adjustments in a dependant variable which depends on the extent to which an explanatory variable deviated from an equilibrium relationship with the dependant variable. An Error Correction Model (ECM) is a neat way of combining the long run, cointegrating relationship between the levels variables and the short run relationship between the first differences of the variables. It also has the advantage that all the variables in the estimated equation are stationary; hence there is no problem with spurious correlation.

A two variable, first order ECM is specified as follows,

$$\Delta y_t = \beta_1 \Delta x_t - (1-\alpha)[y_{t-1} - \gamma_1 - \gamma_2 x_{t-1}] + u_t$$

where, the term in the square brackets is the disequilibrium error in the previous period, i.e. the deviation of y_{t-1} from its long run equilibrium value, and u_t is the standard error term

β_1 measures the short run impact of changes in x on y, γ_2 measures the long run impact. (If the variables are in logs, as is usually the case, then these are short run and long run *elasticities* respectively). $(1 - \alpha)$ is the fraction of the previous period's disequilibrium error that is made up this period. Note that is coefficient is expected to be negative (note the minus sign in front), and, most likely, less than one. Thus, if for example, y_{t-1} is above the long run value predicted by $(\gamma_1 + \gamma_2 x_{t-1})$ the disequilibrium error is positive. Hence this period y_t falls (Δy_t is negative) in order to move y back to its long run equilibrium value.

3.2.3 Variance Decomposition and Impulse Response

Next, the generalized variance decomposition and generalized impulse functions are employed to analyze the short-run dynamics of the variables. Variance decomposition analysis provides the information regarding the proportion of the movement of oil stocks that are due to their own shocks and the shocks to the other variables. Variance decomposition has been used in this study due to its ability in identifying the factors that explain the variations in movement of the oil stocks.

Impulse response functions hace the ability to identify the reactions of the oil stocks to in response to the shocks by each variable in the dynamic model. It is also a process of tracking the effect of shocks (or change in residual) oneach endogenous variable in the system (Gujarati, 2003). Specifically, a unit of shock on each variable from each equation is applied to the error and the effects upon the system over time will be noted. The impulse response function can be considered as a multiplier that shows the response of each variable in the system, to a shock in one of the variables in the system.

3.2.4 Volatility

(a) ARCH-Models

Over the past two decades, enormous effort has been devoted to modeling and forecasting the movement of stock returns and other financial time series. Seminal work in this area of research can be attributed to Engle (1982), who introduced the standard Autoregressive Conditional Heteroskedasticity (ARCH) model. Engle's process proposed to model time-varying conditional volatility using past innovations to estimate the variance of the series.

The conditional variance can be given as

$$\sigma_t^2 = \mathrm{var}(u_t \mid u_{t-1}, u_{t-2}, \ldots) = E[u_t^2 \mid u_{t-1}, u_{t-2} \ldots]$$

(Because E(u_t)=0, variance is just E(u_t^2))

The conditional variance of a random variable with a zero mean and normal distribution is equal to the conditional expected value of the square of u_t . The *conditional* variance changes as more data becomes available.

"Autocorrelation in volatility" is modelled by allowing conditional variance to depend on the immediately previous value of the squared error, this is ARCH (1) process and is given as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2$$

The LM test is usually conducted to determine whether the ARCH effects are present and that the use of the ARCH/GARCH model is warranted.

(b) GARCH

Further extension was introduced by Bollerslev (1986) known as the Generalized ARCH (GARCH) model which suggests that the time-varying volatility process is a function of both past disturbances and past volatility. ARCH and GARCH models are widely used in various branches of econometrics, especially in financial time series analysis, and are specifically designed to model and forecast conditional variances. There is general agreement that capital investors would demand high returns as a compensation for holding risky assets because they generally dislike risk. The investor may thus require a higher risk premium as the degree of market volatility increases, which points to increased investor uncertainty about the future of risky investments and wealth. This, in turn, may lead to lower liquidity and higher transaction costs in the affected markets. Moreover, higher risk premiums and greater uncertainty may also decrease productive direct investment because they may enhance the cost of assets and the cost of new investment projects. If the risk premium is volatile, then the related changes in the returns will cause considerable movement in asset prices. Here, the effect of volatility between the oil price and oil stocks in different markets is exmanied.

The standard ARCH model is specified by the mean equation

$\Delta y_t = \alpha_0 + \sum \beta_i \varepsilon_{t-i},$ where $\varepsilon_t \sim (0, \sigma_t^2)$

and the variance equation

$\sigma_t^2 = \alpha_0 + \sum \alpha_i \varepsilon^2_{t-i},$

Where, ε^2_{t-i} is the ith ARCH term, q is the order of the ARCH term and σ_t^2 is the conditional variance of the residuals.

(c) GJR GARCH

This model is proposed by Glosten, Jagannathan, and Runkle (1993). Its generalized form is given by:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} (\alpha_i \varepsilon_{t-1}^2 + w_i S_{t-i}^{-} \varepsilon_{t-1}^2) + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2$$

Where S^{-}_t is a dummy variable.

In this model, it is assumed that the impact of ε_t^2 on the conditional variance σ^2_t is different when is ε_t positive or negative. That is why the dummy variable S_t takes the value '0' (respectively ‘1’) when ε is positive (negative). Note that the TGARCH model of Zakoian (1994) is very similar to GJR but models the conditional standard deviation instead of the conditional variance.

CHAPTER 4 : Research Results

In this section the results of the analysis performed to test the data under study. Note that all the data was first transformed into the logarithmic form for the uniformity of the units.

4.1 Integration

For the study under consideration, the ADF test is conducted for the time series data of all the variables taking into account all possible deterministic components and lag lengths. The test was first conducted in levels on all the series and the number of the lagged level terms were chosen based on the AIC and SBC information criteria.

Table 4.1 The ADF test results for the ExxonMobil stock prices, oil price, US Interest Rates, US Industrial production Index, NYSE and Chevron stock prices.

Variables	Level			First Difference		
	ADF	Lag	Critical Value	ADF Statistics	Lag	Critical
LEXXON	-1.660069	2	-3.435157	-39.04522	2	-3.435157
LOILPRICE	-0.636074	2	-3.435157	-31.00609	2	-3.435157
LINTRATES	-2.942744	2	-3.435157	-25.37529	2	-3.435161
LINDPROD	-1.828645	2	-3.435153	-7.097346	2	-3.435153
LNYSE	-2.145964	2	-3.435153	-39.40440	2	-3.435153
LCHEVRON	-1.763211	2	-3.435157	-29.37876	2	-3.435153

The length of lags is decided by AIC and SBC. The critical values are for the 1% significance level. All variables are expressed in logarithmic form.

Table 4.1 presents the results from the ADF test for the US Oil stocks and the other variables, which shows that all the variables are non-stationary in (log form) levels at the 1% significance level. From Table 4.2 it can be seen that the computed ADF test statistics for LEXXON (τ=*-1.660069*) is greater than the critical values at 1% significance (τ=*-3.435157*), this concludes that the LEXXON series is non-stationary. Similarly, all the other variables and the data series for Chevron stock are non-stationary.

The test was then conducted again in first differences, and the results for Exxon stocks show that the ADF test statistics (τ=*-39.04522*) is less than the critical tau value (τ=*-3.435157*) at 1% significance. Thus, the LEXXON is stationary at the first difference and the same is true for Chevron stocks also. Similarly, all the individual series are stationary at the first difference, that is, contain a single root, and thus are integrated of degree one, I (1).

Integration test were conducted for the stocks picked from the National Stock Exchange of India (NSE) and London Stock Exchange (LSE). Table 4.2 and Table 4.3 show the results of integration tests for oil stocks in India and UK respectively. In cases of both the countries similar behavior in the data series is seen as in case of US oil stocks. Thus, it is concluded that all the series are non-stationary and integrated of order one, I (1).

Table 4.2 The ADF test results for the Reliance Industries stock prices, oil price, Interest Rates in India, Indian Industrial production Index, NSE and IOCL stock prices.

Variables	Level			First Difference		
	ADF	Lag	Critical Value	ADF	Lag	Critical Value
LREL	-0.646926	2	-3.435150	-34.46300	2	-3.435157
LOILPRICE	-0.636074	2	-3.435153	-31.00609	2	-3.435153
LINTRATE	-0.980538	2	-3.435157	-25.98242	2	-3.435153
LINDPROD	-0.077169	2	-2.566735	-35.52464	2	-2.566737
LNSE	-1.629922	2	-3.435150	-25.98242	2	-3.435153
LIOCL	-0.041827	2	-2.566735	-29.67696	2	-2.566737

The length of lags is decided by AIC and SBC. The critical values are for the 1% significance level. All variables are expressed in logarithmic form.

Table 4.3 The ADF test results for Royal Dutch Shell stock prices, oil price, Interest Rates in UK, UK Industrial production Index, LSX and Gazprom stock prices.

Variables	Level			First Difference		
	ADF	Lag	Critical Value	ADF	Lag	Critical Value
LSHELL	-2.003520	2	-3.435150	-23.83894	2	-3.435157
LOILPRIC	-0.636074	2	-3.435153	-31.00609	2	-3.435153
LINTRATE	-3.957323	2	-3.435150	-36.04538	2	-3.435153
LINDPRO	-1.702512	2	-3.435157	-6.065438	2	-3.435157
LLSE	-0.331778	2	-2.566735	-35.97189	2	-2.566739
LGAZPRO	-1.911544	2	-3.435153	-34.77918	2	-3.435153

The length of lags is decided by AIC and SBC. The critical values are for the 1% significance level. All variables are expressed in logarithmic form.

4.2 Cointegration

A system of two or more time series, which are non-stationary in levels and have individual stochastic trends, can share common stochastic trend(s); in this case those series are said to be cointegrated. Thus, two or more non-stationary time series are cointegrated if a linear combination of these variables is stationary, that is, converges to equilibrium over time. The stationary linear combinations are called cointegrating equations, and may be interpreted as long-run equilibrium relationships among the variables. To check for cointegration amongst the variables the OLS regression is run. The residuals of this regression equation are saved and test for unit root.

The time series are said to be cointegrated if the residual is stationary. Table 4.4 shows the results of the test of cointegration between all the variables. The computed absolute t-statistics (τ= *-3.055400*) is less than the critical 'tau' values (τ= -2.863550) and the Durbin Watson statistics (2.0004) is close to 2. Hence, the null hypothesis is rejected and it can be concluded that the estimated residual (RESID_EXXON) is stationary. Therefore, the variables are cointegrated and have a long term relationship.

Cointegration tests were conducted for stocks of Chevron in US, Reliance Industries and Indian Oil Corporation (IOCL) from India and Shell and Gazprom from UK stock exchange with the oil price and the other variables. The results obtained are similar to that of Exxon stocks and each set of variables are cointegrated over long term. Table 4.4 provides the summary of results of cointegration test for all the stocks with oil price and respective macroeconomic variables.

Table 4.4 The ADF test results for the residuals of the OLS equations of all the oil companies for testing cointegration.

Variables	Level		
	ADF Statistics	Lag	Critical
RESID_EXXON	-3.055400	2	-2.863550
RESID_CHEVRON	-6.705772	2	-3.435157
RESID_REL	-2.787298	2	-2.566735
RESID_IOCL	-3.830846	2	-3.435153
RESID_SHEL	-3.967087	2	-3.435153
RESID_GAZPROM	-4.167971	2	-3.435150

The length of lags is decided by AIC and SBC. The critical values are for the 1% significance level

4.2.1 Vector Autoregression (VAR)

The short run relationship between the variables is tested using the VAR model. The lag order of the VAR which is behind the cointegration analysis is been selected according to the Akaike Information Criterion (AIC). VAR was run using the stationary data of all the variables. Table 4.5 shows the results of the unrestricted VAR for ExxonMobil and Chevron stocks.

In Table 4.5 the standard error of the equation provides a measure of how different the predicted values of the dependent variable are from the actual values. In general, smaller values are better because they indicate a tighter fitting model (less dispersion about the regression line). The results indicate that the ExxonMobil stocks are influenced by both the first and second lag of oil prices, interest rates, the stock index and the ExxonMobil stock itself. However, the Industrial production index does not significantly impact the ExxonMobil stock prices.

Table 4.5 Results of VAR for ExxonMobil Stocks AND Chevron Stocks

Variables	DLEXXON		Variables	DLCHEVRON	
	Co-efficient	SE		Co-efficient	SE
DLEXXON(-1)	-0.037781	0.03791	DLCHEVRON(-1)	-0.145776	0.02757
DLEXXON(-2)	-0.070088	0.03910	DLCHEVRON(-2)	-0.085133	0.02742
DLNYSE(-1)	-0.100694	0.05908	DLNYSE(-1)	0.360543	0.06670
DLNYSE(-2)	0.091261	0.06020	DLNYSE(-2)	0.282498	0.06748
DLOILPRICE(-1)	0.021586	0.02417	DLOILPRICE(-1)	0.023186	0.03618
DLOILPRICE(-2)	-0.008140	0.02341	DLOILPRICE(-2)	0.092351	0.03605
DLINTRATES(-1)	-0.003986	0.03451	DLINTRATES(-1)	-0.063896	0.05326
DLINTRATES(-2)	-0.001775	0.03455	DLINTRATES(-2)	0.037204	0.05330
DLINDPROD(-1)	1.217426	1.223311	DLINDPROD(-1)	-0.903153	1.88740
DLINDPROD(-2)	-1.900842	1.22160	DLINDPROD(-2)	0.875048	1.88374
C	0.000706	0.00037	C	0.000506	0.00058
S. E. Equation	0.013109		S.E. equation	0.020209	

The co-efficient of the VAR model suggest that the price of the stock decreases by 0.0377% for every 1% increase in the first lagged difference of the Exxon Mobil stock prices and by 0.07% for every 1% increase in the second lagged difference of the Exxon Mobil stock prices. For every 1% increase in the first lagged difference and second lagged difference of the NYSE, the price of Exxon Mobil stocks decrease by 0.10% and increase by 0.0913% respectively. For every 1% increase in the first lagged difference of the Oil prices, the price of Exxon Mobil stocks increase by 0.0216% and 1% increase in second lagged difference of oil prices, the Exxon Mobil stocks decrease by 0.0081%. For every 1% increase in the first lagged difference and second lagged difference of the Interest rates, the price of Exxon stocks decrease by 0.0039% and 0.0018% respectively.

Identical relationship between the Chevron stocks, oil price and the other variables is seen. All the variables at their first and second difference have significant short run relationship (at 5% and 10% significance level) with the Chevron stocks except for the industrial production index. It should be noted from the Table 4.5 that over all oil prices have positive significant impact on the US oil stocks. Industrial production index in US does not have a significant impact on the oil stock prices.

In addition the Johansen cointegration test was run (with respect to each company stocks) to test the long run relationship. The Johansen cointegration test indicated the presence of 5 cointegrating equations in the long run. The results of the test are shown in Table 4-6.

Table 4.6 Unrestricted Cointegration Rank Test for ExxonMobil Stocks

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.340135	1799.941	68.52	76.07
At most 1 **	0.315134	1258.675	47.21	54.46
At most 2 **	0.256429	765.8253	29.68	35.65
At most 3 **	0.224518	380.0536	15.41	20.04
At most 4 **	0.036930	48.99378	3.76	6.65

**(**) denotes rejection of the hypothesis at the 5%(1%) level*
Trace test indicates 5 cointegrating equation(s) at both 5% and 1% levels

Table 4.7 Results of VAR for Reliance Industries Stocks AND IOCL Stocks (INDIA)

Variables	DLRIL		Variables	DLIOCL	
	Co-efficient	SE		Co-efficient	SE
DLRIL(-1)	0.033633	0.04286	DLIOCL(-1)	0.142511	0.03344
DLRIL(-2)	0.034315	0.04286	DLIOCL(-2)	-0.038403	0.03321
DLNSE(-1)	0.017396	0.05961	DLNYSE(-1)	0.151595	0.05428
DLNSE(-2)	-0.059029	0.05952	DLNYSE(-2)	0.282498	0.05473
DLOILPRICE(-1)	-0.061513	0.04077	DLOILPRICE(-1)	-0.159796	0.04752
DLOILPRICE(-2)	-0.006317	0.04089	DLOILPRICE(-2)	0.059803	0.04753
DLINTRATES(-1)	-0.130785	0.05665	DLINTRATES(-1)	-0.070665	0.06572
DLINTRATES(-2)	0.006888	0.05658	DLINTRATES(-2)	0.027659	0.06562
DLINDPROD(-1)	0.029760	0.03273	DLINDPROD(-1)	-0.010354	0.03799
DLINDPROD(-2)	0.044845	0.03273	DLINDPROD(-2)	0.007859	0.03797
C	0.001921	0.00064	C	0.000147	0.00074
S.E. equation	0.022850		S.E. equation	0.026508	

Table 4.8 exhibits the results of VAR for the oil stocks picked from UK. For both, stocks of Shell and Gazprom. As in case of US oil stocks, oil stocks in UK also are influenced by all the variables except for the industrial production index.

Johansen cointegration test was run (with respect to each company stocks from India and UK) to test the long run relationship. The Johansen cointegration test indicated the presence of 5 cointegrating equations in the long run.

Table 4.8 Results of VAR for Royal Dutch Shell Stocks and Gazprom Stocks (UK)

Variables	DLSHELL		Variables	DLGAZPROM	
	Co-efficient	SE		Co-efficient	SE
DLSHELL(-1)	-0.014597	0.02803	DLGAZPROM(-1)	0.036855	0.02782
DLSHELL(-2)	0.084724	0.02919	DLGAZPROM(-2)	-0.032582	0.02834
DLLSE(-1)	-0.000962	0.00132	DLLSE(-1)	-0.000148	0.00240
DLLSE(-2)	-0.000345	0.00132	DLLSE(-2)	0.001890	0.00240
DLOILPRICE(-1)	-0.026152	0.02521	DLOILPRICE(-1)	0.007508	0.04422
DLOILPRICE(-2)	-0.008814	0.02396	DLOILPRICE(-2)	0.068050	0.04331
DLINTRATES(-1)	0.218664	0.09417	DLINTRATES(-1)	0.307284	0.17056
DLINTRATES(-2)	-0.015141	0.09451	DLINTRATES(-2)	-0.229933	0.17092
DLINDPROD(-1)	-3.021282	7.10914	DLINDPROD(-1)	-10.03259	12.8734
DLINDPROD(-2)	2.649938	7.10957	DLINDPROD(-2)	6.173976	12.8753
C	0.000221	0.00064	C	0.001199	0.00068
S.E. Equation	0.013438		S.E. equation	0.024338	

4.2.2 Vector Error Correction Model (VECM)

The finding of the presence of cointegration sets the stage for using the error-correction model. If a set of nonstationary variables is cointegrated then an unrestricted vector autoregression model (VAR) comprised of the first differences of these variables will be misspecified. The reason is that the first differences of nonstationary variables impose too many unit roots, and information on long-run equilibrium relationships among the variables will be lost. Then, in this case the error-correction model (VECM) must be used. This model includes a vector of error terms that represents deviations from the long-run equilibrium and lagged short-term deviations.

The VEC model provides information on how the dependent variable, LEXXON is adjusted to restore long run equilibrium in response to the error correction term. In estimating the VEC model, the lag interval was specified based on the results obtained in the VAR lag selection, this VEC is a restricted VAR with two lags. The number of cointegrating equations was specified based on the Johansen cointegration test. Table 4.9 presents the VEC Model for Exxon Mobil stocks.

In the VEC model, the estimates show that the error-correction terms in the equation, which measure the long-run disequilibrium, are significantly different from zero. The addition of the error terms results in a positive value, implying that the Exxon Mobil stock prices show divergence from the equilibrium and that they do not have the tendency to restore back to equilibrium. The co-efficient of the error terms indicate the backward (if negative) or forward movement (if positive) towards equilibrium following a shock to the model over the respective period of time

Table 4.9 VEC model for Exxon Mobil stocks and Chevron Stocks

Error Correction:	D(LEXXON)		D(LCHEVRON)
ECT1	-0.016485*	ECT1	-0.066536**
ECT2	0.026571**	ECT2	0.044106***
ECT3	0.001549*	ECT3	-0.008475*
ECT4	0.015319*	ECT4	0.083252**
D(LEXXON(-1))	-0.028572**	D(LCHEVRON(-1))	-0.093057**
D(LINDPROD(-1))	-0.542740	D(LINDPROD(-1))	-0.248979
D(LINTRATES(-1))	-0.007544**	D(LINTRATES(-1))	-0.055539**
D(LNYSE(-1))	-0.114773***	D(LNYSE(-1))	0.261799***
D(LOILPRICE(-1))	0.013854**	D(LOILPRICE(-1))	0.014667**
C	0.000686	C	0.000700
Log Likelihood	3810.378		3248.423
Akaike Information Criteria	-5.828800		-4.966907
Schwarz Criteria	-5.789128		-4.927235

* Significant at the 1% level.
**Significant at the 5% level.
***Significant at the 10% level.

In the long run, oil prices have significant positive impact on the oil stocks, while the interest rates and NYSE influence negatively, the relationship with industrial production index however is not significant. For every 1% increase in the first lag of the Exxon Stocks, the price of Exxon Mobil stocks decrease by 0.0281%. If the first lag of the interest rates increase and NYSE by 1%, the stock price decreases by 0.007% and 0.114% respectively. However, oil prices have positive effect on the oil stocks; increase in oil prices by 1% would increase the stock prices by 0.0138%.

The results of VEC model for Chevron stocks are also presented in Table 4.9 and are similar to that of Exxon Mobil, except that unlike in case of Exxon Mobil, the NYSE has weak positive impact on the Chevron stocks.

Table 4.10 VEC model for Reliance Industries stocks and IOCL Stocks

Error Correction:	D(LRIL)		D(LIOCL)
ECT1	-0.002580*	ECT1	-0.020353*
ECT2	-0.001285*	ECT2	-0.005019*
ECT3	0.000645*	ECT3	0.003454*
ECT4	0.012763**	ECT4	0.008572*
D(LRIL(-1))	0.035799**	D(LIOCL(-1))	0.146869**
D(LINDPROD(-1))	0.031770**	D(LINDPROD(-1))	-0.016169**
D(LINTRATES(-1))	-0.134683***	D(LINTRATES(-1))	-0.085721***
D(LNSE(-1))	0.013113***	D(LNSE(-1))	0.135063***
D(LOILPRICE(-1))	-0.061013**	D(LOILPRICE(-1))	-0.139311**
C	0.001918	C	0.000231
Log Likelihood	3083.791		2896.642
Akaike Information Criteria	-4.714404		-4.427365
Schwarz Criteria	-4.674732		-4.387693

* Significant at the 1% level.
**Significant at the 5% level.
***Significant at the 10% level.

Long run relationship using vector error correction was also tested for oil stocks picked from India and UK. Table 4.10 gives the results of VEC for the stocks of Indian oil companies, Reliance Industries and IOCL. Incase of Reliance Industries, the sum of error terms is positive indicating divergence from equilibrium. However, for IOCL stocks, the error terms sum up to negative number, showing that the stocks have a tendency to converge to equilibrium. All the variables, including industrial production index have a significant long run relationship with the oil prices and oil price negatively affect the oil stocks in India.

Table 4.11 VEC model for Royal Dutch Shell stocks and Gazprom Stocks

Error Correction:	D(LSHELL)		D(LGAZPROM)
ECT1	-0.015848*	ECT1	-0.004004*
ECT2	0.002349*	ECT2	0.005332*
ECT3	0.001734*	ECT3	0.005026*
ECT4	0.012232*	ECT4	-0.011017*
D(LSHELL(-1))	-0.011910**	D(LGAZPROM(-1))	0.030222**
D(LINDPROD(-1))	-0.274901	D(LINDPROD(-1))	-6.163433
D(LINTRATES(-1))	0.204060***	D(LINTRATES(-1))	0.295498
D(LLSE(-1))	-0.001792*	D(LLSE(-1))	-0.002686*
D(LOILPRICE(-1))	-0.004739**	D(LOILPRICE(-1))	0.005510**
C	0.001918	C	0.001158
Log Likelihood	3776.331		3002.416
Akaike Information Criteria	-5.776582		-4.589594
Schwarz Criteria	-5.736910		-4.549923

* Significant at the 1% level.
**Significant at the 5% level.
***Significant at the 10% level.

Results of vector error correction model of Shell stocks and Gazprom stocks on the London stock exchange are shown in Table 4.11. In case of both the stocks, the error correction term is positive. Here, we see that stocks of both the companies like most of the other stocks in this study show divergence from equilibrium. The results are similar to that of oil stocks in US, all the variables show long run relationship except for industrial production index. Also, mixed behavior of oil stocks is seen under the influence of oil prices; oil price affect Shell stocks negatively and Gazprom positively.

4.3 Variance Decomposition and Impulse Response

Next, the generalized variance decomposition and the generalized impulse response functions are employed to analyze the short-run dynamics of the variables. The purpose of the investigation is to find how oil stock prices respond to shocks by the other variables of the system. The generalized impulse responses provide an estimate of the response of a variable in the case of innovation in another variable.

4.3.1 Variance Decomposition and Impulse Response for Exxon Mobil Stocks

Table 4.12 shows the results of variance decomposition analysis of Exxon Mobil Stocks. The analysis of variance decomposition tends to suggest that each of the variables used in the empirical analysis can be explained by the disturbances in the other variables. Specifically, in the short-run period more than 99% of the variability in the stocks of Exxon Mobil changes is explained by its own innovations, Next, NYSE and industrial production index contribute to 0.4% and 0.2% respectively variations in the Exxon Mobil stock prices, while 0.06 % of the variability in the stock price is explained by innovations in the price of oil and a very minimal effect of interest rates affect the ExxonMobil stocks.

Table 4.12 Variance decomposition analysis of Exxon Mobil Stocks

Period	ExxonMobil Stocks	Industrial Production	Interest Rates	NYSE	Oil Price
1	100.0000	0.000000	0.000000	0.000000	0.000000
2	99.61699	0.084124	0.000746	0.242096	0.056045
3	99.40715	0.116843	0.000880	0.414438	0.060689
4	99.37416	0.146580	0.001135	0.415490	0.062635
5	99.35638	0.163551	0.001512	0.415665	0.062892
6	99.34024	0.179486	0.001520	0.415843	0.062915
7	99.32705	0.192688	0.001535	0.415808	0.062925
8	99.31588	0.203828	0.001556	0.415797	0.062939
9	99.30625	0.213439	0.001569	0.415795	0.062949
10	99.29799	0.221679	0.001581	0.415792	0.062957

Table 4.13 Impulse Response of Exxon Mobil stocks

Period	Industrial Production	Interest Rates	NYSE	Oil Price
1	0.000000	0.000000	0.000000	0.000000
2	0.000382	-3.60E-05	-0.000648	0.000312
3	-0.000239	-1.53E-05	0.000549	-9.12E-05
4	-0.000228	2.11E-05	-4.58E-05	-5.85E-05
5	-0.000172	-2.56E-05	2.09E-05	2.16E-05
6	-0.000167	-3.70E-06	2.07E-05	7.58E-06
7	-0.000152	-5.07E-06	6.03E-06	5.66E-06
8	-0.000139	-6.16E-06	7.95E-06	6.12E-06
9	-0.000130	-4.80E-06	8.22E-06	5.22E-06
10	-0.000120	-4.49E-06	7.37E-06	4.82E-06

Table 4.13 shows the impulse response of Exxon Mobil Stocks and Figure 4-1 gives the graphical representation. It can be seen from the table that the Exxon Mobil stocks restore back to equilibrium in 3 days after any shock in oil prices. Similarly, for any shocks in interest rates and the stock index, the Exxon Mobil stock prices come back to equilibrium in five to ten days. However, shocks from industrial production take a longer period to stabilize.

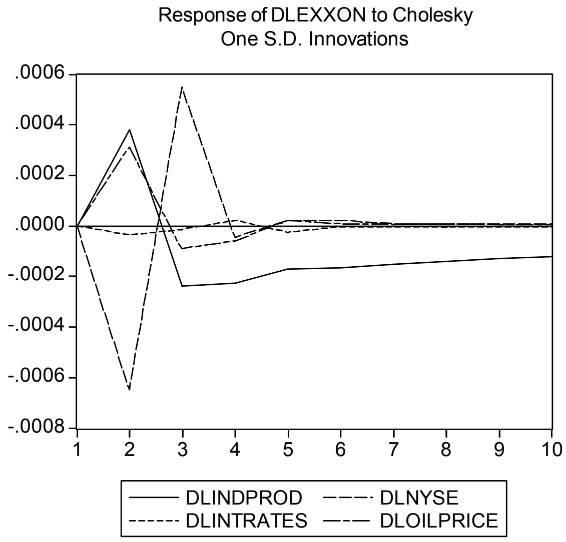

Figure 4-1 Impulse Response of Exxon Mobil Stocks

4.3.2 Variance Decomposition and Impulse Response for Chevron Stocks

The results of variance decomposition for Chevron stocks are shown in Table 4.14. In short-run period more than 96% of the variability in the stocks of Chevron stocks changes is explained by its own innovations. Chevron stocks are affected by NYSE (more than 2%), and then by oil price (0.4%), interest rates (0.18%) and industrial production index (0.03%). Unlike Exxon Mobil stocks, Chevron stocks are affected quiet significantly by interest rates.

Figure 4-2 shows the impulse response of Chevron Stocks. It can be seen from the graph that the Chevron stocks restore back to equilibrium in 4 days after any shock in oil prices. Similarly, for any shocks in interest rates and the stock index, the Exxon Mobil stock prices come back to equilibrium in five to ten days.

Table 4.14 Variance decomposition analysis of Chevron Stocks

Period	Chevron	Industrial	Interest Rates	NYSE	Oil Price
1	100.0000	0.000000	0.000000	0.000000	0.000000
2	97.68585	0.029788	0.116766	2.137656	0.029937
3	96.70228	0.030413	0.169100	2.688601	0.409603
4	96.59847	0.030871	0.176496	2.783547	0.410621
5	96.58421	0.032209	0.181532	2.787244	0.414804
6	96.58086	0.033234	0.182652	2.788270	0.414983
7	96.58034	0.033581	0.182667	2.788321	0.415092
8	96.57991	0.033967	0.182725	2.788308	0.415095
9	96.57952	0.034347	0.182724	2.788315	0.415094
10	96.57922	0.034650	0.182724	2.788310	0.415094

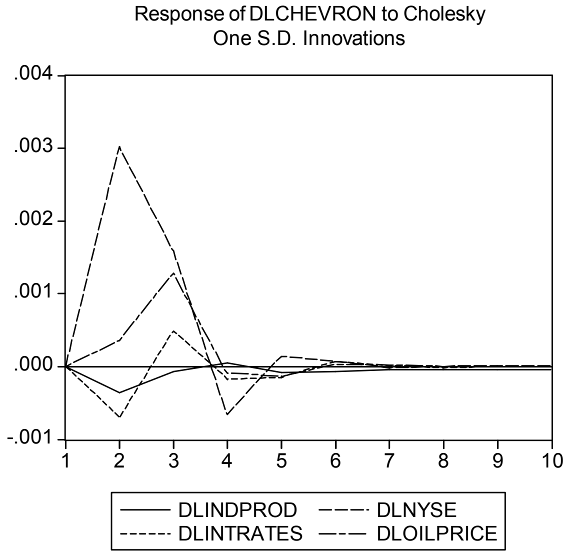

Figure 4-2 Impulse Response of Chevron stocks

4.3.3 Variance Decomposition and Impulse Response for Reliance Industries Stocks

Table 4.15 shows the results of variance decomposition for Reliance stocks. In short-run period almost 99% of the variability in the stocks of Reliance stocks changes is explained by its own innovations. Reliance stocks are affected by interest rates (0.44%), then by industrial production (0.23%), oil price (0.18%) and NSE (0.07%).

Table 4.15 Variance decomposition analysis of Reliance Industries Stocks

Period	Reliance Ind. Stocks	Oil Price	NSE	Interest Rates	Industrial Production
1	100.0000	0.000000	0.000000	0.000000	0.000000
2	99.35354	0.172656	0.007670	0.402088	0.064050
3	99.08097	0.177713	0.076668	0.431928	0.232721
4	99.07331	0.177700	0.076683	0.439489	0.232821
5	99.07085	0.177798	0.077083	0.441450	0.232820
6	99.07043	0.177801	0.077092	0.441852	0.232830
7	99.07034	0.177801	0.077092	0.441934	0.232830
8	99.07033	0.177801	0.077092	0.441951	0.232831
9	99.07032	0.177801	0.077092	0.441955	0.232831
10	99.07032	0.177801	0.077092	0.441956	0.232831

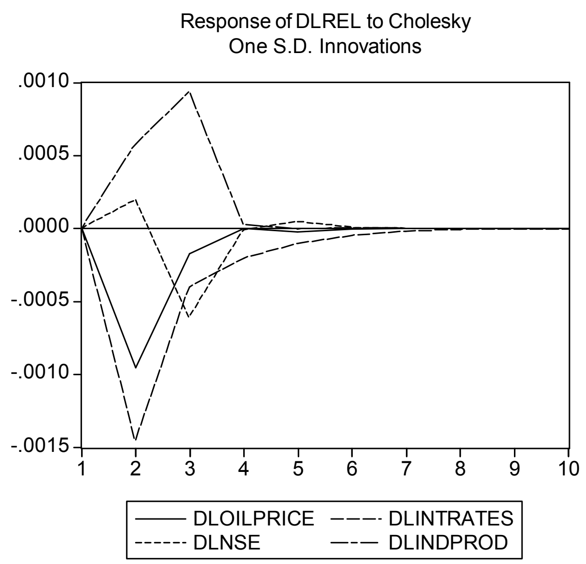

Figure 4-3 Impulse Response of Reliance stocks

Figure 4-3 shows the response of Reliance stocks to short term shocks by oil price and other variables under study. It is evident from the graph that the stock restore back to equilibrium within 4 days from most of the shocks, however, shocks by interest take up to 8 days for recovery.

4.3.4 Variance Decomposition and Impulse Response for IOCL Stocks

Table 4.16 shows the results of variance decomposition for IOCL stocks. In short-run period more than 98% of the variability in the stocks of IOCL stocks changes is explained by its own innovations. 0.8 % of variability in IOCL stocks is explained by oil prices, 06% by NSE, 0.09% by interest rates and a minimal 0.015% by the industrial production index.

Table 4.16 Variance decomposition analysis of IOCL Stocks

Period	IOCL Stocks	Oil Price	NSE	Interest Rates	Industrial Production
1	100.0000	0.000000	0.000000	0.000000	0.000000
2	98.52072	0.811767	0.577281	0.084735	0.005492
3	98.48235	0.812676	0.599983	0.090118	0.014874
4	98.47521	0.818083	0.600857	0.090729	0.015123
5	98.47471	0.818378	0.600913	0.090801	0.015194
6	98.47465	0.818378	0.600925	0.090833	0.015211
7	98.47464	0.818382	0.600925	0.090843	0.015214
8	98.47463	0.818382	0.600926	0.090845	0.015214
9	98.47463	0.818382	0.600926	0.090846	0.015214
10	98.47463	0.818382	0.600926	0.090846	0.015214

Figure 4-4 shows the response of IOCL stocks to short term shocks by oil price and other variables under study. It is evident from the graph that the stocks restore back to equilibrium within 4-5 days from most of the shocks.

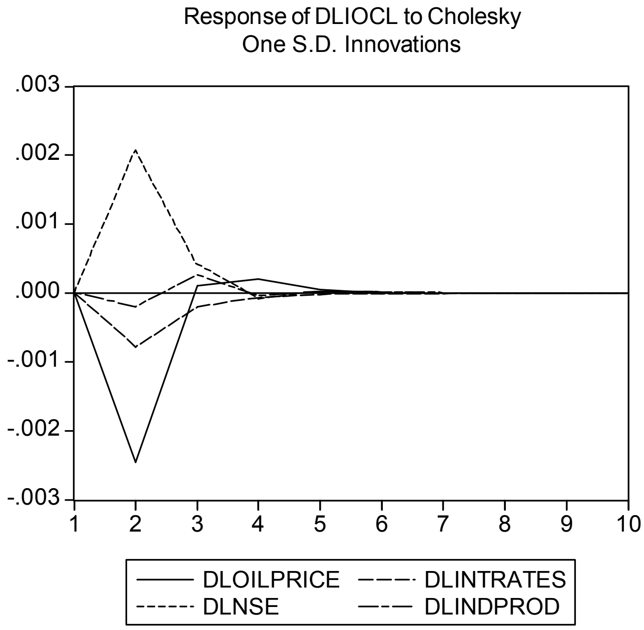

Figure 4-4 Impulse response of IOCL stocks

4.3.5 Variance Decomposition and Impulse Response for Royal Dutch Shell Stocks

Table 4.17 shows the results of variance decomposition for stocks of Royal Dutch Shell. In short-run period more than 99% of the variability in the stocks of Shell is explained by its own innovations. More than 0.1 % of variability in Shell stocks is explained by oil prices, 04% by LSE, 0.42% by interest rates and a minimal 0.015% by the industrial production index.

The response of Shell stocks to short term shocks by oil price and other variables under study is shown in Figure 4.6. It is evident from the graph that the stocks restore back to equilibrium within 5-6 days from most of the shocks.

Table 4.17 Variance decomposition analysis of Royal Dutch Shell Stocks

Period	Royal Dutch Shell Stocks	Oil Price	LSE	Interest Rates	Industrial Production
1	100.0000	0.000000	0.000000	0.000000	0.000000
2	99.44573	0.083652	0.039557	0.418462	0.012599
3	99.41445	0.108288	0.043695	0.418344	0.015220
4	99.41010	0.110768	0.043829	0.419883	0.015415
5	99.40984	0.110824	0.043839	0.419951	0.015548
6	99.40983	0.110825	0.043839	0.419953	0.015548
7	99.40982	0.110825	0.043839	0.419953	0.015563
8	99.40981	0.110825	0.043839	0.419953	0.015569
9	99.40981	0.110825	0.043839	0.419953	0.015575
10	99.40980	0.110825	0.043839	0.419953	0.015580

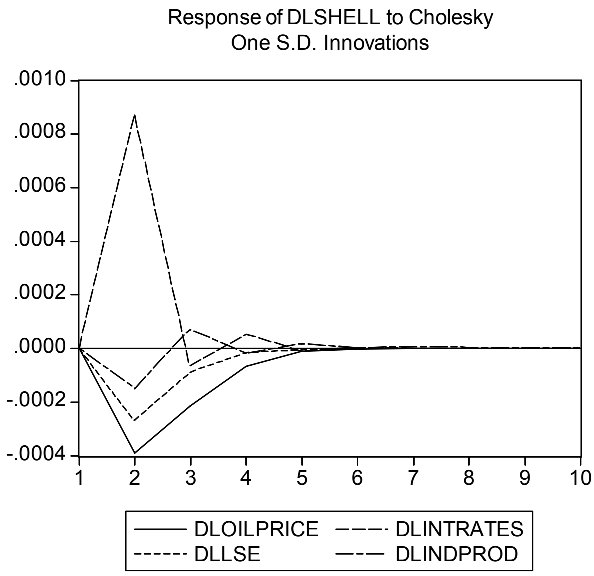

Figure 4-5 Impulse response of Shell stocks

4.3.6 Variance Decomposition and Impulse Response for Gazprom Stocks

Table 4.18 shows the results of variance decomposition for stocks of Gazprom. In short-run period more than 99% of the variability in the stocks of Shell is explained by its own innovations. More than 0.1 % of variability in Shell stocks is explained by oil prices, 047% by LSE, 0.4% by interest rates and a minimal 0.05% by the industrial production index.

Table 4.18 Variance decomposition analysis of Gazprom Stocks

Period	Gazprom Stocks	Oil Price	LSE	Interest Rates	Industrial Production
1	100.0000	0.000000	0.000000	0.000000	0.000000
2	99.70388	0.002207	0.000295	0.253707	0.039913
3	99.34976	0.172296	0.047377	0.390748	0.039817
4	99.33467	0.177760	0.047423	0.393651	0.046500
5	99.33162	0.177766	0.047542	0.394717	0.048353
6	99.32942	0.177780	0.047541	0.394710	0.050551
7	99.32770	0.177784	0.047541	0.394716	0.052257
8	99.32615	0.177786	0.047540	0.394716	0.053806
9	99.32482	0.177787	0.047539	0.394715	0.055135
10	99.32366	0.177788	0.047539	0.394715	0.056296

The response of Gazprom stocks to short term shocks by oil price and other variables under study is shown in Figure 4-6. It is evident from the graph that the stocks restore back to equilibrium within 5-6 days from most of the shocks. However, shocks from industrial production take a longer period to stabilize.

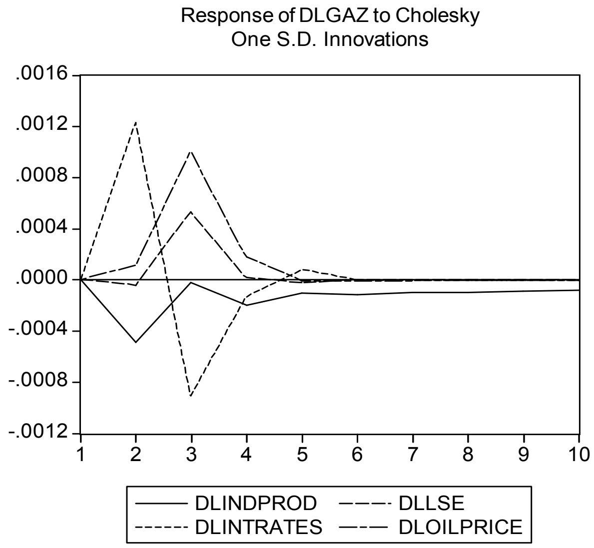

Figure 4-6 Impulse response of Gazprom stocks

4.4 ARCH AND GARCH

The LM tests for all the oil stocks (individually) and oil price indicate that the ARCH effects are significant at the 1% level, suggesting the use of the ARCH/GARCH methodology is warranted (see Table 4.19).

Table 4.19 The ARCH Lagrange multiplier (LM) test for the oil stocks and oil price

Stocks	EXXON MOBIL	RELIANCE INDUSTRIES	ROYAL DUTCH SHEL
Constant	0.000382	0.004377	0.000194
AR(1)	0.970257	0.977934	0.978343
Probability	0.0000	0.0000	0.0000
F-statistics	19614.06	28836.11	16065.04
Probability	0.0000	0.0000	0.0000

The null hypothesis is no ARCH.
All ARCH effects are significant at the 1% level.
All variables are in logarithmic form

Based on the methodology, the volatility of oil prices coming on the oil stocks was examined using the GJR GARCH model. From the Q-Q plots it was seen that the time series data for oil price and all the oil stocks was not normal and hence, Student's t distribution was used in the estimation of GARCH model. The estimates of the GJR GARCH model for the oil stocks and oil prices are provided in Table 4.20.

Table 4.20 Estimates of GJR GARCH

	EXXON MOBIL	RELIANCE INDUSTRIES	ROYAL DUTCH SHELL
Mean equation			
Oil price	0.620847* (248.7385)	1.863194* (205.7621)	0.515737* (258.2248)
Constant	1.572677* (161.2549)	-4.895373* (-132.4518)	1.282430* (173.7750)
Variance equation			
Constant	0.000160* (4.379959)	0.001117* (3.367979)	0.000124* (6.854251)
ARCH	0.840256* (3.998672)	0.942672* (3.035662)	0.925324* (5.374756)
I(Dummy variable)	0.029910 (0.142617)	0.032610 (0.092621)	0.011570 (0.058585)
GARCH	0.128752 (1.533471)	0.046100 (0.993239)	0.058918 1.177387

All variables are in logarithmic form. Z statistics are in parentheses.
* Significant at the 1% level.
**Significant at the 5% level.
***Significant at the 10% level.

The four coefficients in the variance equation are listed as C, the intercept; ARCH (1), the first lag of the squared return; the dummy variable and GARCH (1), the first lag of the conditional variance. The ARCH term is significant while the GARCH term is not significant. This entails that, the long term moving average volatility of oil prices has an impact on the oil stocks while the short term volatility does not significantly affect the oil stocks. Notice that the coefficients sum up to a number less than one, which is required to have a mean reverting variance process. Since the sum is very close to one, the volatility has quiet persistent shocks. The dummy term is not significant which implies that the oil shocks to the oil stocks are positive. In addition, the sum of the co-efficient of the error term and the dummy variable is greater than zero, which implies that any bad news increases volatility and its effects.

4.5 Summary of Results

The overall results suggest that there exists co-integration between oil stocks, oil prices, interest rates, industrial production and the stock index and there is a significant short term as well as long term relationship between them. It was seen that oil prices affect the oil stocks and this relation is influenced by the stock index and interest rates. Thus, the hypotheses H_1 through H_3 are accepted. The influence of the industrial production index could not be warranted as it is not significant in case of US and UK, while in India the effect is significant. Hence, hypothesis H_4 is indecisive.

The results of variance decomposition implies that oil prices account to 0.1% to 0.9% variance in the oil stocks depending on the extent of the effect of other variables. The impulse response function suggest that the in the short run, the oil stocks recover from most of the shocks from the variables in a period of 4-8 days.

From the GARCH results it is clear that volatility shocks of oil prices on the oil stocks are quite persistent and that long-run average shocks are more influential than the immediate volatility shocks.

CHAPTER 5 : Conclusion and Recommendations

5.1 Summary and Conclusion

This study investigates the effects of oil prices on oil stocks of three different markets (US, India ad UK) using daily data for the available period August 08, 2003 to August 08, 2008. The oil price is the London Brent Crude Oil Index. The oil stocks include the Exxon Mobil and Chevron stocks from the New York Stock Exchange, Reliance Industries and Indian Oil Corporation Limited stocks from the National Stock Exchange of India, and Royal Dutch Shell and Gazprom stocks from the London Stock Exchange.

The empirical investigation employs unit root tests, cointegration tests, variance auto regression, error-correction models with variance decomposition and impulse response, and ARCH/GARCH models. The cointegration tests for the variables (oil price, stock price, stock index, interest rates and industrial production index) system indicate that these variables have long-run relationship and have five cointegrating relationship.

Moreover, the VAR and VEC model for the system suggest that there exists significant short run and long run relationship between oil price and the oil stocks including the effect of the other variables such as interest rate and the stock index. According to the estimated coefficients of the structural part of the model it is noted that oil prices in US have a positive impact on the oil stocks. The results in for US oil stocks are in agreement with those achieved by Nandha and Raff (2007) which say that oil price rises have positive impact on the equity returns of oil and gas companies.

In case of Indian oil stocks the impact of oil price is negative, while in case of UK, the impact is mixed, negative for Royal Dutch Shell and positive in case of Gazprom. One way to explain the variation in these results would be based on the oil reserves owned by these countries. The Oil & Gas Journal, Vol. 103, No. 47 (Dec. 19, 2005) estimated the US has oil reserves of 21.4 billion barrels while India has only 5.8 billion barrels. Thus, increase in oil price is good news to US and not for India. Accordingly, after acquisition of the oil company Sibneft, Gazprom, with 119 billion barrels (1.89×1010 m3) of reserves, ranks behind only Saudi Arabia, with 263 billion barrels (4.18×1010 m3) and this explain the positive relationship of its stocks with the increase in oil price while this is not the case with Shell. The industrial production index except for India does not have any influence on the stock prices. The effect of interest rates on the stocks prices of the oil companies can relate to the D/E ratio of the company. If the oil company has high liability the effect on its stock is negative and vise versa. Cassar, Gavin John (2005) explains financing-investment linkages play an important role in both the future operating performance of firms and how the market prices the firm.

The variance decomposition and impulse response analysis suggests the existence of instantaneous, temporary effect of oil price innovations on the oil stock prices. However, the effects of all the variables vary with each company. The impulse response funtion also indicate that the UK (London) market is more efficient than the other markets under study.

The volatility analysis using GJR GARCH for the oil stocks suggests that the oil price volatility transmission has a persistent effect on the volatility of the stocks of the oil companies in all the countries studied here. It also implies that oil volatility effects of higher oil prices are more than that during the low oil prices. These results are similar to that obtained by Hammoudeh, Dibooglu and Aleisa (2002) where the studies the relationship between the oil price and oil equity indices in US. It was also observed historical prices to be responsible for more volatility transmission than the spot price.

5.2 Suggestions for Future Research

This study can be extended further by considering more oil companies in each stock exchange and also including other important countries. By doing so, the results obtained will be more generalized. The popular notion of a simple correlation between crude oil price and oil stocks needs to be modified to take account of the complexities brought on by vertical integration, multinational organization and the regulatory climate.

5.3 Implication

This paper contributes to the knowledge of the dynamic relationships between oil stock and oil prices, including other macro-economic variables and stock index. The results highlight the varying significance of the variables in explaining the stock prices in the markets. The results of the study should be useful to the various oil companies who are engaged in different phases of this industry and whose shares are traded on those stock exchanges. For the oil companies, they can adjust their liabilities knowing the effect of interest rates on their stocks. The oil companies can also study their comovement with the market. With this they can track the systemetic risk the company hold and can adjust their beta.

The results should also be useful to the individual investors, hedgers, and arbitrageurs who buy the shares of these companies and wish to understand how the stocks of the different companies react to changes in the level and volatility of the oil spot/futures prices. If an increase in the oil price leads to a decrease in the stock prices, this increase should be a precursor for the investors to avoid these stocks. Moreover, the presence of long-run relationships among the oil prices, oil stocks and other macro-economic variables also throws light on having these oil stocks in the portfolio in the long run taking the economic condition into account. The impulse reponse anaysis for various stocks also throws light on the efficieny of the markets in response to shocks. Thus, investors can decide on the market they wish to invest based on their efficiency.

The policy implication for oil volatility transmission is that, at times of oil volatility, traders should choose the oil company stocks that match their tolerance for volatility and use the right financial derivative to profit from this volatility.

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