# Valuation of Integrated Oil & Gas Companies

***A comparative analysis of methodologies and empirical practices***

## MSc Thesis

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## Abstract

The paper examines a number of empirically utilised and academically established valuation methodologies in order to value Integrated Oil & Gas Company's common stock. By applying and comparing DCF, SOP and Real Options based valuation methodologies with the aims of establishing both, an absolute share price value and relative value for the sample representatives of for Exxon Mobil Corp and BP Plc, the paper highlights key input parameters for each methodology and discusses the key differences in the outputs of the models. The study finds that the market relies on the Discounted Cash flow Valuation methodology and that the Real Option based valuation attributes significantly higher value to the companies, while the Sum Of Parts valuation demonstrates significant discounting of the value in upstream assets and a rather large holding discount as measured by stand alone market peers.

The paper then goes further by providing a historical twenty year back test of the global Integrated Oil & Gas stock portfolio based on publicly available company financial factors, and provides a stock selection model for the custom universe in the long/short, market neutral setting. Lastly, a strategic perspective for key stakeholders is provided based on the findings from the comparison of valuation methodologies, highlighting their strategic implications for the practicing investors, corporate leadership and regulatory entities.

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# 1. Introduction

There has been a great debate about the number of different methods available to an analyst for valuing and comparing valuations for Major Integrated Oil & Gas companies that are listed on global stock exchanges. There is a balance between the simplicity of the methods and their value added to shareholders and management. In this thesis, I will present and compare several existing theoretical and empirically most commonly applied valuation methodologies and analyse them in the best interest of an Equity shareholder as well as highlighting key issues and considerations for the management. I present methods in order of ascending complexity, describing their advantages, disadvantages uses and misuses. By starting out with the most basic DCF and Sum of the Parts methodologies of stock price valuation and later moving into the Real Options, I will aim to present the principal theoretical foundations of valuing an Integrated Oil & Gas companies, with emphasis on theoretical methodologies relevant to sector, later to compare these methods to the empirically most actively used Relative Multiples Based methodologies used in Public Equity Investment Community and analyse the findings. The sample for the study will be Exxon Mobil Corp. and BP Plc. for testing the customized DCF, NAV, Options based models and Global Major Integrated Oil & Gas[1] universe for econometric tests.

Based on the findings after examining each method, I will attempt to reflect on usefulness of application methodologies discussed with the use of econometric back tests, for an active equity investor wishing to maximize value, in this case reflected by share price returns. The paper will also highlight some key strategic parameters of focus, for the management of the companies, to better present them with more detailed shareholder rationale for their expectations. Thus, the aim of this paper is to improve the scope of accurate valuation by highlighting most critical issues for valuing Integrated Oil & Gas Companies and thereby reduce the potential and typical miscommunication of expectations and thereby value, between shareholders and the management.

## 1.1 Overview of the Valuation quandary in Oil & Gas Industry

The scrutiny of valuation methodologies, their predictive power and accuracy of their estimation has had extensive research in the past. The conventional stock market wisdom[2] suggests that value of a listed equity for an Oil & Gas Integrated is largely determined by reserves, production and cash generation ability. Meanwhile, a growing body of theoretical research has been arguing

[1] As defined by Standard & Poor's and MSCI Barra jointly developed the Global Industry Classification Standard (GICS®)

[2] Lehman Brothers Research

that standard capital accounting based valuation methodologies tend to undervalue Oil & Gas companies when compared to Real Options based valuation methodologies. While the most common criticism of the DCF (Discounted Cash flow Valuation) from both camps of thought is based on the notion that DCF method fails to properly account for the flexibility of the business decisions regarding production increase/decrease, delays in reserve bookings, and liquidation by management Triantis and Hodder (1990), Hayes and Abernathy (1980). Thereby implying that the more options the company has the more valuable it should be. The problem with that, however, is that managers and senior executives have often failed to properly account for their company's embedded options and have wasted them to expire worthless. Although, trying to value a company based on a valuation model that uses a portfolio of real options to value resource based stocks makes more intuitive sense, unfortunately, it is often overly cumbersome and not scalable solution for an equity portfolio manager as well some operational managers.

In contrast to Real Options Valuation, the DCF is based on the assumption that an investment is to be made now or never, is unchangeable across life, assumes passive management and constant discounting for time and risk. The Real Option Valuation methodology, however, can defer investment with dynamic lifeline, assumes active management and discounts for time and managed risk.

With respect to options, it must be noted that main difference amongst Real Options and Financial Options is that management can take actions that affect and potentially enhance the value of the options portfolio, and this argument is strong for both the investors and the management. Financial Option holders, however, are passive and have zero impact on the value of the options they hold. Therefore Real Options theory, intuitively demonstrates greater flexibility and more reason to be further investigated.

Lastly, equity portfolio managers often use Relative Based Valuation Methodologies based on accounting ratios in order standardise the comparison within an industry. This thesis will explore and find appropriate ratios in terms of their predictive power of usefulness in relative stock selection as more often than not, analysts use flawed and unadjusted figures which can lead to disastrous consequences on portfolio managers as well miscommunication in terms of expectations to the management of existing companies, thereby jeopardising the future of the companies as well the industry in its entirety.

## 1.2 Thesis Aims and Objectives

1. Compare Theoretical and Empirical Equity Valuation Frameworks for Integrated Oil & Gas companies and outline key principles for valuation and investment.

2. Empirically explore the relationship between Relative Valuation Indicators and Share Price Performance of Integrated Oil & Gas Companies.
3. Based on the findings, assess the Strategic Implications facing the companies, shareholders and the state.

### *1.2.1 Research Questions*

In order to scientifically fulfil the above listed aims of the thesis, the paper will aim to answer the following questions:

- What are the key tools and methods currently applied in valuing Integrated Oil & Gas Companies?
- What is the most valid theoretical methodology for valuing an Integrated Oil & Gas Companies from the choice of DCF, SOP, Relative Valuation and Real Options and what are the most critical factors to consider for shareholders during valuation?
- How much value added is there from using commonly utilized relative valuation multiples often emphasised by the banking and financial markets community?
- How is valaue added from multiples based relative valuation methodology and how it can be used to generate shareholder returns?
- What are the common, officially reported, operational and financial characteristics of companies that have predictive power to outperform the listed public equity market consistently over the last 20 years relative to their peers?
- What are the implications and how can this knowledge be useful to the corporate management, which has often been accused of erroneous project valuation and mismanagement resulting in poor share price performance, from equity shareholder point of view?
- What happens when theory does not deliver indicative performance? Where does theory diverge from results? And where should the academics meet the practitioners in the future?

The more general desire for the thesis is to analyse an existing theoretical and practical framework for valuing Integrated Oil & Gas stocks and to outline a theoretically sound and applicable mix of methodology based on empirical results.

There are several directions from which one can address a problem of such proportions in the more efficient manner. First, one must draw a distinction between valuing a company in absolute terms or relative to peer terms. Secondly whether one chooses to examine a company as a "black box in which we as shareholders put in money which generates dividends"[3] or analyse each individual project that the company is involved in and then sum them. In more basic DCF methodology, the task would be to forecast what the company's future cash flows between the company and its financiers rather than on operational cash flows. Such models often provide inaccurate results based on their simplicity and ignorance of a great deal of information that is readily available. As a consequence to wanting to integrate as much relevant information as possible, we might step inside the black box and analyze the internal cash flows of the company in an attempt to figure out what the whole company is worth. Alternatively, one might describe valuation models by the output they generate in terms of the model result Vs historical valuation. In absolute valuation models, one may generate an estimated dollar value for the stock, which as I will demonstrate, is an accurate assessment of market perception of value. Yet the question of whether the market is right in terms of valuation will be answered by exploring the real options methodology. In relative valuation models, however, I do not seek to estimate the dollar value of the stock, but rather to determine whether a stock appears to be a better or worse buy than other, similar stocks. This will become useful in terms of wanting to isolate key factors that give the investors an ability to differentiate in terms of which stocks to buy relative to peers and similarly which stocks to sell. The implications of the multitude of the frameworks assessed in the thesis are quite different. In the former, we might conclude that a stock is undervalued. In the latter, we cannot conclude that a stock is undervalued, but we might conclude that a stock is undervalued relative to its peers. In addition, because relative valuation is overcrowded with re occurring ratios, the differences are shrinking amongst companies and regional risk and return characteristics are not always differentiated appropriately. As an equity investor one must be careful to interpret the models for various different purposes. As it will later become visible, relative valuation models are easier to implement than absolute valuation models, but the conclusions to be drawn are also weaker.

### *1.2.2 The Relevance of Thesis*

The recent evolution in the oil price and the cyclical high point at which the industry currently finds itself, has again come to have raised numerous question in Oil & Gas's role in the global economy in multiple dimensions. The global relationships and consequences of, among Oil& Gas Prices, Supply, Demand and global economic growth have evolved dramatically in the last two decades. The world economy is less oil intensive overall, especially in the developed world, but oil remains the lifeblood that sustains global trade and transportation as well as economic growth in emerging markets. The degree to which the oil industry can convert challenges into

[3] Hoover, Scott. Stock Valuation. Blacklick, OH, USA: McGraw-Hill Companies, The, 2005. p 293.

opportunities will shape future industry as a whole, as well as influence international relations, determine whether Oil & Gas continues to be an enabler of economic growth or becomes a constraint.

Given that publicly listed international Oil Companies constitute +10% of global Oil & Gas reserves and production, correctly understanding and accurately assigning value to the decisions, risks, assets and growth of these companies has become evermore crucial.

In addition to representing a significant part of global resource base and supply delivery of these companies, Major Integrated Oil & Gas companies also constitute significant portion of Global Equity Benchmarks like MSCI World, in which Integrated Oil & Gas constitutes +10% of the index. A more detailed examination of OIL & Gas industry will be discussed in the next section, where the impacts of Integrated Oil & Gas stocks become truly visible.

It therefore becomes interesting to investigate how these companies are valued and what impacts that valuation assigned by the investment community has on strategic decisions of Integrated Oil & Gas, whilst faced with demands for greater cash flow generation as well more short term oriented shareholder value creation.

Periodically high oil prices, commonly referred to oil price shocks, often raise a number of opinions amongst governments, shareholders and the public. In particular as to who should reap the benefits and the costs during high oil price periods and who should be incentivized and left to face doom during periods of low prices. Although the macroeconomic causes and implications of crude oil price volatility on the world economy is a fascinating topic, I will only note the key findings and maintain the focus of the paper on the valuation methodologies.

In a larger energy context however, the relevance of this thesis is best explained by the Global energy consumption trend which has nearly doubled since the 1973 oil crisis resulting from large scale value propositions initiated by the state and corporate executives for their quest to new resources and increased diversification of production. In terms of the energy mix, oil provides approximately 36% of total primary energy consumption that is primary fuels that are commercially-traded. Despite the implications for global warming and the environment, coal represents 29% of total energy use followed by natural gas, which meets 26% of energy demand. Hydro-power and nuclear energy account for approximately 6% each. Not surprisingly, the surge in oil prices during this decade has encouraged the development of alternative energy sources such as modern bio-fuels and renewable energies such as wind, solar, geothermal and tidal power. However, altogether these represent less than 2% of global energy demand, although they are beginning to play an increasing role in the balance sheet of Integrated Oil and Gas companies as well as for nation states in their proportion of the fuel mix. Fuels such as wood, peat and animal waste are still important in many economies, for example the International Energy Agency estimates that more than 10% of China's energy use in 2007 was in the form of such traditional biomass. However, these are generally not counted in global energy statistics.

As it currently stands, a large part of the Oil & Gas Industry relies on the DCF based valuation methodology where in the management tends to define the discount rate, price of oil to be used in valuation and discounting the future cash flows based on production targets. These assumptions are less likely to remain flexible unless there are short falls in production, aggressive price movements or other unaccounted events. As result, market uncertainty in price tends to be ignored, the discount rates are not always risk adjusted and the optionality in analysis in not taken into account, therefore raising the question of how should Oil & Gas companies and their shareholders value companies? And on what basis should the management best satisfy shareholders demands? What should shareholders expect from the companies and what should the management of these companies strive to deliver to truly add value for shareholders hungry for capital gains?

### *1.2.3 Delimitation*

The object of this work is to provide the essential content of what long existed in the valuation processes for Integrated Oil & Gas companies and to outline which processes are used and which are most useful, as opposed to inventing a new valuation methodology.

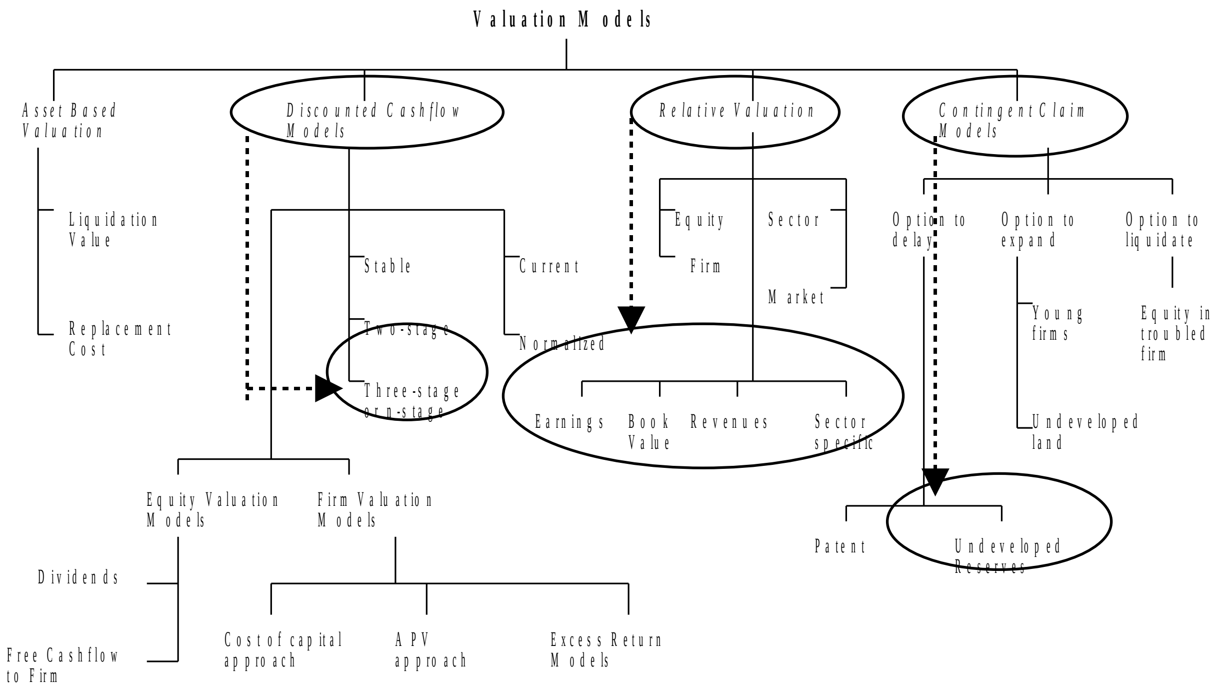
The thesis will not aim to anticipate or make any forecasts on the price of oil nor does it attempt to provide a forecast mechanism. The paper will not try to derive a process of valuation oil or any other commodity. This paper also does not claim that it has better information on corporate production estimates than any other, therefore more detail should be focused on methodology and not on the exact reserve figure estimates.

## 2. Theoretical Foundation and related Valuation Methodologies

In order to asses how to best approach valuing Integrated Oil & gas companies, it makes sense to examine the relevant and existing theoretical approaches which will be used in the thesis to attribute absolute and relative value to the companies selected as prime examples in the sector (Exxon Mobil Corp. and BP Plc,)

To summarise the diversity of valuation methodologies into perspective, Aswath Damodaran provides a good overview in terms of available methods as demonstrated below. I highlight the three dimensions of valuation that will be elaborated on in this thesis.

**Figure 1: Valuation Framework**




**Source:** Damodoran

A significant amount of theoretical research aimed to explore the relationship between financial performance and valuation of Oil & Gas companies exists for quite some time now. The general tendency of the existing research for valuing resource based companies has been to focus on accounting information and its interpretation, for DCF and Relative Valuation Multiples methodologies as well as using Real Options based methodologies to estimate the value of resource projects. Damodaran [4] classifies the three methodologies well when he describes that the DCF relates to value of an asset to present value of expected future cash flows of that asset; Relative Multiples Based Valuation estimates the value of an asset by looking at the pricing of

[4] Damodaran, Aswath: Investment Valuation (1996) Wiley and Sons.p9

comparable assets based on various accounting based values; lastly he describes the Contingent claim valuation, which uses Real Option pricing models to measure the value of an assets that share option characteristics. This paper will explore the abovementioned methodologies.

## 2.1 The Discounted Cash flow Approach

The DCF based methodology is founded on the Present Value Principle[5] where in the value of an asset is the present value of expected future cash flows demonstrated in the formula below. It is important to highlight the difference between Equity and Firm Value, as the main point here is the discount rate that one applies. From an equity perspective Cost of Equity is appropriate, when considering overall Firm Value, WACC is recognised as the main method for estimating discount rate. In terms of Cash Flow, cash flow to Equity is more like the dividend and cash flow to firm is prior payments to debt-holder or equity holder. The theoretical explanations that follow will be elaborated in more detail during the empirical analysis section of the report.

**Figure 2: DCF**

$$\text{Value Asset} = \sum_{T=n}^{T=n} \frac{CF_t}{(1+r_e)^{tn}}$$

Where,
n = life of the asset
$CF_t$ = Cash Flow to Equity, in period t
$r_e$ = Discount rate reflecting the friskiness of the estimated cash flows.

Relating the equation to valuing Equity yields the below formula;

**Figure 3: Value of Equity**

$$\text{Value of Equity} = \sum_{t=1}^{t=\infty} \frac{\text{CF to Equity}_t}{(1+r_e)^t}$$

Where,
CF to $\text{Equity}_t$ = Expected Free Cash Flow to Equity in period t $r_e$ = Cost of Equity

Since DCF applied to just equities is the dividend discount model (DDM), discount cash flows to equity holders (dividends) at the discount rate to equity holders (in this case denoted by $r_e$) can be seen below;

[5] Damodaran, Aswath: Investment Valuation (1996) Wiley and Sons.p9

**Figure 4: Value of Equity Derived**

$$
\begin{aligned}
V_0 &= \sum_{t=1}^{\infty} \frac{D_t}{(1+r_e)^t} \\
&= \frac{D_1}{(1+r_e)} + \frac{D_2}{(1+r_e)^2} + \frac{D_3}{(1+r_e)^3} + \ldots\infty \\
&= \frac{D_1}{(1+r_e)} + \frac{D_2}{(1+r_e)^2} + \frac{D_3}{(1+r_e)^3} + \ldots + \frac{D_T + P_T}{(1+r_e)^T}
\end{aligned}
$$

The intrinsic value of the stock in this case becomes;

**Figure 5: Value of Equity Derived Cont.**

$$V_0 = \frac{D_0(1+g)}{r_e - g} = \frac{D_1}{r_e - g}$$

In order to estimate growth we arrive at the following formula;

In terms of moving from a single stage DCF model to a multiple stage model the below formulation is applicable:

For Stable Firm:

**Figure 6: Value of Equity Stable State of Growth**

$$V_0 = \frac{CF_t}{r-g_n}$$

**Formula #:** Value of Equity Three State Growth according to Damodaran

For two stage growth:

**Figure 7: Value of Equity Two State Growth**

$$V_0 = \frac{CF_0+(1+g)*\left[1-\frac{(1+g)^n}{(1+r)^n}\right]}{r-g} + \frac{CF_{n1+1}}{(r-g_n)(1+r)^n}$$

For three-stage growth Model, with help from Damodaran the following formulation is obtained:

**Formula 1: Value of Equity Three State Grate Growth**

$$P_0 = \sum_{t=1}^{t=n1} \frac{CF_0+(1+g_a)^n * \prod a}{(1+r)^n} + \sum_{T=n1+1}^{t=n2} \frac{CF_t}{(1+r)^n} + \frac{CF_{n2}(1+g_n) * \prod n}{(r-g_n)(1+r)^n}$$

Where,

$CF_0$ & $CF_t$ = earnings per share in year t
$g_a$ = growth rate in high growth phase
$g_n$ = growth rate in stable state growth phase
$\prod_a$ = payout ratio in high growth phase
$\prod_n$ = payout ratio in stable growth phase

The Three Stage Growth Model is most applicable pillar to my valuation analysis as the models flexibility makes it useful for valuing any firm. This model is also most appropriate as the companies in question, are undergoing slow state of growth, post 2010 to accelerate and to later deplete their leading differential advantage over time into a steady state of growth. Although a four-stage model would be even more appropriate I will refrain from adding this optionality till the empirical analyses stage of the paper.

The model has a flexible methodology for dealing with assumed growth. The model I developed uses IBES consensus estimate figures for stage one then moves to extract historical fundamental growth based on Reinvestment Rate and Return on Invested Equity to determine 2nd stage growth and lastly uses the terminal value growth calculation as discussed below for the third and the final stage of growth as opposed to using the GDP or any other methodology which has little to d with the company as the world is more global now than ever before. This time varying growth methodology takes into account a historical blueprint of the company and is useful for comparing with IBES based analyst expectations for the current and forward year growth.

In terms of estimating the terminal value growth rate, the following formula is used.

**Figure 8: Terminal Value Growth**

$$\boxed{g = b \cdot \left( ROA + D/E \cdot \left( ROA - r_D \left(1 - t\right)\right)\right).}$$

Where g is,
b = Beta
ROA = Return on Assets
D/E = Debt to Equity
R = discount rate
T = tax

The rational behind 2nd-stage growth is that it includes potential margin expansion capacity based on historical proof and cyclicality that is best suited for new technological projects such as Gas To Liquids Technology, Coal to Liquids etc and the phasing out of old technologies which are more Oil Production and development oriented as fundamentally demonstrated in the past technological leaps by the companies.

Lastly, the opportunity cost, which is defined as the return that stockholders could earn on alternative investments of equal risk, here defined a $r_e$ is typically defined with the use of the four most common methodologies described below;

**Figure 9: Cost of Capital**

CAPM: $r_e = r_{RF} + (r_M - r_{RF})\beta$ — As already derived above.

$r_e = r_{RF} + (r_{PM})\ \beta$ — Market $r_e = r_d$ + Bond Risk Premium

DCF: $r_e = D_1/P_0 + g$ — Market Risk premium plus Risk Free Rate shortcut

For the standard methodology as defined by Damodaran, cost of equity can be approached via the use of the Capital Asset Pricing Model (CAPM). The risk-free rate can typically be taken as the interest rate on a generic 10-year government note, which usually matches the maturity of projections used in DCF. $\beta$ in this case refers to the covariance of returns to market divided by the market variance as described below usually estimated using a regression:

$= Cov(r, r_M)/Var(r_M)$

Based on CAPM, cash flows between periods are assumed to be independent. The expected part of the cash flow numbers is often forgotten. Below figure demonstrates the three-stage DCF method which is most commonly applied due to its simplicity and intuitive rational.

**Figure 10: Three Stage Growth Model g**

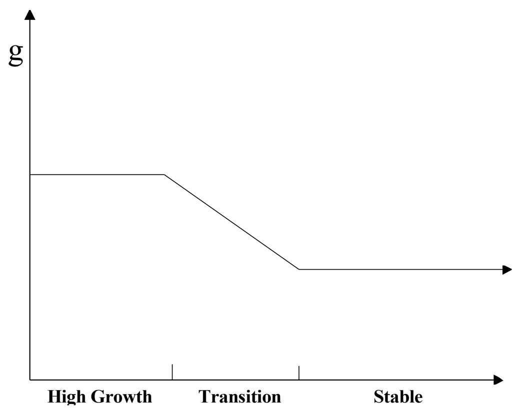
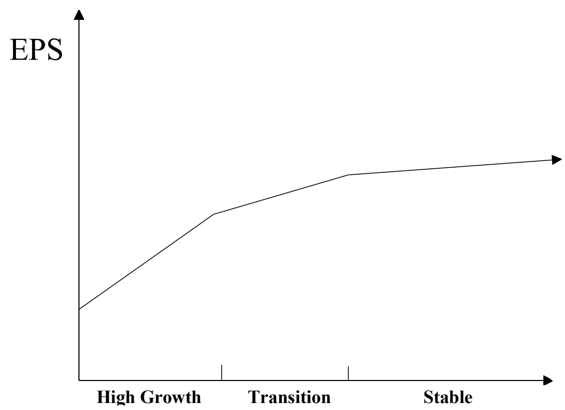



**Figure 11: Three Stage Growth Model EPS**




Theoretical distribution of NPV at risk adjusted rate r is not always correct because, the NPV is the amount of money that the company values the project at today. Since a NPV is the net present value, it can have no uncertainty. Having double counted the risk of the project by first discounting at the risk adjusted discounted rate r and then showing the NPV as a distribution. One should determine re from the cash flow distributions, as re is greater when uncertainty is larger Simulation to get NPV mean value is only way to take into account correlations in cash flows such that, P(>0) is the probability that the IRR exceeds the risk-adjusted discount rate NPV distribution discounting at the risk-free rate is correct rf, but not much use for decision-makers.

Ideally, valuation should be undertaken by means of net present value analyses. The value of a firm is then determined by the cash flow, growth and risk characteristics. As analysts lack the necessary data to do such analyses in a proper manner (asymmetric information), they often resort to relative valuation. According to Damodaran (2002), the use of relative valuation is widespread. The reasons are that valuation based on multiples can be completed with far fewer explicit assumptions and far more quickly than an exhaustive discounted cash flow (DCF) valuation. Furthermore, relative valuation is simpler to understand and easier to present to clients. Finally, relative valuation is according to Damodaran much more likely to reflect the current mood of the market, since it is an attempt to measure relative and not intrinsic value.
On measuring intrinsic value, Damodaran goes further to discuss Brennean and Schwartz who presented methodology for valuing a gold mine using options. Damodaran states that "An important issue in using option pricing models to value natural resource options is the effect of development lags on the value of these options."[6] In broader terms Damodaran argues that since the assets owned by natural resource firms can be viewed as options, the firm itself can be valued using option pricing theory. Thus, to value a natural resource firm one would need to consider and value each option separately and accumulate the values into one sum, keeping in mind the lags after which the options become active.

Lastly the Weighted Average Cost of Capital was calculated using the following notion:

**Figure 12: WACC**

WACC = ***r***equity (E/V) + ***r***debt (D/V)

D,E = current market value of debt and equity
V = Debt + Equity = sum of debt and equity value
***r***debt = current rate of borrowing
***r***equity = current expected rate of return on stock

An interesting, Oil industry related analysis of DCF Valuation with Real Option Valuation methodologies is summarized by Grafstrom & Lundquist[7] (2002) examination of the comparison of the two methods by applying them to North Sea Oilfields. They highlight that DCF cash flow analysis fails to account for the flexibility in the business decisions as confirmed by previous research of Tiantis and Hodder (1990), Hayes and Abernathy (1980). In their examination of an undeveloped oilfield differs dependant on if Real Option valuation of DCF valuation is used. As I will argue later, the Real Option valuation methodology not only highlights the delay value attribute, but also the potential optionality of the unproved resource base. They also go further by highlighting the disastrous impacts of neglecting the great flexibility in options based

[6] Damodaran, Aswath: Investment Valuation (1996) Wiley and Sons.
[7] Lundquist, L & Vinnel, L *Real ption Valuation vs. DCF Valuation:* An application to a North Sea Oilfield. Stockholm University, School of Business, MSc in Financial Economics. Spring 2002

approaches, because of significant undervaluation of assets and miss allocation of resources that follow as a consequence in the industry.

The theoretical pillars of examining the Real Options Based Valuation Methodology are based on Fischer Black and Myron Scholes as modified by Robert Merton and later extended to the Gibson and Schwartz one-factor model (1990) for evaluating natural resource investments. As a foundation of Options theory, Black Scholes Financial Options[8] framework will be applied and discussed with its relation to the Real Options related to and used in the Oil & Gas Industry. In addition, the discussion on validity of Spot Convenience Yield Models for Energy Assets is well taken by Ludkovski & Carmona (2003) where in they review the relevant literature on convenience yield models and add two additional extensions. The depth of their discussion is, however, outside of the scope of this thesis but nonetheless needs to be mentioned, as prediction of future spot or contract prices is not the aim of this thesis. Nevertheless, an approximation of the above discussed methodology will be used in thesis, but limited to the point of at which the model starts estimation processes for future spot and derivative contract prices. That decision is due to the fact that in most cases, whether the future price estimations is attempted, majority of empirically tested models fail to achieve fully satisfactory model that is both consistent with the spot and futures prices realised prices. Therefore I will avoid tackling, or basing my models on the wholly grail of commodity market participants, wherein I attempt to estimate the future realised spot and derivative prices.

[8] Liu, J., Nissim, D., and J. Thomas (2001), "Equity Valuation Using Multiples", *Journal of Accounting Research* 40.

## 2.2 Real Options Approach

In Damodoran's application of Real Options in Oil Reserves valuation, the methodology is intuitively visible wherein the Current Value of an Asset, which in simplified form can be attributed to single asset listed equity, is equal to Value of the Developed Reserve discounted back to the length of the Development Lag at the Dividend Yield. With respect to time to maturity, the most commonly accepted premise for this estimation was used, proved resource base divided by the production today.

**Figure 13: Real Options Pricing Model Inputs**

| Model Inputs | Corresponding Input for Valuing Natural Resource Firm |
|---|---|
| 1. Value of Underlying Asset<br>2. Exercise Price<br>3. Time To Expiration<br>4. Discount rate<br>5. Variance in Asset Value<br>6. Dividend Yield | 1. Value of accumulated estimated reserves P1 & P2 & Undeveloped<br>2. Estimated accumulated cost of developing estimated reserves<br>3. Average relinquishment period across all reserves owned by the firm, or estimate of when reserves will be exhausted, given current production rates.<br>4. Riskless rate corresponding to the life of the option<br>5. Variance in the price of the natural resource.<br>6. Estimated annual net production revenue as a percentage of the value of the reserve |

There are several methods for estimating the value of a financial option, but I will utilize the most commonly used is the *Black-Scholes1* equation[9], which expresses the value as a function of six variables:

**Figure 14: Options Pricing Model**

Value of the **Call = SN(d1) – Ke$^{-rt}$ N(d2)**

Where, $d_1 = \dfrac{\ln \frac{S}{K} + (r - d + \frac{\delta^2}{2})t}{\delta\sqrt{t}}$

$d_2 = d_1 - \delta\sqrt{t}$

Where;
S = Stock/Reserve Price
Ke = Exercise Price
d = Dividends
r = risk-free interest rate
δ = uncertainty
t = Time to expiry
N(d) = Cumulative normal distribution function

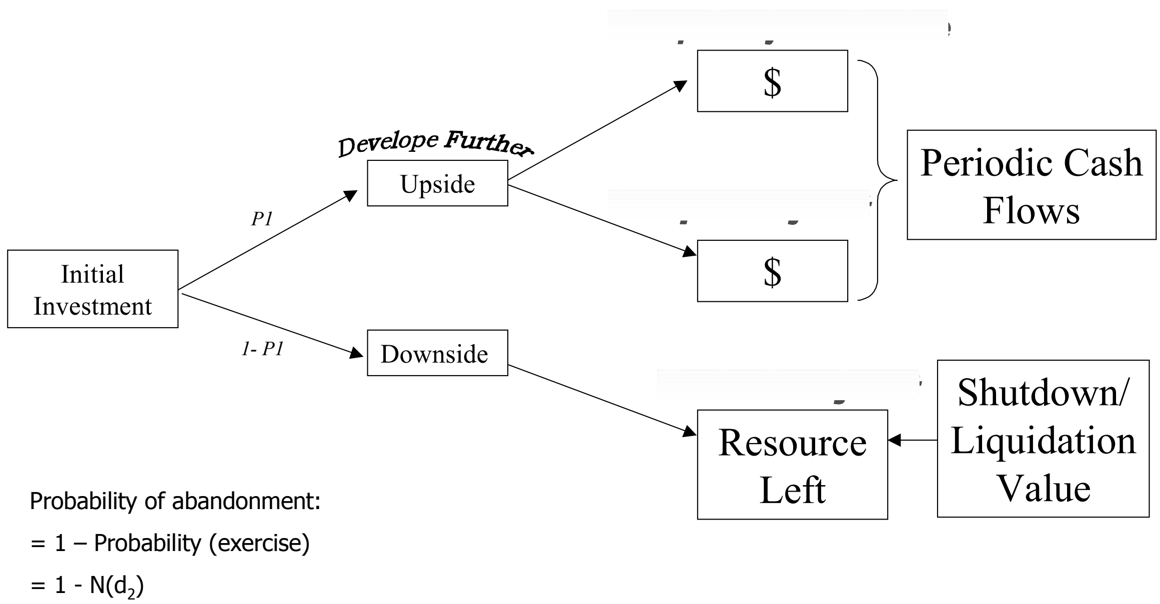
[9] Fischer Black and Myron Scholes of the MIT Sloan School of Management developed the original option valuation model using five variables. The dividend yield variable was added by Robert Merton in 1975. Fischer Black and Robert Merton won the Nobel Prize in Economics for their work on the option valuation model in 1997.

Stewart Myers of the Massachusetts Institute of Technology observed that the Black-Scholes model could be used to value investment opportunities in real markets-the markets for products and services. As has already been done before, I will use this methodology for Oil and Gas Industry. In addition, stock/call price as defined above is in this case based on the present value of cash flows expected from the investment opportunity while the exercise price is symbolic for the present value of all fixed costs expected over the lifetime of the investment opportunity. The uncertainty in the case of Oil & Gas industry can be most commonly summarized as the unpredictability of future cash flows related to the asset, i.e the standard deviation of the growth rate of the value of future cash flows based on production and pricing. In this case I used standard deviation of historical oil price with an earliest historically, annual time series data set.
Since the determinants of value in the Black-Scholes are the same determinants in the binomial, the current value of stock price, the variability in stock prices, the time to expiration on the option, the strike price and the riskless interest rate, elaborating on this approach to the Binomial by estimating variance in the log of price, allows to convert these inputs in the following way. Here ***u*** and ***d*** represent up and down movements per unit time for the binomial, therein ***T*** is the life of the option, and ***m*** is the number of periods in the lifetime of the project.

**Figure 15 Real Options**

$u = \exp([r-\delta^2/2][T/m] + \sqrt{[\delta^2 T/m]})$

$d = \exp([r-\delta^2/2][T/m] - \sqrt{[\delta^2 T/m]})$



The value of keeping one's options open is clearest in oil extraction related indutires, in which the licensing, exploration, appraisal, and development processes fall naturally into stages, each pursued or abandoned according to the results of the previous stage. In the context of this thesis, the option will be considered to delay production. This notion is very important for the upstream segment of Integrated Oil & Gas Industry and will be discussed in greater depth in the empirical part of the thesis in the form of measuring the Delay option.

It is also important to emphasise that the option to stop and delay can be quite valuable, even if the project has positive (negative if changing the sign of initially deployed capital) NPV if started immediately. The value of these options is ignored by standard DCF techniques. Proper analysis of these options is needed not just for project valuation, but also for project timing. Although companies that position themselves to tap possible future cash flows without making a final decision to invest until the potential is confirmed do allot better than ones that do not do analysis of similar kind.

Furthermore, even though Options pricing models are at times superior valuation tools for specific industries, the usual use of the theory in which that real options can also provide a systematic framework serving as a strategic tool for managerial strategic and decision-making applications.

## 2.3 Sum of Parts and Relative Valuation Approaches

Lastly, on exploring the relationship between Valuation and Share Price Performance, past research by Chua and Woodward (1994) serves as a part of the foundation of past theoretical research for this thesis, in which they performed econometric valuation tests for the American oil industry for the periods of 1980 till 1990. In their research they tested the commonly used multiple based valuation metric of P/E (Price to Earnings Ration[10]) of integrated oil companies against dividend payout, net profit margin, asset turnover, financial leverage, interest rate, and Beta. Although initially the research fell short of testing valuation indicators on share price prediction, they nonetheless demonstrated systematic methodology used to explore the relationship of various multiple valuation metrics amongst each other and with other earnings related factors. As result of their research they did not manage to uncover significantly robust relationships amongst P/E and earrings related indicators. They later went on to test the stock prices against cash flow from operations (t+1 and t-1), dividend payout, net profit margin, total asset turnover, financial leverage, interest rate, Beta, and proven reserves. Future cash flow and

[10] See Appendix for Formula

proven reserves turned out to be statistically significant explanatory factors for their time period of investigation, thus offering support for a fundamental approach to valuation and further advocating the use of Multiples. They established a basic rule of thumb that an increase in proven reserves of 10% resulted in an average increase in the stock price of 3.7%. Although, this explanatory relationship is now dwarfed by the volatility swings in share prices from the fluctuations of the underlying commodity price moves.

With respect to going further into multiples based valuation based on more detailed Oil & Gas related production and reserves indicators, Quirin (2000), in his analysis of US oil and gas exploration companies from the short period of 1993 to 1996 offers interesting methodology. The paper aims to find whether, industry specific ratios such as the Reserves Replacement Ratio, Reserves Growth, Production Growth and the Finding Costs to Depreciation Ratio are perceived by analysts as being key during the equity valuation process of oil and gas companies. Their results indicate that these industry specific valuation ratios provide incremental information over accounting information, including earnings and book value of equity. Even more Recently, Cormier (2003) found that cash flows and changes in reserves provide valuable information over reported earnings for a data set of Canadian Oil & Gas companies.

Although a number of studies have in the past concluded that accounting information, such as net income and the book value of equity are relevant in relative cross-sectional studies, the absolute value perspective view has been that historical cost accounting is inappropriate for accurately estimating the oil and gas companies' financial performance to the financial markets. "Historical cost based financial statements for oil and gas producing enterprises have limited predictive value. Their usefulness is further reduced because a uniform accounting method is not required to be used for costs incurred in oil and gas producing activities" (FASB, 1982)[11]. Thus, there is a potential hazard in relying solely on accounting measures, such as RoACE[12], P/E, ROE, P/B, EV/DACF, EV/Ebitda, and various other Relative Valuation related Multiples in equity valuation as they do not claim universal consistency due to regional accounting variations in practice and application.

McCormack and Vytheeswaran (1998) point out particular problems in valuation of oil and gas companies, based on the notion that accounting information in the upstream sector "does a distressingly poor job of conveying the true economic results". There are measurement errors in petroleum reserves. Since, the response to new market participant information is asymmetric; bad news is quickly reflected in the reserve figures whereas good news takes more time to be

[11] US Financial Accounting Standards Board
[12] University of Oslo Research Paper: See Ratios in the Appendix

accounted. In my own event driven studies I have come to empirical findings that companies whose share price moves +/- 10% in a given trading session, on average the companies whose share value falls by more than 10% in a given day tend to keep underperforming the markets for 4-6 weeks on. Where as, companies whose share prices rally more than 10% in a given trading session show no evidence of out performance post event. Furthermore, in the Oil & Gas Industry, reserves may be exposed to measurement errors since they are noted in real time oil price, and since they do not include the value of any implicit real options can add further inefficiency into using Asset Value related accounting ratios.

McCormack and Vytheeswaran (1998) performed econometric tests on financial relations for the largest oil and gas companies. In their studies, total shareholder return was tested against EBITA (earnings before interest, taxes and amortization), RONA (return on net assets), after-tax earnings, ROE (return on equity), and free cash flow. Estimated relations between valuation and financial indicators were very weak or non-existent. Therefore, I will take the above mentioned work further by performing econometric tests of various additional financial ratios (this time including performance, valuation and financial ratios), against share price performance of the companies and describe the findings in the Empirical Findings section of the thesis.

## 3. Industry Background & Valuation History

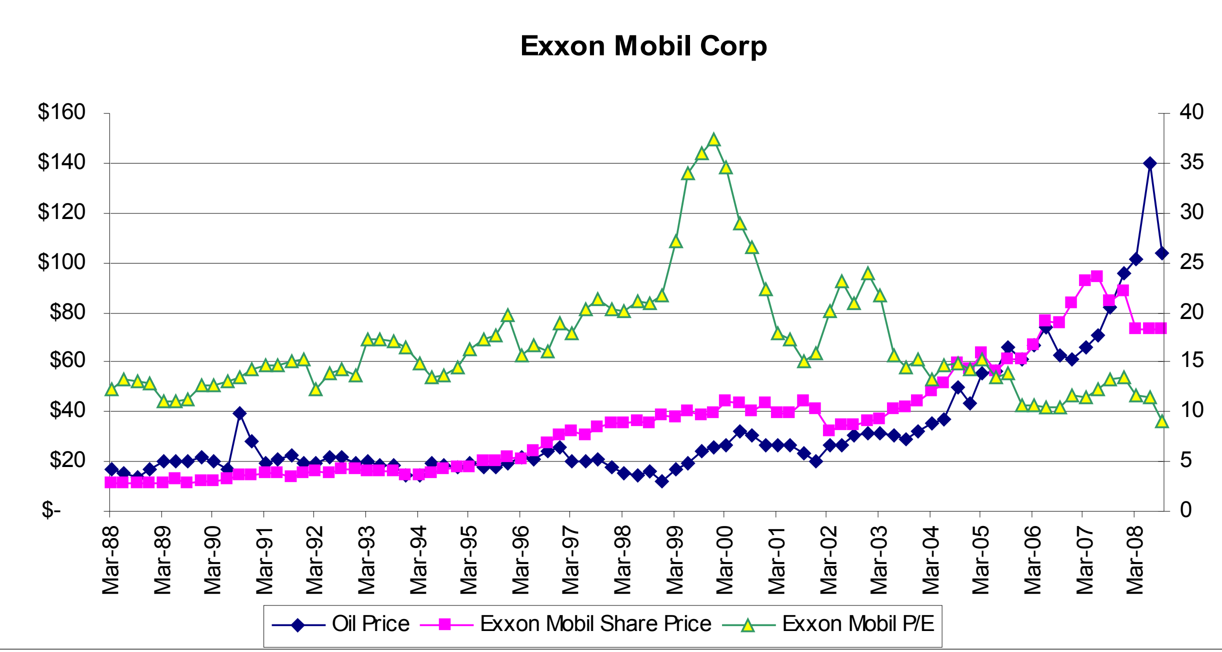
The Integrated Oil & Gas business model begins with production of crude oil and natural gas in the Exploration and Production side of the business commonly referred to as the upstream. Processing of oil and natural gas into end-user distillate products extracted from raw input occurs in the Refining & Marketing and Chemicals segments of the business commonly referred to as the downstream.

The truly integrated majors have a number of common features; they all possess global scale and asset diversification, are operationally levered to high oil price shocks, have little leverage, high levels of surplus cash flow, well above average cash returns to shareholders, cost advantaged assets that consistently make returns on capital that are a multiple of cost of capital and are all backed by stable and effective longer term oriented strategies. These features ought to have stood the sector well throughout the last decade and especially in volatile markets equity markets like today post 2007, which tend to react negatively to higher prices of commodities, but the fact is that they in reality haven't over the longer time horizon as demonstrated by the figure below.

In terms of how better understanding the valuation pattern demonstrated historically by the two star stocks in the industry, on the following page I provide a valuation snapshot along with Oil Prices and Price to Earnings Ratio to best see the key potential drivesr of the share price along the valuation trend witnessed.

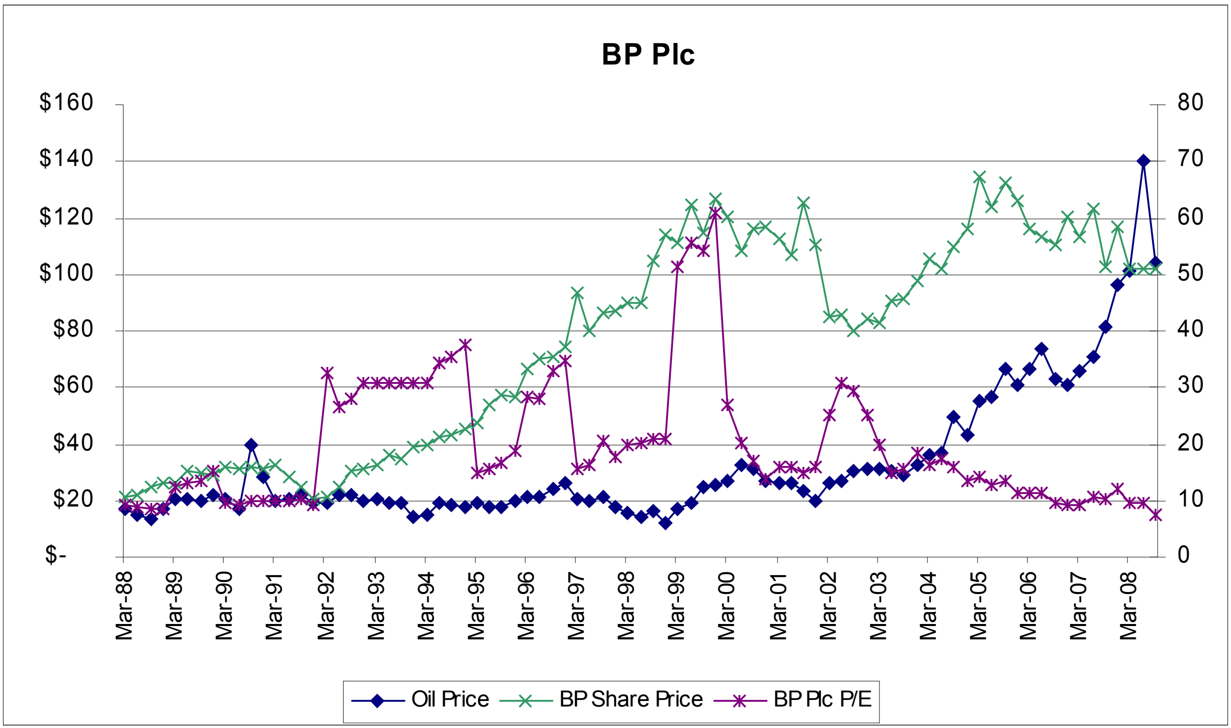
The figure below also shows the P/E spike that occurred in 1999 as Oil Prices fell below 10$ per barrel, indicating that integrated Oil & Gas companies had become expensive relative to their earnings potential. Inversely, in late 2007 as Brent Crude hovered around 100$ mark, the P/E ratio has not significantly been different from 2003 onwards, indicating that market did not expect the rising Oil Prices to stay. Nevertheless, we can still see that typically as the earnings are at risk due to low oil prices, the P/E ration rises and the share price is not impacted significantly until the multiple starts to contract. In which there appears to be a period of slow re adjustment of the P/E ratio to normal levels and it is after this readjustments that the share prices tend to rally. This in large can be explained by earnings sustainability confidence attributed by the market to the share price. As the earnings growth expectation appears to be increasing, especially post normalisation stage such as post 1997 and post 2002, the share prices tend to rally and be supported by the positive earnings revisions. It is also interesting to note that even though there was significant share price volatility in the 1990's shares in the industry delivered a remarkable performance.

**Formula 2: Exxon Mobil Corp, Valuation Summary (P/E)**




The BP Plc Share price is a multiplied by 10 * in order to provide a clear axis depiction. This was done in order to see true effect of share price moves against the Oil Price and P/E valuation.

**Formula 3: BP Plc, Valuation Summary (P/E)**



Furthermore, we can also see that both companies have not been very generous with their dividend yield as demonstrated below, until most recently. This also provided less incentive to holding the stock.

**Figure 16: Exxon Mobil Corp, Dividend Yield**

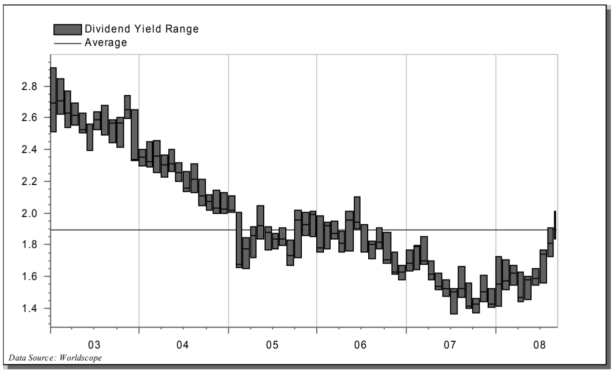
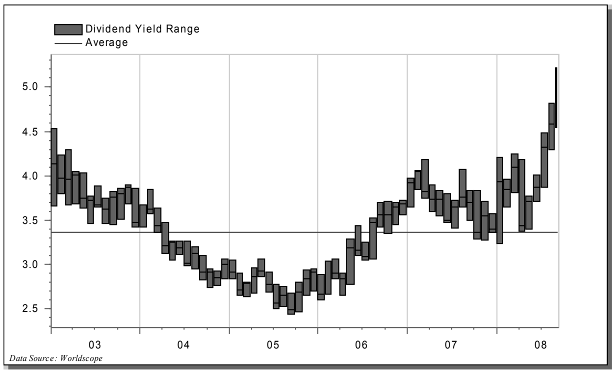



**Figure 17: BP Plc, Dividend Yield**




For an industry snapshot and a comparative analysis of the two stocks in terms of the key ratios and characteristics see appendix.

Given the challenge of structurally declining production rates in the industry, the sector needs a higher oil price to remunerate higher risk and higher cost projects. Such a perspective would further argue that if the industry doesn't get a higher price for it crude and products, it will not invest into capacity and that will ultimately induce a higher price. The industry's costs and the price remain rationally tied, yet the market continues to fear high costs will stick, the oil price will slide and thereafter returns tend to crumble. This is the markets explanation for valuation of Integrated Oil& Gas Companies as demonstrated by the most common metric of P/E ratio. Meaning, when Oil Prices rise, Earnings increase and expected shrinkage of earnings and thus its decline on a forward basis reduces forward based nominator to yield a lower P over a high current E as demonstrated below.

Since "the most important parts of a financial model are its base case assumptions. The rest of the process is, essentially, mechanical"[13], it is necessary to provide a historical background on the industry to justify the later assumptions in the models discussed subsequently in this Thesis.
Since 1970 to date, the Oil Prices are at their historical highs, despite a slowdown in global oil demand growth. The incremental supply/demand is very tight with a significant lack of spare OPEC Capacity. Although the OECD inventories have increased, forward day's cover is below the historical average.

[13] English, James R. Applied Equity Analysis : Stock Valuation Techniques for Wall Street Professionals. Blacklick, OH, USA: McGraw-Hill Companies, The, 2001. p 231.

Oil and Gas as investible commodities through Equities, Futures and Options as well as other Capital Market Instruments are increasingly viewed by institutional investors as a standard asset class which can offer diversification to more traditional holding in the portfolio. The flows of funds into the sector have made it more prone volatility, however. The recent decline in the US Dollar has also increased the demand of investing into the sector as well as in many cases reduced the international producer's revenues.

## 3.1 Industry State & Structure

A renown investor Jim Rogers provided a fitting description of the current state of the industry as "…there's been no major elephant oil fields (more than a billion barrels of oil) discovered in over 40 years. Alaskan oil fields are in decline; Mexican Oil fields are in rapid decline; North Sea is in decline. The UK has been exporting oil for 27 years now. Within the decade, the UK is going to be a major importer of oil again. Indonesia is going to get thrown out of OPEC because they no longer export oil, they are now net importers of oil. Within the decade, Malaysia is going to be importing oil. 10 years ago, China was one of the major exporters of oil, now they are second largest importer of oil in the world".

The excess capacity in both Upstream and Downstream added during the 1980's and 1990's as a consequence of the 2$^{nd}$ Oil Shock has now been consumed. Increasing capacity has become an enormous struggle in the industry since the emergence of China and India. The reason for underinvestment into the capacity on all fronts, has been attributed to the low prices of the 1990s for Oil and Gas (see price figures below) leading to shorter term oriented management decisions to buy back stocks and slash Capex to prop cash flows as some management teams looked to management incentives. In addition, the declines of accessible reserves and falling production in Iraq and Venezuela were unforeseen by many industry experts. The same could be said for large part of aging infrastructure which has lead to accidents and interruptions that have plagued both the Upstream as well as the Downstream segments.

In terms of geo political uncertainty, from the perspective of OECD nations the resources are vastly concentrated in the countries with a questionable track record in cooperation with traditional and transparent oil companies. So in short, the situation on the supply side is and has been degrading for some time now, limiting any potential positive surprises going forward.

To better place this perspective, the rational of integration in the business has become to provide for assured supply for refiners, otherwise the refiners will have to integrate backwards or use long-term contracts. Vertical Backward integration involves investment risks for any refiner. While the Long-term contracts are subject to price risks, the industry has evolved based on difficult choice of lesser of two evils and the situation has no easy solution. This backward vertical integration, led to the question of diversification of the business versus the diversification of the shareholder. After the first oil shock, the stock market reacted unfavourably to the efforts of the oil companies to engage in unrelated diversification. As the oil companies divested most of these unrelated activities in the late 1980s and early 1990s, the stock market responded favorably. By 1990, the oil companies had essentially completed the divestment of unrelated diversification efforts, 1975±1984

The diversification efforts imitated by the majors to counter the bleak outlook for domestic exploration and developments and to find more attractive profitability opportunities resulted in investments into pharmaceutical companies, food companies, microelectronics, biotechnology, a solar energy company, and coal mining and mineral companies as well as metals producers, healthcare technology manufactures, precision metal casting, and some high-tech business ventures. Chevron, Exxon invested in nuclear activities, microelectronics and office equipment, an electrical motor company, semiconductors, coal mining and other metal mining activities. Mobil bought Montgomery Ward (a retailer and container corporation) plastic resins, fertilizers, uranium processing, a plastic bag operation, real estate, coal and metal mining. Texaco began uranium exploration, funded biotech and electronic start-ups and licensed a coal gasification technology. In that period turmoil, price of oil had dropped below lifting and production costs. [14]As a consequence, immediate improvements in profitability could be achieved by shutting down exploration and development activity. However, this would have resulted in declines in reserves in relation to production operations. Hence, logical buyers were companies whose reserve positions were already relatively strong. This resulted in the under spending into the upstream side of the business until the early nineties in which capex spiked as the underinvestment became a visible hindrance to the oil price stability.

## 3.2 Demand for Oil, Gas and Energy

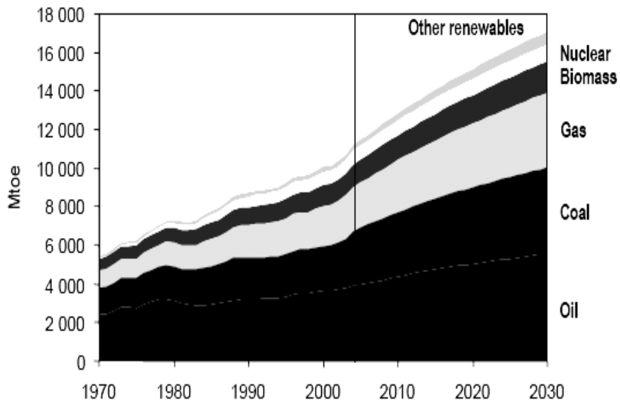
Had this thesis been written twenty years ago, perhaps the title of this section would have been simply Demand For Oil & Gas. But, given the recent historical leap in technology for Oil & Gas end product alteration and substitutability, in large thanks to last Oil shock of the 80's as currently witnessed through the rise alternative energy sources and uses, it would be a incorrect to overlook the broader context of Oil & Gas in the greater scheme of Energy.

Below I demonstrate World Primary Energy Demand as defined by the International Energy Agency. It becomes clear to see that Renewables, Nuclear and Biomass are speedily growing in contrast to dominant roles of Oil, Coal and Gas, in large due to more populous world whose energy hunger is only growing. It also is clear that neither, Oil or Coal is going to be swiftly replaced any time in the immediate future. The figure to the right, demonstrates the visible under investment in real terms into the Oil & Gas sector as seen in the last decade. Although corporates

[14] Petroleum Economist

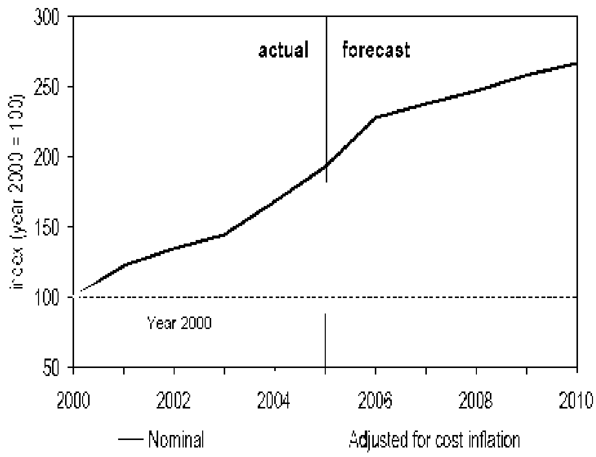
are showing record Capex budgets in nominal US$ denominated terms in investments into Exploration and Production, adjusted for inflation, the industry barely avoided decline through a period of significant rise of demand by the merging China and India. Furthermore, the potential shortage in future production capacity based current technologies and current identified reserve pools and current consumption trends indeed points towards more price rises and supply demand deficits in the future. As the profitability of the business grows for respective nation states that produce and lay claims to the resources the status quo in this fossil fuel dependence will remain until the regulators step in.

**Figure 18: World Primary Energy Demand: Reference Scenario**




**Source:** IEA: *World Energy Outlook 2006*

**Figure 19: Global Upstream Oil & Gas Investment & Inflation**

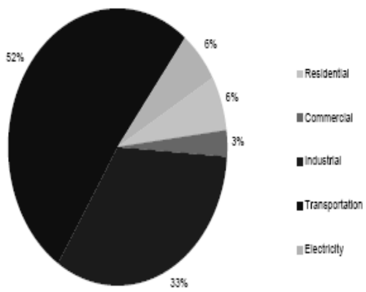



**Source:** IEA: *World Energy Outlook 2006*

As is demonstrated in the figures above, global energy demand in BOE terms is expected to growth significantly according to industry experts although capital invested has been lagging, significantly. The new paradigm shift for Big Oil, which the industry is undergoing what I can only call the electrification evolution, as witnessed in the automotive market as well the power generation market, as companies and entire industries are slowly trying to shift from petroleum based input energy sources to renewable and sustainable electricity generation. The only y of this shift ;, over expanded and outdates technologies, which are the foundation of the worlds energy generation. Since "the most important parts of a financial model are its base case assumptions. The rest of the process is, essentially, mechanical"[15], it is necessary to provide a historical background on the industry to justify the later assumptions in the models discussed subsequently in this Thesis.

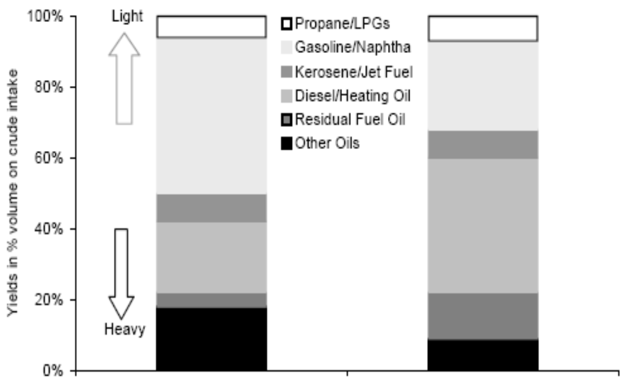
[15] English, James R. Applied Equity Analysis : Stock Valuation Techniques for Wall Street Professionals. Blacklick, OH, USA: McGraw-Hill Companies, The, 2001. p 231.

**Figure 20: Petroleum Product Market***




**Source:** US Department of Energy

**Figure 21: Petroleum Product Breakdown**

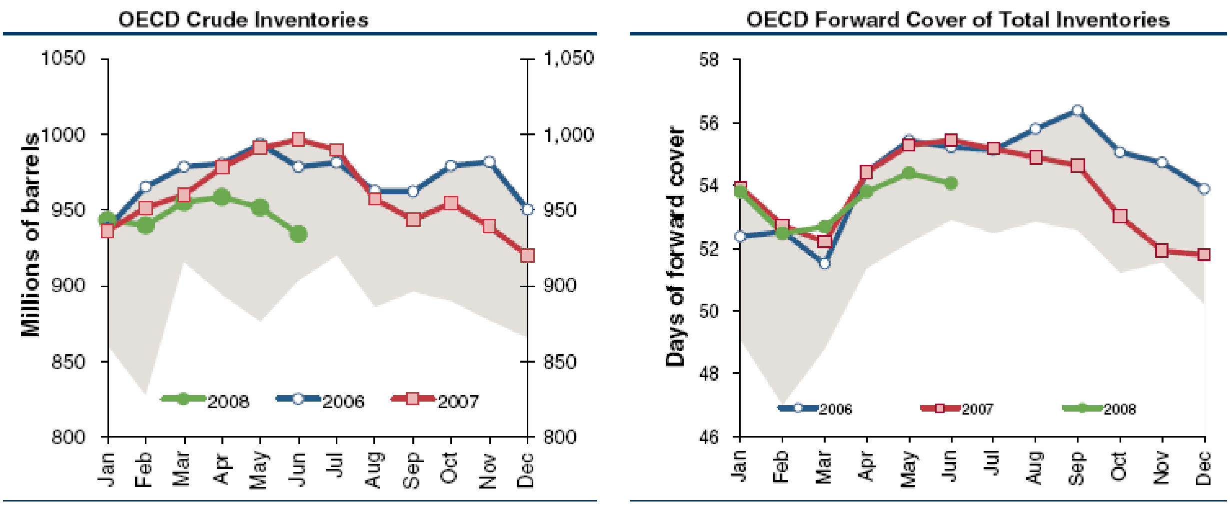



**Source:** Nymex ICE

## 3.3 Supply of Petroleum Industry

Since 1970 to date, the Oil Prices are at their historical highs, despite a slowdown in global oil demand growth. At this point the incremental supply/demand is very tight with a significant lack of spare OPEC Capacity especially for long term as questions loom over Russia's reliability as consistent supplier and Saudi Arabians un tested Reserve Base. As demonstrated in the figure beneath, although the OECD inventories have increased, forward day's cover is below the historical average. Based on rather tight supply demand fundamentals of the industry, Oil and Gas Integrated companies are often seen as an investible universe for commodities exposure through Equities by some investors, also Futures and Options as well as other Capital Market Instruments are increasingly viewed by institutional investors as a new standard asset class. The flow of funds into the sector has made it more prone to volatility, however. The recent decline in the US Dollar has also increased the demand of investing into the sector as well as in many cases reduced the international producer's revenues. I will avoid commenting in speculative oil price flows and their impact on crude pricing as there is little evidence to support the price impact for two key reasons; 1$^{st}$) If one takes a basket of commodities that have liquid futures contracts available versus a basket of commodity prices that have no liquid futures markets the prices of listed commodities underperforms thus supporting inverse notion that in fact so called commodities speculators that trade in futures markets have any significantly inflammatory impact on prices in the long run. 2$^{nd}$) Most of the Evidence supporting this thesis oputs into question the premise of free markets and their efficiency.

**Figure 22: OECD Inventories**

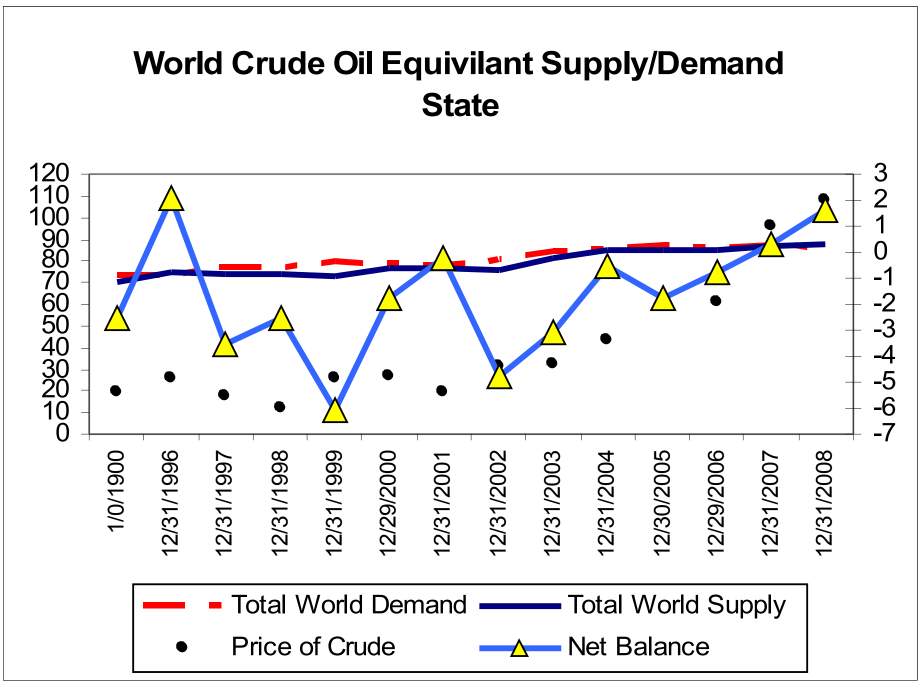



**Source:** IEA

As of September 2008, it is clear OECD has managed to build inventory quickly in the face of decelerating demand, leaving the market more balanced than it appears via a simple reading of OECD crude in Storage for the short-medium term time horizon. Non-OECD inventory trends are generally difficult to track, but based on recent data China's refined products appear to have risen significantly either based on stocking up for the pre Olympic period or limited drawdown during Olympic emission limitations on traffic volumes.

The Left hand scale is used to indicate Crude Oil Price in $/BOE and the amount of crude oil equivalent supply/demand in millions of BOE. The right hand scale demonstrates the Net Balance position after subtracting World Oil Demand from World Oil Supply.

**Figure 23: World Oil Equivalent Supply & Demand**




**Source:** OPEC & OECD Data

## 3.3 Importance of Reserves Figures

The reserves statement is a key to providing a view of the as yet un-depleted assets of the company and as such the potential for a company's future growth. As the definitions of reserves are classified differently by various institutions and since NAV valuation and Real Options valuation methods will use these extensively, it makes since to provide a brief overview. Reserves classifications provide a strong and yet potentially misleading representation of the extent to which a company's exploration efforts have met with success in any one year i.e. expressed as a percentage of current year production it illustrates both the extent to which the oil & gas reserve base of the company has been replenished over the preceding year and, by taking reserves in their entirety, how many years the current rate of production could be sustained for. This fits well with DCF Model projections and adds foundations to broader assumptions such that companies are constantly aiming to keep production volumes from declining and thereby aiming to bring more fields to production and add more reserves.

At the same time, reserve recordings are also important to reported profitability. This is because oil companies amortize their production assets on a unit of depletion basis. Thus the greater the barrels of oil (or units) associated with an investment project (e.g. the reserves booked), the lower the level of amortization per unit of production.

The key question is how are recoverable reserves defined? Since, the absolute level of reserves in a given field and their recoverability will never be known until production reaches the economic limit and the reservoir is abandoned. It is fair to say that an analyst's reserves estimate is thus almost certain to be inaccurate, or less accurate than the oil companies engineers With this in mind the objective of the guidelines and requirements on reserves reporting is to provide investors with a realistic but, if anything, conservative estimate of available reserves.

From an industry standpoint, definitions and industry parlance tends to focus on those guidelines provided by both the Securities Exchange Commission SCE and the Society of Petrochemical Engineers or SPE. Some knowledge of both is therefore necessary. However, most significant for investors and, as a consequence, companies are those laid down by the SEC not least given that use of the SEC's definitions is obligatory under US reporting requirements. These tend to be more conservative in their approach. Yet, they have also come under some considerable degree of criticism in recent years not least as technological developments within the industry for estimating the scale of recoverability have left them looking somewhat antiquated in their requirements

### 3.3.1 SEC Reserves – Proven developed and proven undeveloped

Under SEC rules, reserves can only be recorded if, per the guidelines as laid down, they are deemed to be *proved*. Two types of recoverable reserves exist namely *proved developed and proved undeveloped*. Per SEC guidelines these are defined broadly (but not literally) as follows. *Proved oil & gas reserves*[16] are estimated quantities of oil, gas and Natural Gas Liquids which geological and engineering data demonstrate with reasonable certainty to be recoverable from known reservoirs under existing economic conditions (i.e. prices and costs). Reservoirs are considered proved if economic production is supported by either actual production or conclusive formation tests. The area of a reservoir considered proved includes that portion outlined by drilling and defined by gas-oil/water oil boundaries and the immediately adjoining portions not yet drilled but which can be reasonably judged as economically productive on the basis of geological and engineering data. In the absence of data on fluid contacts, the lowest known occurrence of hydrocarbons (i.e. how far do we conclusively know the oil bearing rock extends) should be used. Reserves that can be produced economically through improved recovery techniques can be included as proved when successful testing by a pilot project or operation of an installed program is supportive of enhanced recovery in that specific rock formation.

*Proved developed oil & gas reserves* are reserves that can be expected to be recovered through existing wells with existing equipment and operating methods. Additional oil and gas expected to be obtained through the application of fluid injection or other improved recovery techniques for supplementing the actual forces and mechanisms of primary recovery should be included as "proved developed reserves" only after testing by a pilot project or after the operation of an installed program has confirmed through production response that increased recovery will be achieved

*Proved undeveloped oil & gas reserves*[17] are the reserves that are expected to be recovered from new wells on un-drilled acreage or from existing wells where major expenditure is required for re-completion. Under no circumstances should estimates for proved undeveloped reserves be attributable to any acreage for which contemplation of an enhanced recovery technique is contemplated unless such techniques have been proven effective by actual tests in the area and the same reservoir. As stated the above definitions represent a summary rather than the guidelines in full. They emphasize, however, the conservative bias of the guidelines and that as more becomes known about an oil field and its potential, revisions to estimates of reserves will almost certainly need to be made.

[16] As Defined by the U.S Securities and Exchange Commission (SEC)
[17] As Defined by the SEC

### 3.3.2 SPE definitions - Proven, Probable and Possible

The intent of the Society of Petroleum Engineers (SPE) and World Petroleum Council (WPC, formerly World Petroleum Congresses) in approving additional classifications beyond proved reserves is to facilitate consistency among professionals using such terms. In presenting these definitions, neither organization is recommending public disclosure of reserves classified as unproved. Public disclosure of the quantities classified as unproved reserves is left to the discretion of the countries or companies involved.

It has already been stated that it is the SEC definitions that are most important in determining reported recoverable reserves. The SPE definitions which are based on a more probabilistic approach are, however, also important not least as they potentially present a better representation of the reserves that might more realistically be expected to be recovered. Under the SPE's definitions, reserves are presented as proven, probable and possible depending upon the likelihood of their recovery. Thus:

- **Proven (1P) reserves.** These are those reserves that, to a high degree of certainty (90% confidence or P90), are recoverable from known reservoirs under existing economic and operating conditions. There is relatively little risk associated with these reserves. As described earlier, *proven developed reserves* are reserves that can be recovered from existing wells with existing infrastructure and operating methods. *Proven undeveloped reserves* require development. This classification will be used extensively in the Real Option Assessment.
- **Proven plus Probable (2P) reserves**. These are those reserves that analysis of geological and engineering data suggests are more likely than not to be recoverable. There is at least a 50% probability (or P50) that reserves recovered will exceed the estimate of Proven plus Probable reserves. All told this is the level of oil that based on probability analysis is most likely to be recovered. This classification will be used extensively in the Real Option Assessment.
- **Proven, Probable plus Possible (3P) resserves**. These are those reserves that, to a low degree of certainty (10% confidence or P10), are recoverable. There is relatively high risk associated with these reserves. Reserves under this definition include those for which there is a 90% chance of recovery (proven), a 50% chance of recovery (probable) and up to a 10% chance of recovery (possible). Evidently, 3P reserves are the least conservative and, whilst ultimately 90% recovery may occur, from the outset the odds are that use of this measure will overstate the level of recovery. Perhaps the simplest way of considering these guidelines is by reference to the probability curve shown below. The curve

represents the probability distribution of the amount of oil recoverable in a field under a multitude of different variables and sensitivities. Through reference to the curve is possible to interpret that, under the differing assumptions, in 90% of cases the field would hold at least 270m barrels of oil, in 50% at least 310m barrels of oil and 10% of cases at least 350m barrels of oil. Conservatively and on a P1 basis, the number of barrels that is exceeded by 90% of the scenarios plotted is that which would be recognized as the 1P reserve estimate or in this instance some 270m barrels.

In addition to these three definitions of reserves, a further category exists for those reserves, which for whatever reason are not, deemed commercially recoverable at the present time namely contingent resources (or technical reserves). Thus *Contingent Resources* are those quantities of hydrocarbons, which are estimated, on a given date, to be potentially recoverable from known accumulations, but which are not currently considered to be commercially recoverable. Contingent Resources may be of a significant size, but still have constraints to development. These constraints, preventing the booking of reserves, may relate to lack of gas marketing arrangements or to technical, environmental or political barriers. Thus, for example, in the world of LNG while the gas deposits required for plant throughput may be known to be in place, a project will almost certainly not be deemed commercial and investment approval granted until contracts have been signed for the majority of the LNG product. As such, even though the gas reserves are known to exist, the absence of a secure market means that they cannot be treated as recoverable.

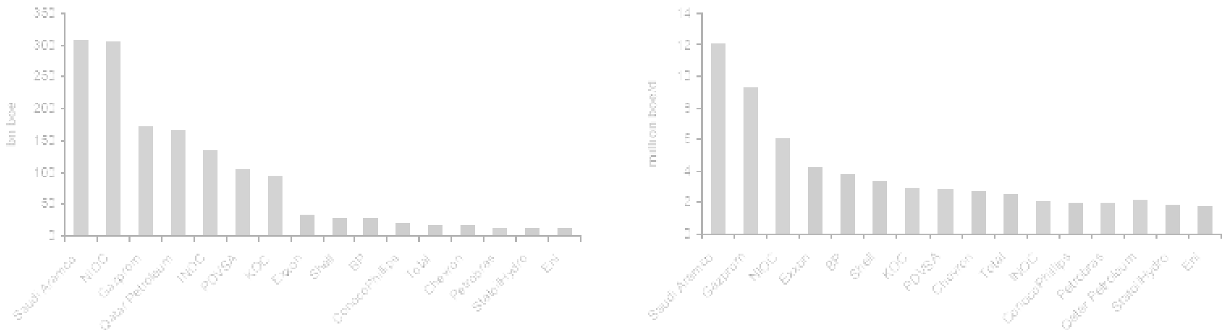
Where SEC and SPE overlap is by, reserves that companies may claim as proven under SEC rules correspond with 1P (or P90) reserves under SPE definitions. SEC rules do, however, add additional constraints not least the exclusion of Enhanced Oil Recovery echniques unless their efficacy has been demonstrated and liquids recovered from mining methods. There are however additional overlaps to consider, not least the two below. The SEC guidelines require the use of the market price of oil on 31 December as a basis for calculating proven reserves and future discounted cashflow whereas under SPE requirement long run budgeting assumptions are permitted. For those company's involved in profit sharing contracts (PSC's) this can have a meaningful impact on the reserves statement. This is because under PSC's the oil companies recover their capital costs through reserves and production entitlement to 'cost oil'. Clearly, the higher the oil price used to estimate their entitlement, the lower their entitlement to reserves. For those for whom PSC's are significant, the result of applying this guideline in a year when the price of oil has shifted markedly is to require a meaningful negative adjustment to reserves. For example, we estimate that the c. $10 shift in oil prices between 31 December 2003 and the same date in 2004 resulted in a potential 15% reduction in industry reported reserves.

### 3.3.3 Reserve Figures

Below I demonstrate the International Oil Company Resource breakdown as reported according to the definitions described in the previous section of the thesis. The key takeaway is that

**Figure 24: IOC & NOC Oil Equivalent 2P Reserves BoE & Production Million Bbls Per Day**

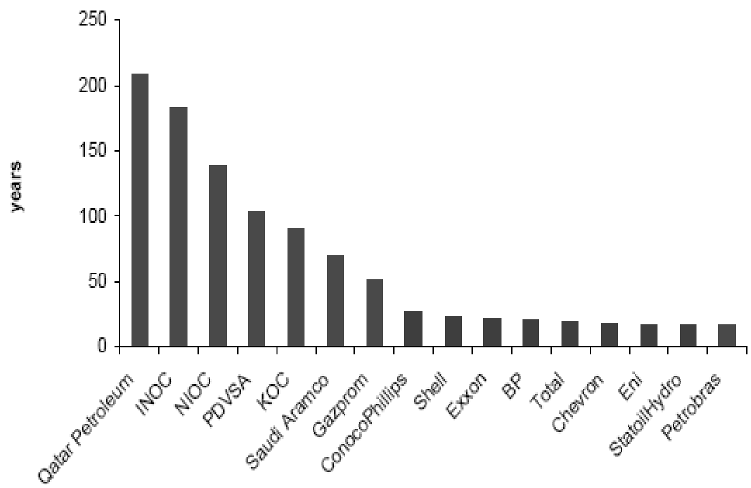
**Source:** Wood Mackenzie




National Oil & Gas companies hold a large bulk of the reserve base in a time when reserve nationalism and energy use for political means is growing with prices.

In addition, the below figure provides an overview to the question of how long will oil last, by showing the reserve live at current levels of production based again on 2P criteria discussed above. It becomes clear that the average is around five decades remaining at current production levels and that most production will be relied on National Oil Companies with inefficient production.

**Figure 25: IOC & NOC 2P Reserve Life at current Production**




**Source:** Source Deutsche Bank and Woodside

# 4. Empirical Analysis

This section of the report will discuss key inputs, outputs and main determinant factors that influence the models discussed for obtaining value for a listed, integrated international Oil & Gas Major company. Initially the DCF for BP Plc, and Exxon Mobil Corp, will be examined, followed by the sum of the parts NAV Model Analysis then, by the Real Option valuation, and lastly to be followed by the historical Back test of the financial and accounting ratios in terms of their relative valuation predictive power and their utility to outperform both, broad equity market such as the S&P 500 and relative integrated oil & gas stocks related benchmark.

## 4.1 DCF Output and Discussion

The DCF model valuation methodology that was constructed and the foundation's of which already have been discussed in the theoretical section, was added with three functional scenario tests. One model that is my own hybrid construction, which I argue, is empirically most relevant approach for a DCF based model is founded on the three stage growth premise with assumptions that I have outlined in the theoretical section of this thesis. Since, the most important component of the model, in my view is the fundamental growth rate derived from the historical performance of the company to be used in the second stage of growth. The second model is based on forward revenue growth strictly being a function of forward curve of Brent Crude Oil prices. Although crude in its truest sense, the approach manages to provide a good overview of what the share price expectation is, given the outlook of the today's and tomorrows Oil Price change expectations, as dictated by end of the forward futures market and not an opinion. Lastly, the third DCF model which will be referred to as the fundamental model is based on using first, second and third stage growth assumption as a function of historical growth achieved by the company given its historical plowback ratio and historical returns on invested capital. This methodology aims to value the model based on internal indicators rather sourcing external assumption for the medium to the longer term, either from the market via expected IBES estimates or via industry averages from peers and country growth indicators.

### 4.1.1 BP Plc DCF Model

The figure below provides the valuation summary of BP Plc as the analysis would have been conducted on the first of January of any given year between 2002 till 2008. As the bulk of the data used in the model is in large based on full year end figures with the exception of the share price, the purpose is to demonstrate the time varying components of the model like the terminal value and sum of discounted future cash flows as well as growth, for each ear within the period discussed.

**Figure 26: BP Plc, DCF Summary Output**

| Disounted free cashflows | 2002 | 2003 | 2004 | 2005 | 2006 | | 2007 | 2008E | 2009E |
|---|---|---|---|---|---|---|---|---|---|
| **Terminal Value** | 19,924 | 21,550 | 23,244 | 25,055 | 27,042 | | 29,648 | 32,438 | 35,719 |
| 2002 | (738) | | | | | | | | |
| 2003 | 2,325 | 2,515 | | | | | | | |
| 2004 | 3,943 | 4,265 | 4,600 | | | | | | |
| 2005 | 7,510 | 8,123 | 8,761 | 9,443 | | | | | |
| 2006 | 3,137 | 3,393 | 3,659 | 3,944 | 4,257 | | | | |
| 2007 | 3,254 | 3,520 | 3,796 | 4,092 | 4,417 | | 4,842 | | |
| 2008 | 5,510 | 5,959 | 6,427 | 6,928 | 7,478 | | 8,198 | 8,970 | |
| 2009 | 4,853 | 5,249 | 5,662 | 6,103 | 6,587 | | 7,222 | 7,902 | 8,701 |
| 2010 | 4,319 | 4,672 | 5,039 | 5,432 | 5,862 | | 6,427 | 7,032 | 7,744 |
| 2011 | 3,966 | 4,289 | 4,626 | 4,987 | 5,382 | | 5,901 | 6,456 | 7,109 |
| 2012 | 3,641 | 3,938 | 4,248 | 4,579 | 4,942 | | 5,418 | 5,928 | 6,527 |
| 2013 | 3,343 | 3,616 | 3,900 | 4,204 | 4,537 | | 4,974 | 5,442 | 5,993 |
| 2014 | 3,069 | 3,320 | 3,580 | 3,859 | 4,165 | | 4,567 | 4,997 | 5,502 |
| 2015 | 2,818 | 3,048 | 3,287 | 3,543 | 3,824 | | 4,193 | 4,587 | 5,051 |
| 2016 | 2,587 | 2,798 | 3,018 | 3,253 | 3,511 | | 3,850 | 4,212 | 4,638 |
| 2017 | 2,375 | 2,569 | 2,771 | 2,987 | 3,224 | | 3,534 | 3,867 | 4,258 |
| 2018 | 2,181 | 2,359 | 2,544 | 2,742 | 2,960 | | 3,245 | 3,550 | 3,909 |
| 2019 | 2,002 | 2,165 | 2,336 | 2,518 | 2,717 | | 2,979 | 3,260 | 3,589 |
| 2020 | 1,838 | 1,988 | 2,144 | 2,311 | 2,495 | | 2,735 | 2,993 | 3,295 |
| **NPV** | **61,932** | **67,785** | **70,399** | **70,926** | **66,359** | | **68,086** | **69,195** | **66,317** |
| | | | | | | | | | |
| Sum discounted free cashflows | 61,932 | 67,785 | 70,399 | 70,926 | 66,359 | | 68,086 | 69,195 | 66,317 |
| Terminal Value | 19,924 | 21,550 | 23,244 | 25,055 | 27,042 | | 29,648 | 32,438 | 35,719 |
| Growth rate in perpetuity | | | | | | | **1%** | | |
| | **2002** | **2003** | **2004** | **2005** | **2006** | | **2007** | **2008E** | **2009E** |
| Enterprise value | 81,856 | 89,335 | 93,642 | 95,981 | 93,401 | | 97,734 | 101,633 | 102,036 |
| less net debt | (12,590) | (11,308) | (11,257) | (3,769) | (5,645) | - | (10,666) | (9,973) | (10,012) |
| Equity value | 94,446 | 100,643 | 104,899 | 99,750 | 99,046 | | 108,400 | 111,606 | 112,048 |
| **Price per share** | **5.04** | **5.37** | **5.59** | **5.32** | **5.28** | | **5.78** | **6** | **6** |
| No. of shares | 18,751.1 | 18,751.1 | 18,751.1 | 18,751.1 | 18,751.1 | | 18,751.1 | 18751 | 18,751.1 |
| Actual last Price | | | | | | **Actual Share Price** | **£5.19** | | |
| **12-month target today:** | | | | | | **Model Share Price** | **£5.97** | | |

**Source:** Irakli Menabde; See Appendix for full details of the model

As can be seen from the DCF output of BP Plc, the methodology indicates upside to current share price, thereby offering an investment opportunity to buy the stock and the inverse for Exxon Mobil Corp which, also offering an investment opportunity, only to sell the stock short. Before the examination of the model output, its rationale and implications, I will provide a brief assessment of performance of the model in order to demonstrate its robustness of the approaches across three DCF methodologies discussed.

**Figure 27: Exxon Mobil Corp, DCF Summary Output**

| d free cashflows | 2002 | 2003 | 2004 | 2005 | 2006 | | 2007 |
|---|---|---|---|---|---|---|---|
| **Terminal Value** | 74,590 | 80,565 | 87,292 | 94,199 | 101,660 | | 111,616 |
| 2002 | 3,254 | | | | | | |
| 2003 | 12,328 | 13,315 | | | | | |
| 2004 | 19,074 | 20,602 | 22,322 | | | | |
| 2005 | 24,097 | 26,027 | 28,200 | 30,432 | | | |
| 2006 | 18,358 | 19,828 | 21,484 | 23,184 | 25,020 | | |
| 2007 | 17,637 | 19,050 | 20,641 | 22,274 | 24,038 | | 26,393 |
| 2008 | 16,485 | 17,805 | 19,292 | 20,819 | 22,467 | | 24,668 |
| 2009 | 15,685 | 16,942 | 18,356 | 19,809 | 21,378 | | 23,471 |
| 2010 | 14,498 | 15,660 | 16,967 | 18,310 | 19,760 | | 21,695 |
| 2011 | 13,451 | 14,529 | 15,742 | 16,987 | 18,333 | | 20,128 |
| 2012 | 12,480 | 13,480 | 14,605 | 15,761 | 17,009 | | 18,675 |
| 2013 | 11,579 | 12,506 | 13,550 | 14,623 | 15,781 | | 17,326 |
| 2014 | 10,742 | 11,603 | 12,572 | 13,567 | 14,641 | | 16,075 |
| 2015 | 9,967 | 10,765 | 11,664 | 12,587 | 13,584 | | 14,914 |
| 2016 | 9,247 | 9,988 | 10,822 | 11,678 | 12,603 | | 13,837 |
| 2017 | 8,579 | 9,267 | 10,040 | 10,835 | 11,693 | | 12,838 |
| 2018 | 7,960 | 8,597 | 9,315 | 10,052 | 10,848 | | 11,911 |
| 2019 | 7,385 | 7,977 | 8,642 | 9,326 | 10,065 | | 11,051 |
| 2020 | 6,852 | 7,400 | 8,018 | 8,653 | 9,338 | | 10,253 |
| **NPV** | **239,657** | **255,341** | **262,233** | **258,894** | **246,557** | | **243,234** |
| | | | | | | | |
| Sum discounted free cashflows | 239,657 | 255,341 | 262,233 | 258,894 | 246,557 | | 243,234 |
| Terminal Value | 74,590 | 80,565 | 87,292 | 94,199 | 101,660 | | 111,616 |
| Growth rate in perpetuity | | | | | | | **1%** |
| | **2002** | **2003** | **2004** | **2005** | **2006** | | **2007** |
| Enterprise value | 314,247 | 335,906 | 349,525 | 353,094 | 348,217 | | 354,851 |
| less net debt | (3,519) | 1,081 | 14,842 | 25,284 | 24,501 | - | 24,934 |
| Equity value | 317,766 | 334,825 | 334,683 | 327,810 | 323,716 | | 329,917 |
| **Price per share** | **61.2** | **64.5** | **64.4** | **63.1** | **62.3** | | **64** |
| No. of shares | 5,194.0 | 5,194.0 | 5,194.0 | 5,194.0 | 5,194.0 | | 5,194.0 |
| Actual last Price | | | | | | *Actual Share Price* | **$ 77.95** |
| **12-month target today:** | | | | | | *Model Share Price* | **$ 67.96** |

As will be demonstrated by the back tests of the DCF methodology, the methodology I demonstrated gives a margin of error of 7% for Exxon Mobil Corp and –6 % for BP Plc. These numbers demonstrate the deviation of the model-estimated price at the beginning of each year to that years end realised share price over the period of last 5 years. The figures also mean that the DCF methodology used, on average tended to undervalue BP Plc and Overvalue Exxon Mobil Corp. As the numbers are within acceptable share price estimation error bandwidth, it is clear to see that the methodology works well to anticipate future market price for the shares. Whether the market in itself is correct to assume that price will be questioned further as we explore the Multiples based methodology and Real Options. Until then it is safe to assume that discounted cash flow based valuation works rather well in assigning market value to the International Oil & Gas Companies.

### 4.1.3 DCF Models Robustness Tests

**Figure 28: BP Plc, DCF Model Backtest**

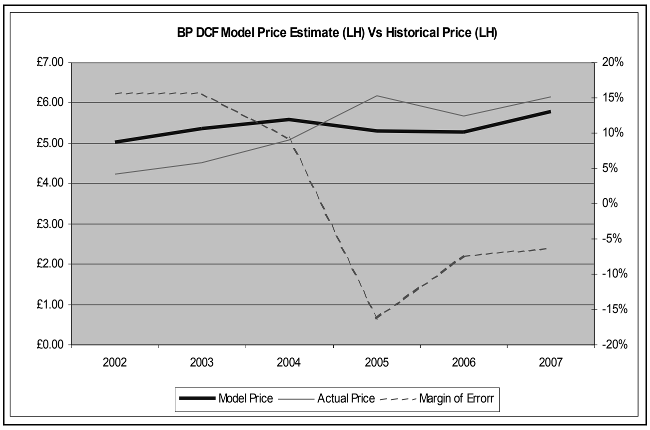



**Figure 29: Exxon Mobil Corp, DCF Model Backtest**

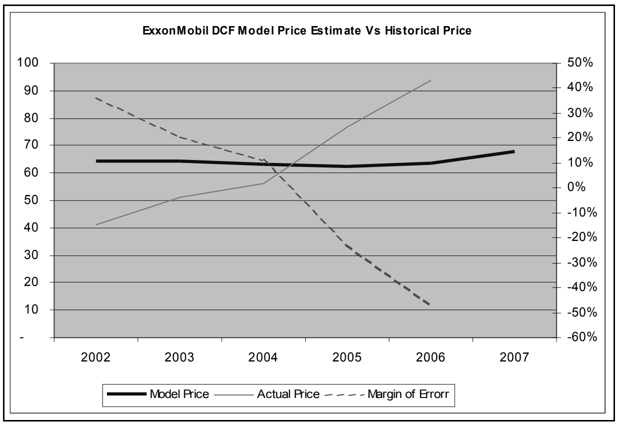



**Figure 30: BP Plc, DCF Oil Price Based Model Backtest**

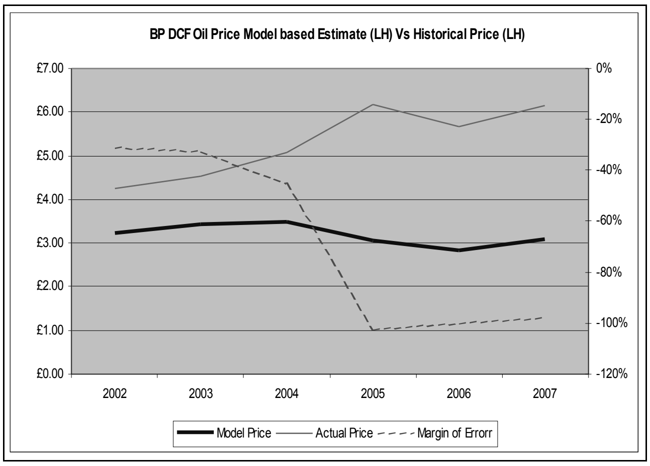



**Figure 31: Exxon Mobil Corp, DCF Oil Price Based Model Backtest**

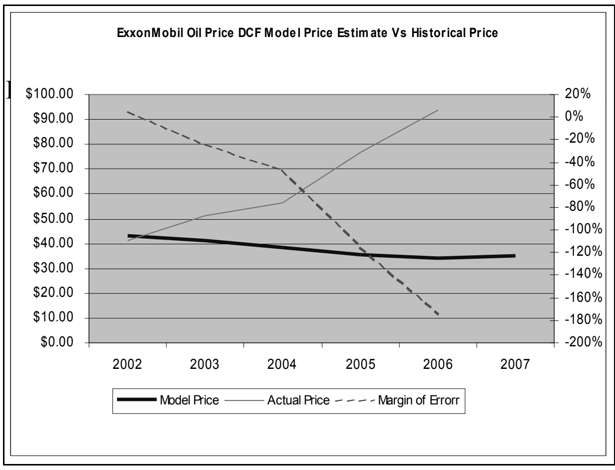



**Figure 32: BP Plc, DCF Fundamental Model Backtest**

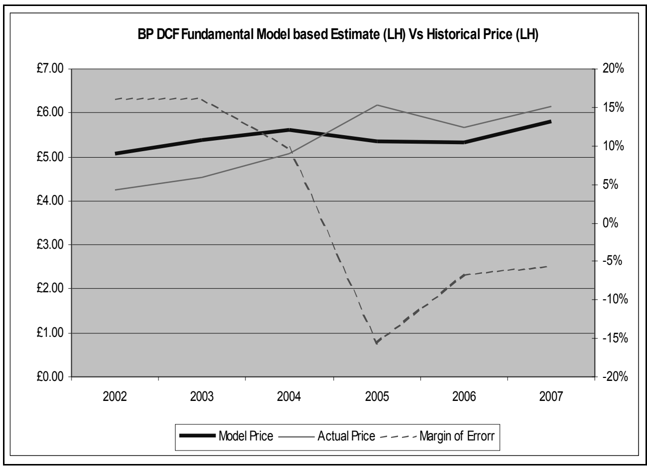
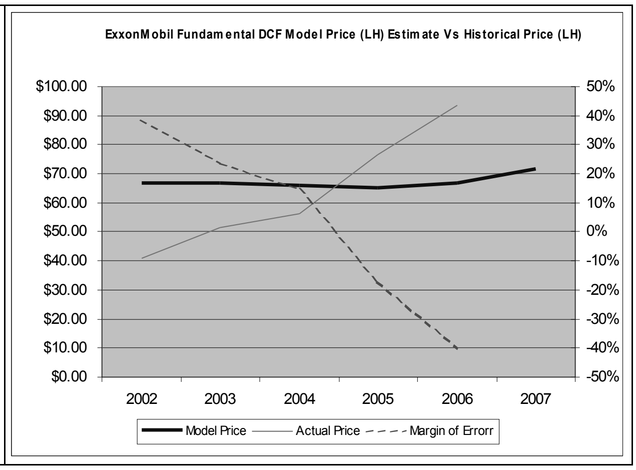



**Figure 33: Exxon Mobil Corp, DCF Fundamental Model Backtest**

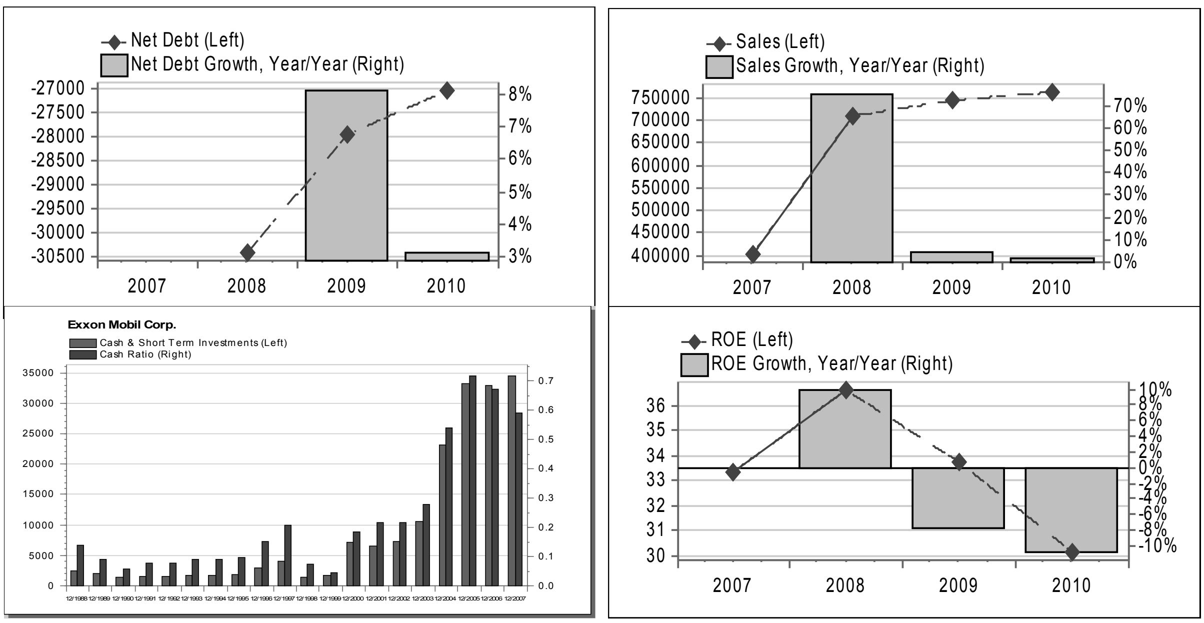



As can be seen from the above described scenarios, the DCF model base on my argued methodology delivers the most robust result in terms of back tested predicative power as indicated by the margin of error line shown in the graph. Where as, the Oil Price based model assumes the lowest share price and had the lowest predictive power. This raises the following dilemmas about Oil Price and its input to the model. First, the Oil Price curve during the analysis was in Backwardation, meaning spot price was higher than long end of the forward curve thereby limiting future assumed Oil Prices, although such an assumption would have been a costly one over the last 5 years, as the market fell into a structural backwardation.

The key findings from the DCF based methodologies are the following:

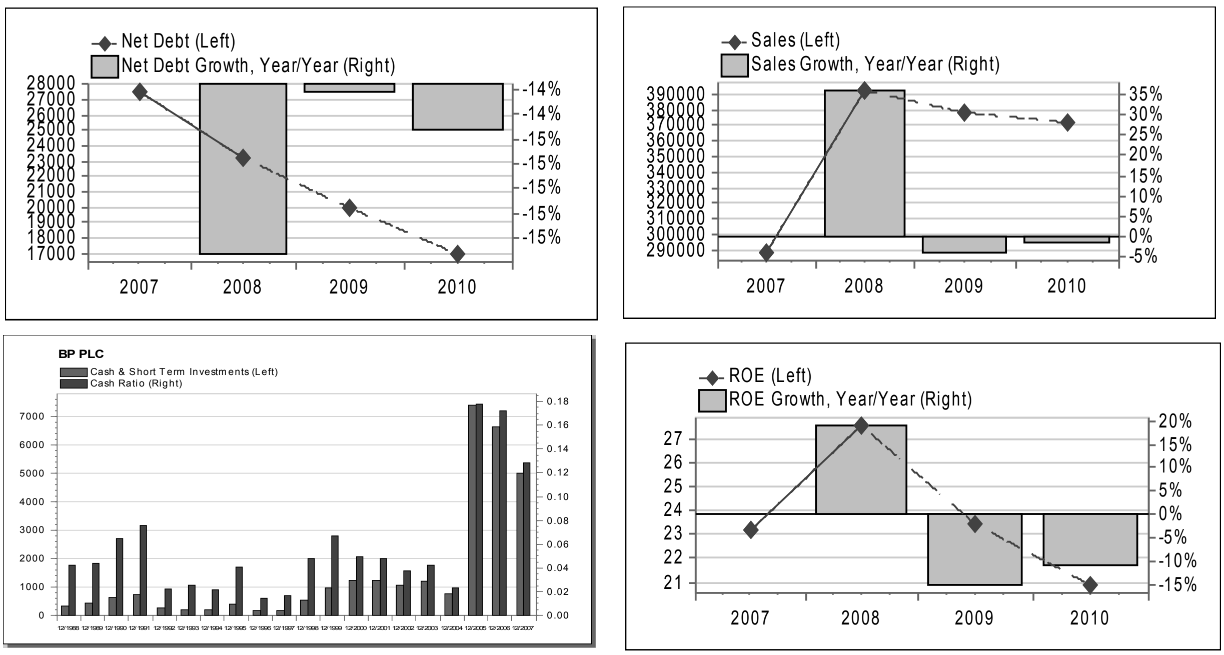
1. Exxon Mobil Corp was found overvalued by 13 % when compared to current share price for the following reasons
    a. The Terminal Growth (Steady State Growth) for the company is lower than Fundamental Growth (Medium-Term Growth) rate, while Fundamental Growth is lower then IBES Consensus (Short-Term Growth) assumed growth rate for the next three years. That implies that the Analysts are too optimistic about future growth. It also means that companies are under allot of pressure to deliver growth, and since the Oil Prices are not in their hands that means improvement of margins and increase of structurally declining production.
    b. The Model assumes that we have now entered a structural and long term period in which the company goes back to the average end of capital expenditures as opposed to have had cyclically underinvested over the past two decades.
    c. Return on Equity for Exxon Mobil Corp is assumed to decline modestly with time, assuming that the commodity price rise will not lag behind growing cost inflation as potentially opposed to steady price state while cost inflation escalates with time.

**Figure 34: Key Financial Factor Analysis Exxon Mobil Corp**



1. BP Plc was found to be undervalued by 15 % when compared to current share price for the following reasons:
    a. The Company's short term oriented IBES mean growth estimates as indicated by sales growth show negative expectation for the forward year two and forward year three as demonstrated below.
    b. The Return on Equity discounted in the share price is assumed to a have an abrupt fall of more than 15% for 2009 thereafter to normalise its assumed decline. This aggressive downturn expectation of the return generation ability of the company in the short terms is depressing the share price valuation.
    c. The Net Debt of BP Plc, looksto visibly improve with time as expected by the market

**Figure 35: Key Financial Factor Analysis BP Plc.**

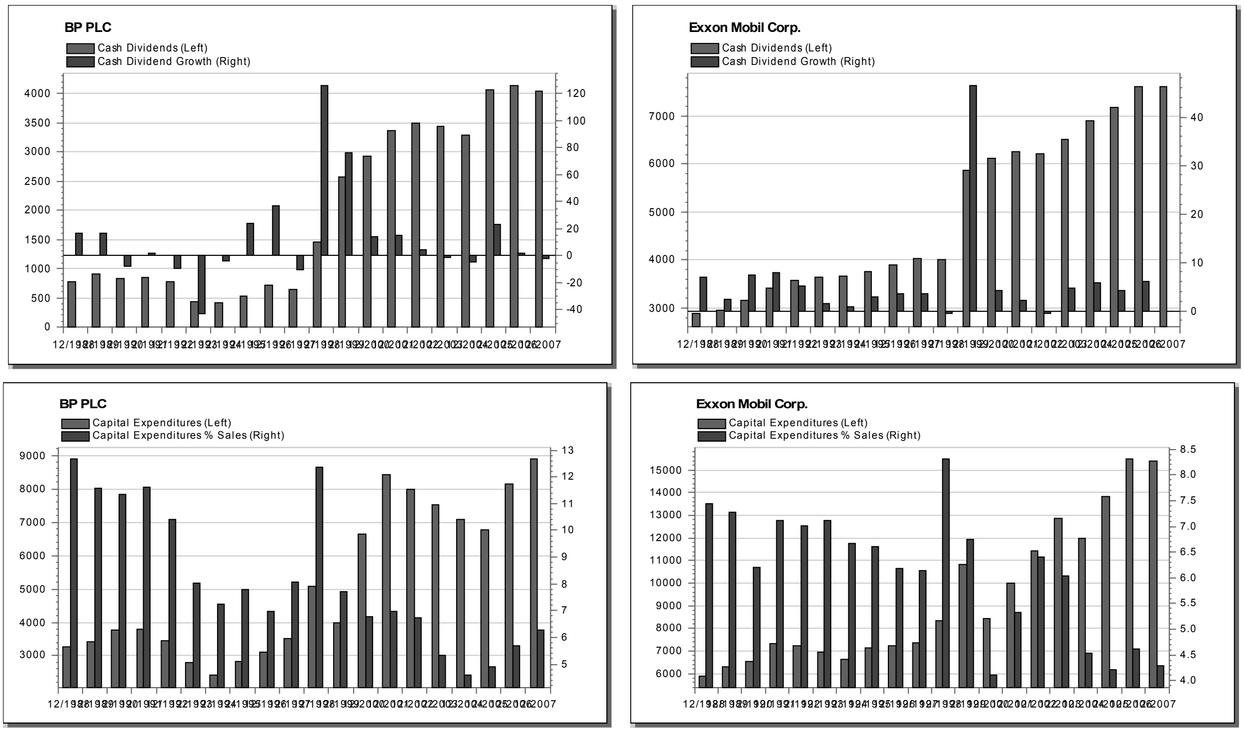



Furthermore, broad and immediate interpretations of current company status are as follows: Given the currently high oil price environment, as more cash appears on the balance sheets than debt, both companies are faced with shareholder demands to increase its share buy-back program given that Exxon Mobil's as well as BP's free cash flow is enormous typically blamed for the rather stingy dividend payout of earnings and as some could argue, inflation restrained capital spending programs. Based on that premise both companies could buy back at least 5% of their stock from free cash flow, alone. The question however, would be whether such a decision is indeed beneficial for shareholders as opposed to for example increasing capex programs into new capacity and new technology, and focusing more on long term projects which may not yield cash flows in the short-medium term, yet may ensure the company's future for the long term.

This is the eternal question between shareholder demands and managerial decision-making. Yet, given the fact that there are different types of investors holding the stock, some of which want short term absolute returns, others wanting long term dividend reinvested related returns and some simply not knowing what they want by aiming to gain crude oil price exposure through equity all constitute a diverse group of non-aligned demands. So if the provision of dividend or share buyback programs may be seen as a positive step by the management by a portion of the investment base, it may have opposite view by the other shareholder base.

Below figures demonstrate the conundrum of rising cash on balance sheet yet real Capex underinvestment as measured in percentage of Capex to sales, although the nominal multibillion budget allocations sound impressive at first. In addition, it also becomes visible that Dividend growth is not exactly a priority for the management. So what will the industry do with all the cash? Or rather how should the management deploy the growing cash balance especially in time of rising inflation as we have now?

**Figure 36: Key financial indicators, historic comparison**




From the DCF model analysis, it becomes clear, that the management must ensure that top line growth stays positive and that it also translates well into cash flow margin improvement. In addition, the management must invest heavily today in mega projects with significant delay in construction, to insure its production volumes and stable margins in the future. With that in mind, continuous re-investment into the business should ensure superior valuation. Although that may mean growing even more the already high nominal Capex to industry average historical levels in proportional terms to sales, some short term share holder expectations such as share buy backs and dividend growth may need to be sacrificed for short term oriented shareholders. I would further argue that Integrated oil & gas companies like the ones discussed are better suited for Long Term shareholders as opposed to short term oriented, oil price leverage seeking traders. I argue this because, if the industry does not capitalize on the current high oil price environment and does not reinvest the currently growing cash balance to ensure future production and profitability, then longer term growth may end up negative even with high oil prices as production declines and cost inflation continues for both economical as well environmental reasons.

In such a scenario a question for the management would be how will they know if they are adding value to the shareholder base? Or rather to which part of the shareholder base? And if a decision is taken to satisfy intense demands by large shareholders which, with their shorter-term horizons unwillingly jeopardise the long term strategic future of the companies, what is the management to argue? The solution I propose for this dilemma is that the management of a large integrated Oil & Gas multinational, must have an unbiased and rational shareholder expectation framework mapped out in order to symbiotically ensure both, shareholder demands and long term strategic future of the companies. The Integrated Oil & Gas Backtest section of the thesis provides and will discuss an overview of the most shareholder adding accounting benchmarks that lead to superior shareholder returns over as back tested for the period of last 20 years on monthly holding periods and thus provide guides to also the shorter term shareholder tastes as well as the long term.

## 4.2 Sum of the Parts Valuation

This methodology aims to add an empirical view of valuation in terms of valuating the company based on in its business composition on separate basis and then sum the attributed values together. As each sub sector of the business has listed peers, an already existent valuation framework exists in terms of assigning market multiple based value of assets and more specifically earnings of each segment. The methodology is quite straightforward and is founded on P/E ratio and can be extended to EV/DACF/EBITDA. I have managed to extract the estimates of net income lines for 2009 as well 2000 thanks to some free published broker estimates.

**Figure 37: BP Plc SoP Based Model Output**

| BP Plc | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| Total Capital Employed | 78,813 | 72,689 | 72,689 | 80,058 | 233,192 | 226,196 |
| 4 segments Cap. Emplyd | 89,766 | 89,556 | 99,104 | 115,326 | 131,617 | 139,302 |
| Cap Empl Gap | (10,953) | (16,867) | (26,415) | (35,268) | 101,575 | 86,894 |
| Total Net Debt | (11,257) | (3,769) | (5,645) | (10,666) | (9,973) | (10,012) |
| Total Market Cap | £109,137 | £121,883 | £110,722 | £116,375 | £527,531 | £347,738 |
| Total EV | £97,879 | £118,114 | £105,077 | £105,709 | £517,558 | £337,726 |
| | | | | | **PE FY1** | **PE FY2** |
| **Implied Historical P/E** | 13 | 10 | 9 | 11 | 9 | 6 |
| **Actual Historical & Forecast By IBES** | 13 | 11 | 10 | 11 | 6 | 6 |
| **Sector Forecast Ibes** | | | | 10 | 8 | 8 |
| Stock is at trading at a premium = Overvalued(+) | 1% | 14% | -14% | 1% | -35% | -4% |
| **Stock has been Undervalued by on Average** | -6% | | | | | |

| BP Plc | | |
|---|---|---|
| **Actual Share Price** | | |
| **£5.06** | | |
| | | |
| **Target Price** | | |
| This Year | Next Year | **Average Predicted Price** |
| £28.13 | £18.54 | **£23.34** |

BP Plc, was found to be significantly undervalued to its current share price, in particular its upstream business. This was because the multiples on which the upstream market trades are much higher than the valuation of the integrated stock universe. Thus, even as more capital is invested and production revenues might be spiking, the ownership of the segment depresses the segments true stand alone value.

**Figure 38: Exxon Mobil Corp, SoP Based Model Output**

| Exxon Mobil Corp | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| Total Capital Employed | $150,869 | $160,488 | $168,542 | $182,319 | $425,046 | $446,298 |
| 4 segments Cap. Emplyd | $107,339 | $116,961 | $122,573 | $128,760 | $139,562 | $150,323 |
| Cap Empl Gap | $43,530 | $43,527 | $45,969 | $53,559 | $285,484 | $295,975 |
| Total Net Debt | ($14,842) | ($25,284) | ($24,501) | ($24,934) | ($22,390) | ($22,390) |
| Reported Net Debt | -14842 | -25284 | -24501 | -24934 | | |
| Total Market Cap | $ 269,288 | $ 328,115 | $ 344,491 | $ 439,013 | $ 486,100 | $ 297,021 |
| Total EV | $ 254,446 | $ 302,831 | $ 319,990 | $ 414,079 | $ 463,710 | $ 274,630 |
| | | | | | **PE FY1** | **PE FY2** |
| **Implied Historical P/E** | 11 | 9 | 9 | 11 | 8 | 5 |
| **Actual Historical & Forecast By IBES** | 13 | 10 | 12 | 13 | 8 | 8 |
| **Sector Forecast Ibes** | | | | 10 | 8 | 8 |
| Stock is at trading at a premium = Overvalued(+) | 24% | 8% | 33% | 19% | 4% | 67% |
| **Stock has been overvalued by on Average** | 26% | | | | | |

| **Exxon Mobil Corp** | | |
|---|---|---|
| **Actual Share Price** | | |
| **$78.02** | | |
| | | |
| **Target Price** | | |
| This Year | Next Year | **Average Predicted Price** |
| $93.59 | $57.19 | **$75.39** |

We can see that based on the SoP methodology Exxon Mobil Corp roughly fare priced although, clearly the stock has been overpriced relative to peers in the industry for the demonstrated period. In addition, Exxon Mobil Corp looks to be significantly under priced on a forward year basis, implying that the market expects a downturn in earnings growth in the future as previously discussed in the DCF section. For full details of the model please see appendix.

In addition, SoP valuation serves well when comparing companies relative to each other for given Merger and Divestment transactions in terms of the fairness to market value. Yet the impact and implication of the cash flow estimates by investors will be key in the impact of determination of new value for the acquirer.

## 4.3 Real Options Valuation

Ten Real Option based models were developed to assess the resource-based methodology for valuing BP Plc and Exxon Mobil Corp, five for each. First model was constructed to take P2 Resources which are based on Wood Mackenzie 2P reserves mmboe measurement aimed to establishing a value of the companies based on their productions life estimates as published from their own accounts. The second model was constructed to establish the value for SEC Proved 1P Reserves mmboe based on current reserve replacement ratio to establish the real tangible value of the company as it has reported itself to the SEC. The third model was built to establish the separate value of the Upstream Unproved and Undeveloped resource base, as this would be the real option value for all unproven resources that the company guess estimates it has. This is in fact is the true option that comes with a resource company in terms of its reflection in the unknown upside potential for the share price and therefore current values of the companies. The fourth model was developed to estimate the value of delaying production of the Unproven Resources, that again the company believes it has. All of these models were constructed to also extract implied Oil Price from current valuations of the companies as implied by the market perception of the share prices of the respective companies. Lastly, the fifth model was developed to forecast the option value path for the Unproven Resources over the company based on current oil price as implied by the market alone, through Nymex Crude Oil long term Futures Strip.

**Figure 39: Reserves Breakdown of Companies**

| | Upstream NAV $ Mill SEC | 2P NAV Implied Oil Price Discount to Spot | Upstream NAV + Premium | SEC Proved 1P Reserves mmboe | Wood Mackenzie 2P reserves mmboe | Upstream Unproved and Undeveloped mmboe | Upstream NAV/1P Reserves ($/boe) | Upstream NAV/2P Reserves $/boe |
|---|---|---|---|---|---|---|---|---|
| **ExxonMobil** | 413,383 | -83.30% | 306,687 | **21,757** | **40,290** | **18,533** | 13.4 | 6.4 |
| **BP** | 259,448 | -86.82% | 156,877 | **17,297** | **31,790** | **14,494** | 11 | 4.9 |

Both ExxonMobil's and BB's reserve lifes at current production rates are more than 10 years which are amongst the longest in the industry. In addition to proved reserve additions, both

**Figure 40: Reserve Replacement and Production of Companies**

| 2007 | Total Reserves Addition (2003 - 2007) | | Reserve Replacement Ration (2003 - 2007) | | Total Production 2003 -2007 | Annual Av | Total Reserves | |
|---|---|---|---|---|---|---|---|---|
| | Inorganic | Organic | Inorganic | Organic | | | **Oil Mmboe** | **Gas MCBF** |
| **ExxonMobil** | 8,436 | 8,668 | 108% | 111% | 7,782 | 2,594 | 10,380 | 68,262 |
| **BP** | 7,334 | 7,366 | 103% | 104% | 7,096 | 2,365 | 9,165 | 48,789 |

companies are continuously strenghtening their total resource bases which must fairly be included in valuation. The models assume no growth of production volumes over the long term based on the notion that current production upkeep is already reching points of unsustainability and lack of any visible growth over the last 3 years across the developed world industry average. In the medium term, latest SEC Proved 1P resource is used as prodcution life discussed earlier, for the longer term, epsecially in the delay option valuation the compnay assumed reserve lifes are used. In the case of BP that is 42 years as reported[18] assuming total resources as estimated by the companay iself. As such a figure was difficult to find for Exxon, given the speculative nature of guessing I used the crude estimate and applied the figure of BP Plc. Without a doubt some of the assumptions are crude in terms of accuracy but they are meant explain the methodology used rather than internal estimates of the companies. Although information assymetry is undeniable in the investment industry.

[18] http://www.bp.com/genericarticle.do?categoryId=2012968&contentId=7041569

The inputs for calculating the strike price were based on discounted, expected cashflows to the firm, based on the derived per barrel profitability projections from historic production and throughput volumes. Meaning, given a stable production and throughput volume and their proprotional profit margin for each company, one can establsh a target calue value as an input for all expected future cashflows expected from developeing all of fimrs reserves in a multide of classification schemes as demonstred in the outcome below. The dsicounting of the cashflows for each firm based on these reserve estimates were condutcted on the same principles of DCF forecasting assumptions, in particular for discount rate, segment profitability and time horison, as in this case assumed to be the reserve to production life of the companies.

**Figure 41: Real Options Model Input Parameters**

| Real Options Model Inputs | | |
|---|---|---|
| Model Inputs | **BP Plc** | **Exxon Mobil Corp** |
| Price of Resource end of futures curve $ /Bbl | $ 118.3 | $ 118.3 |
| Price of Resource Today is 114$ / Bbl | | |
| Extraction Cost (As disclosed by the companies) | $ 7.9 | $ 6.7 |
| Life of reserves in Years (As disclosed by the companies) | 13.5 | 16.7 |
| Variance of Oil Price | 0.14 | 0.14 |
| Unproven Strike 2P-1P (Resource * Today P) in Bln US$ | $ 1,538 | $ 1,990 |
| Unproven 2P-1P Exercise Price in Bln US$ | $ 1,600 | $ 2,068 |
| Proven Strike 1P (Resource * Today P) in Bln US$ | $ 1,836 | $ 2,427 |
| Proven 1P Exercise Price in Bln US$ | $ 2,045 | $ 2,573 |
| Processed Boe Annually Million/Boe/Per Year | 3,420 | 5,600 |
| Produced Boe Annually Million/Boe/Per Year | 4,000 | 2,500 |

The figure below provides an input summary into the real options model, in particular, the todays Oil Price and the end of the futures curve of 118 $/Boe in 2015.

**Figure 42: Current Oil Price and furthest contract in Futures curve**

| Real Option on Actual and Forward Oil Price | Actual Oil Price | Market Implied Oil Price BP | Market Implied Oil Price Exxon |
|---|---|---|---|
| Oil Price Today | $ 114.05 | $ 118.26 | $ 118.26 |
| Oil Price In the Future (End of the Listed Curve) | $ 118.26 | $ 118.26 | $ 118.26 |

In the tables below I demonstrate the Implied Oil Price and the Market Oil Price based outputs of the real optins based models. This means that in the Market Implied approach, I equiate the output of the model to the current share price, y leaving interest rate, volatiliy and time unchanged and only altering the oil price in oder to uncover the Crude Oil Price implied by the market valuation. Coneresely, the Market Oil Price valuation takes the futres based oilprivce as an input for calcualting strike and current share price and gives true real option based output.

All outputs of Real Option Values are adjusted to shares outstanding and are based on the premise that a companys share price is the option valuation devided by number of shares out.

**Figure 43: Real Options Models output BP Plc.**

| Option Model Outputs for BP Plc | Implied Oil Price | Market Oil Price |
|---|---|---|
| Todays Actual Share Price | £5.19 | £5.19 |
| Real Option Value Including Unproven Using Capex | £10 | £170 |
| Total Company Option Value | £7.09 | £80.54 |
| Proved + Unproved +Delay | £3.30 | £41.14 |
| Value of Delay | £0.40 | £0.02 |
| Price of Booked Reserves Option in share equivilant | £1.0 | £21.6 |
| Price of Delay Optionality | £0.40 | £0.02 |
| Average Price of Options | £5.19 | £60.84 |
| Synergy Gap | £3.78 | £39.40 |
| Synergy As % of Company Value | 53% | 49% |
| Synergy As % of 3 Options Value | 115% | 96% |
| Share Price Upside implied by Real Options Valuation | 0% | 1072% |

**Figure 44: Implied Oil Price in Reverse Real Option Model**

| Reverse Real Option on implied Oil Price | Actual Oil Price | Market Implied Oil Price BP | Market Implied Oil Price Exxon |
|---|---|---|---|
| Oil Price Today | $ 18.00 | $ 18.00 | $ 28.00 |
| Oil Price In the Future (End of the Listed Curve) | $ 18.00 | $ 18.00 | $ 28.00 |
| Price Implied in today's share price | | **$ 18.00** | **$ 28.00** |

**Figure 45: Real Options Models output Exxon Mobil Corp.**

| Option Model Outputs for Exxon Mobil Corp | Implied Oil Price | Market Oil Price |
|---|---|---|
| Todays Actual Share Price | $77.95 | $77.95 |
| Real Option Value Including Unproven Using Capex | $53.69 | $631.43 |
| Proved + Unproved +Delay | $96.15 | $427.11 |
| Value of Delay | $23.37 | $6.56 |
| Total Company Option Value | $60.30 | $621.92 |
| Price of Delay Optionality | $23.37 | $6.56 |
| Price of Booked Reserves Option in share equivilant | $52.01 | $229.33 |
| Average Price of Options | $78.23 | $524.52 |
| Synergy Gap | -$35.86 | $194.81 |
| Synergy As % of Company Value | -59% | 31% |
| Synergy As % of 3 Options Value | -37% | 46% |
| Share Price Upside implied by Real Options Valuation | 0% | 573% |

In this case the implied Oil Price for BP Plc turned out to be lower than that of Exxon Mobil, implying a discount to a barrels worth for BP Plc, compared to Exxon Mobil Corp. In addition. It can be seen that should the market re rate the implied option price of a barrel of oil for the industry as a whole, BP Plc stands to gain much more than Exxon Mobil as seen in the Share

Price Upside Implied by Market Oil Price. In addition, Price for Option to Delay in the undeveloped resource model indicate that based on the current forward market price of Oil being in backwardation, the option to delay loses its value as the market is in backwardation.

Lastly, assuming that the one believes that the Futures market for Oil Price is an efficient and unbiased estimator of future value, then true real option valuation of an oil & gas company lies in taking the Damodaran approach as discussed earlier.

Below I demonstrate the 50 paths of real option value of undeveloped resource base to which the company holds current and future claim for the next years as indicated by their production life estimates, based on today's and futures based oil prices. For Exxon Mobil Corp, this implies a Real Option based Resource Value ranging from 1.6 trillion USD$ to 2.5 trillion USD$ equivalent. Similarly for BP Plc, the valuation ranges from 1.5 to 2.3 Trillion USD$.

**Figure 46: Possible Reserves Value Simulation BP Plc.**

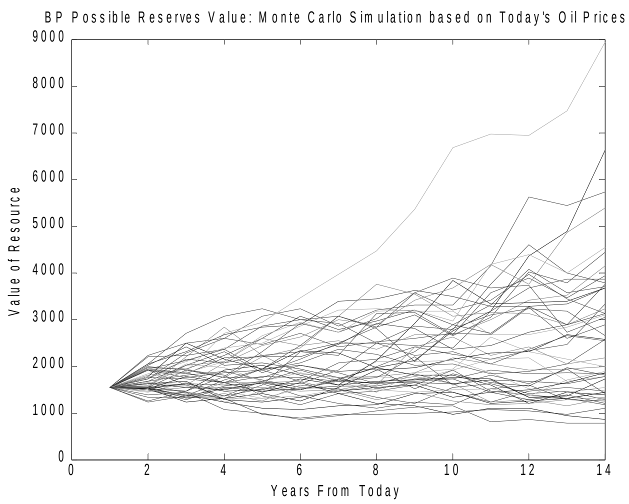
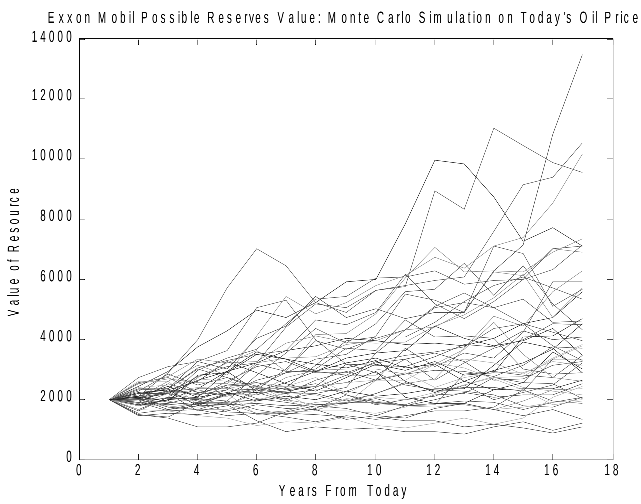



**Figure 47: Possible Reserves Value Simulation Exxon Mobil Plc.**




The above Monte Carlo simulations demonstrate the paths of the value of the underlying resource for each company. Obviously as the time increases the forecast accuracy decreases and the range of value increases in width. Nevertheless, it manages to demonstrate the P2-P1 upside potential of SEC unproven resource base. This indicates the value in today's oil prices that the companies hold option to.

## 4.4 Econometric Tests

In demonstrating the strength of the final model for stock selection, two separate tests were conducted, one in which I tested the performance of a stock selection model in five buckets i.e being long the top two quintiles of the universe and short the bottom two Vs equally weighted universe constituent benchmark of integrated Oil & Gas as defined by Dow Jones Global Integrated Oil and Gas Index. The difference in the two tests was the benchmark, depending on the investor taste and investor competitive benchmark. For the first test the benchmark used was Equally Weighted Universe as demonstrated in results in the figure below, while for the second test I used broad market prime equity S&P500 as benchmark for a typical investor. This was done to see first of all which were more relevant factors in terms of stock selection in their predictive powers and measured by the Information Ratio on an individual Factor basis as well Hit rate as defined by whether the chosen stocks based on chosen factors and thereafter final stock selection model went up or down given their portfolio allocation relative to their benchmarks.

The methodology used for Back test is based on the following inputs:

- Equally weighted stock portfolio allocation
- Cash Neutrality across exposures
- Full Investment, no cash positions
- Transaction Costs with 10 basis points per round trip
- Target Optimization of Information Ratio
- Monthly rebalancing
- 5 sections (buckets) of the universe
- Model is Rank based

In a long only portfolio, profits and losses are often expressed as a return percentage. The same holds for long□short portfolios. In a long only situation, return will be defined as the profit of a certain security (portfolio), divided by the initial value of the security (portfolio). These returns are called arithmetic returns and can be expressed by the following function.

The rational for using the Information Ratio as target for optimization, is that it measures the active return of an investment manager divided by the amount of risk the manager takes relative to a benchmark rather than against the risk free return like in the Sharpe Ratio. This is because truly active portfolio managers tend to have higher and more relevant benchmarks based on the universes in which they compete in. This is proven by the fact that the IR is used in the analysis of performance of hedge funds, etc. More specifically, the information ratio is defined as active excess return divided by tracking error. Since, the active return is the amount of performance over or under a given benchmark index, the active return can be positive or negative. In the case of this back test, tracking error is the definition for the standard deviation of the active return of the strategy on a long short basis. Another alternative interpretation for the IR calculation will be that it is alpha divided by tracking error, although it is preferable to use pure active return in the calculation. So the ratio in this back test will be based on the comparison of the annualized returns of the strategy in which the long names selected by the stock selection model and short names are either the sector benchmark or the S&P500 broad market index over a given time horizon, the lowest ranking stocks in the bottom bucket of the model. So, the IR the ratio is at this point a solid indicator of the risk-adjusted active return of the strategy over the given benchmark. The objective of increasing the ratio is based on the logic that the higher the Information Ratio, implies higher active return the strategy generates, given the amount of risk undertaken, and thus the better the strategy. The formula is described below:

**Figure 48: Information Ratio**

$$IR = \frac{S(R - Rb)}{\sigma} = \frac{S[R - Rb]}{\sqrt{\mathrm{var}[R - Rb]'}}$$

Where,

R is the return of the Long Portfolio
Rb is the return of the Benchmark Portfolio
S is the sum of historical returns based on the backtests

Below figures provide tangible, performance indicators of top and bottom most influential factors that were discovered in univariate factor ranking tests. It is visible that forward year, IBES consensus based price to earnings ratio is the dominant stock selection criteria for the stock selection within the universe based on the factors tasted. Furthermore, it visible that the top five explanatory factors for successful stock selection as assessed by the premise of the model in Integrated Oil & Gas Universe are Value, Size and Return on Equity oriented, in contrast to the least value adding factors related growth, depreciation and interest payments.

**Figure 49: Factor Ranking**

| # Rank | Factor Name | Information Ratio |
|---|---|---|
| 1 | E2 over P (IBES) | 0.648013339 |
| 2 | Market Cap (WS) | 0.504773537 |
| 3 | B over P (WS) | 0.449417104 |
| 4 | E over P (WS) | 0.292207051 |
| 5 | Return on Capital | 0.245693422 |
| 5 | Sales Gr 5yr | -0.816888342 |
| 4 | Interest Cover | -0.830239635 |
| 3 | Sales Gr 3yr | -0.843828526 |
| 2 | Cashflow over Depr | -0.922086632 |
| 1 | Growth Hist Sales | -0.941886833 |

Similarly, the below figures demonstrate the Mean Arithmetic relative returns vs. own universe benchmark as defined by Dow Jones Integrated Oil & Gas industry universe. It can similarly be seen that value is indeed the dominant factor for successful stock selection in direct contrast to growth.

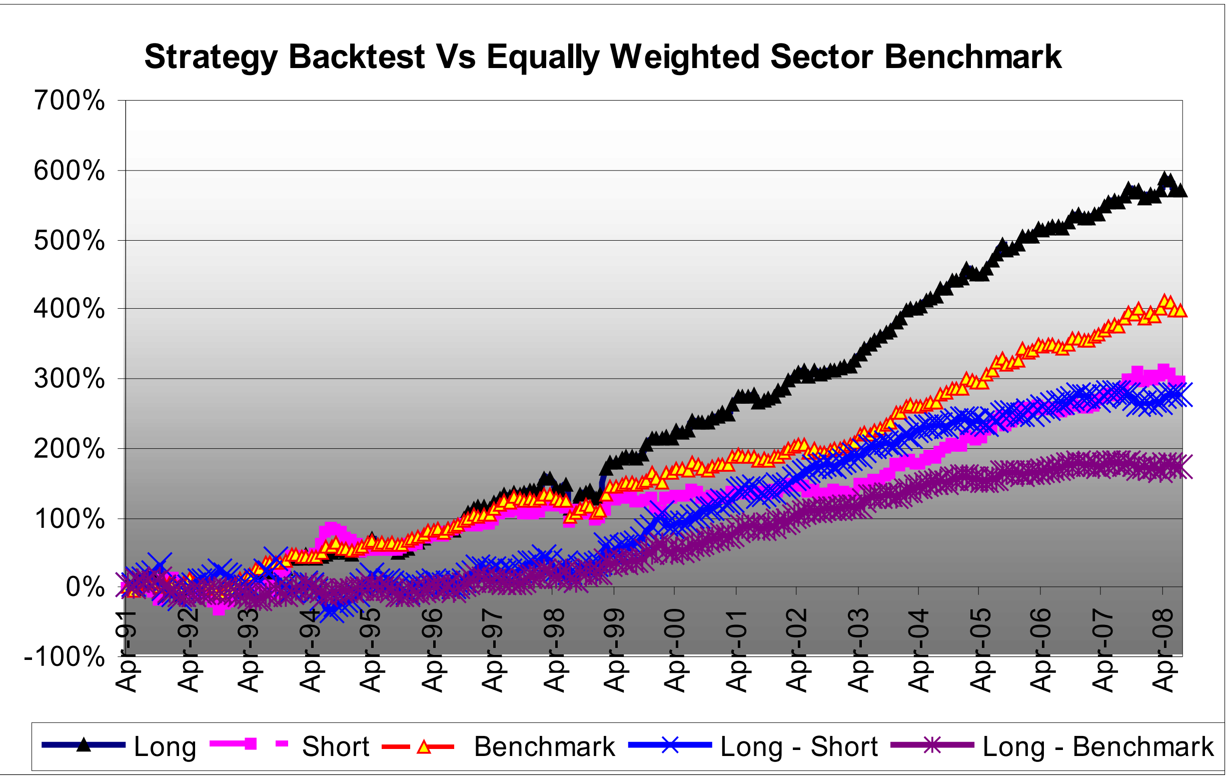
**Figure 50: Factor Ranking Continued**

| # Rank | Mean of (Arithmetic) relative returns (annualised) | World - Universe |
|---|---|---|
| 1 | E2 over P (IBES) | 8% |
| 2 | B over P (WS) | 7% |
| 3 | Market Cap (WS) | 5% |
| 4 | E over P (WS) | 4% |
| 5 | Return on Capital | 3% |
| 5 | Interest Cover | -9% |
| 4 | Sales Gr 5yr | -9% |
| 3 | Sales Gr 3yr | -9% |
| 2 | Growth Hist Sales | -10% |
| 1 | Cashflow over Depr | -11% |

On the following page, I present the results of the Back test and the performance of the model stock selection methodology on a custom constructed factor model that was based on results of the univariate factor tests as summarized by most outstanding factors above. The top line indicated by triangle shape is the performance of the long leg of the stock selection model, visibly outperforming the benchmark as well as all other time series visible. The line below denoted as light triangular is the equally weighted sector benchmark.

The implications are threefold, first that there are systematic methods for trading and outperforming the stock market. Second, that these methods can deliver investment strategies that generate continuous excess returns or alpha and not be diversified with the market as demonstrated here. Third, that although one can argue potential; over fitting of the model on a small universe, the model shows robust performance across out of sample sectors and thereby implies strength nonetheless.

**Figure 51: Backtest 1**




It can be seen from both figures that the Long leg of stock selection, delivers superior performance over the 20 year historical period. In addition the results of long/short and

**Figure 52: Backtest 2**

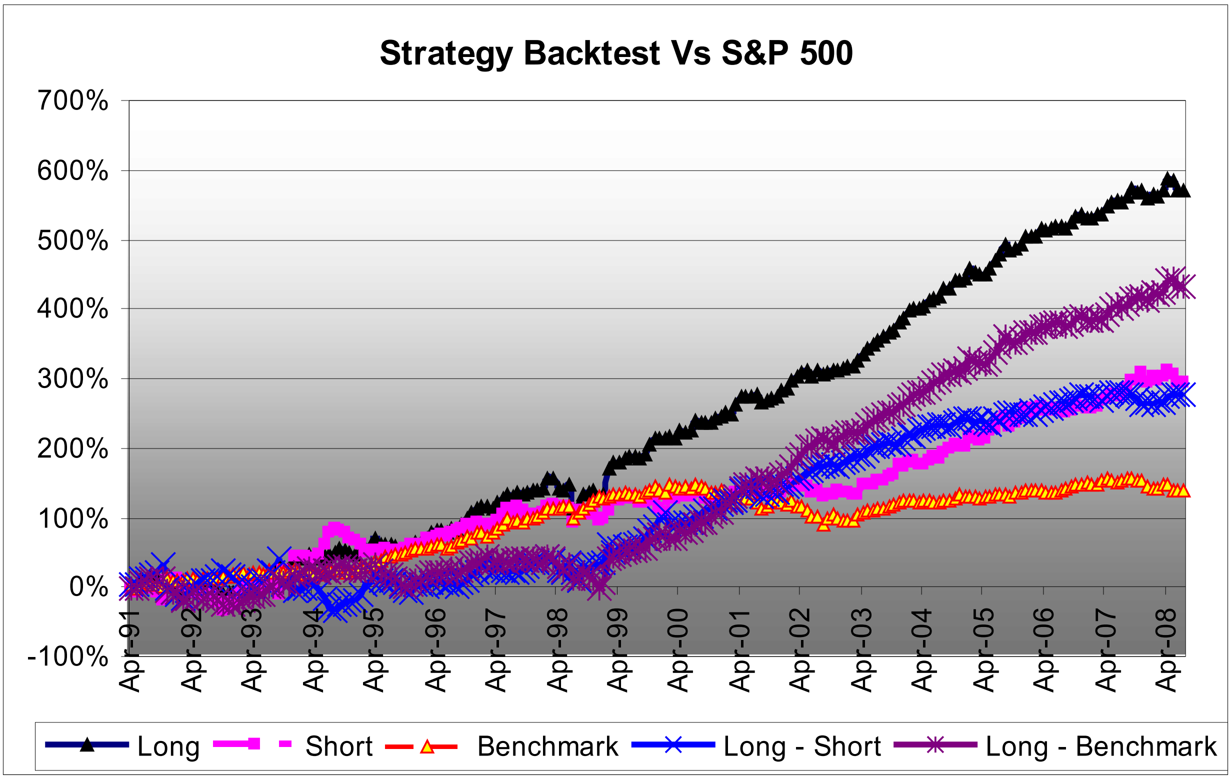
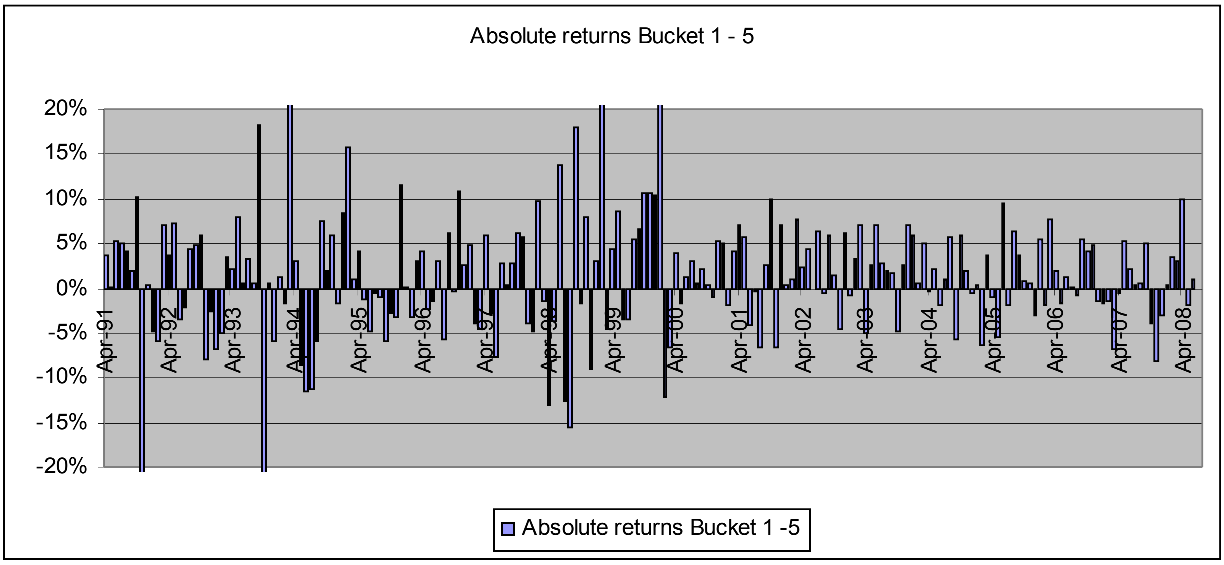


**Figure 53: Backtests Summary Output**

| *Strategy Backtest Output* | IR | Mean of (arithmetic) absolute returns (annualised) | Volaltility Mean (annualised) | Alpha (annualised) | Mean of (Arithmetic) relative returns (annualised) | Beta | Monthly Alpha | Hit Rate | Alpha (t-value) |
|---|---|---|---|---|---|---|---|---|---|
| S&P 500 as Benchmark | 1.20 | 21.30% | 17.81% | 23.04% | 21.30% | -0.22 | 1.92% | 61.54% | 5.37 |
| Equally Weighted Sector Benchmark | 0.57 | 6.40% | 11.31% | 8.72% | 6.40% | -0.10 | 0.73% | 0.53% | 3.07 |
| Bucket 1 - Bucket 5 | 0.58 | 14.51% | 24.84% | 14.33% | 14.51% | 0.02 | 1.19% | 59.13% | 2.36 |

The below figure provides a backtest monthly performance of long portfolio as defined by the top quintile of stocks versus the performance of shot portfolio as defined by bottom quintile. It becomes clear to visualise that the long portfolio depicted by the grey bar is systematically outperforming the black bars being the short portfolio.

**Figure 54: Long Short Portfolio Overview**




The Quantitative Stock Selection Model:

The model is based on ranking methodology commonly used in active Asset Management industry. The principle of the model is based on factor identifications that explain returns over multiple markets and style cycles. Factors are then grouped into distinguishable drivers based on performance characteristics, thereafter, overweighting and underweighting of individual stocks based on their return and risk characteristic demonstrated over the period of the Backtest, in this case 20 years, is implemented in the form of ranking from top chosen quintile and bottom quintile stock baskets. The idea is to assign a rank to each stock based on a given accounting and market information based factor that is available for all stocks based on the performance (excess returns) and volatility (Std Deviation) that it delivers versus a given benchmark. In this case two separate back tests of the model are provided for equally weighted sector and S&P 500 benchmarks. Based on the right weighting scheme for the correctly identified factors, a model is then developed on the basis of optimizing the information ratio. Although by no means do I claim that Past performance is an indication of future results, it certainly improves ones chances.

Value Compendium Factor: This is a factor based on averaging the rank attributed to Price to Book Ratio, Forward Year 2 Price to Earnings based on IBES consensus estimates, current Price to Earnings Ratio and Price to Sales ratio, all on quarterly basis and then ranking the stock in its universe[19].

Inverse Growth Compendium Factor: This variable is a combination of the 1 year, 3year and 5 year inverse or descending sales growth. Meaning, the model aims to give high ranks to a company, which in fact has low average growth as measured by the sales over the periods discussed. This is quite interesting as the logic behind this is based on the assumption that companies with low growth and companies that are very cheap as measured by valuation multiples have less downside risk that high growth and expensive companies, so the growth surprise is meant to remain on the upside given the beaten up valuation. This finding in contrarily to typical assumption that one should be buying companies with strong production growth. Although the reserves are not back tested as such data for all forty companies would be very difficult to come by, my opinion would be that high reserves and low growth would fall in line with the models top pick as typically it will be large capitalization companies that will have largest resources that typically find it difficult exceed current levels of productions by a long shot.

Return on Capital and Assets Compendium Factor: Similarly to growth compendium of factors used as one factor, this return based indicator averages Return on Capital and Return on Assets as reported by the company in worldscope date bases on a quarterly basis. The model ranks stock based on the facto in the descending order aiming to attribute high priority for stock selection for the companies that have high ROE and ROA. This is self explanatory for obvious reasons, but is worth mentioning that the factor has high added value in terms of successful stock selection.

Revisions Compendium Factor: This factor is composed of equally weighting the commonly published data points for each stock defined as Percentage of analyst upward FY1 EPS Revisions net of FY1 downward revisions + the same for FY2 analyst EPS revision in proportion to total analysts covering the stock, all on rolling basis.

Debt to Equity: This is the basic Debt to Equity Ratio as outlined in more detail in appendix.

[19] See Appendix for Formulas

# 4. Conclusions

The DCF methodology for valuing and Integrated Oil & Gas Company shows closest relationship with value of the companies assigned by the market. Relative valuation models undervalue internal segments of the company when grouped together under the integrated business model. Real Option based valuation demonstrated excessive results and the gap between market estimate and theoretical estimate of the value of these companies. Furthermore, a model was fitted demonstrating risk adjusted stock selection performance for systematic investment into the sector, both for gaining efficient exposure to the sector, as well as hedging exposure.

Theoretically, Real Options pricing theory is the correct way of valuing an asset because the assumptions of DCF are imbedded into the model, yet pure DCF has demonstrated the most accuracy in terms of the back tests. The implementation of a DCF however, is riddled with misuses. Arguably, the analyst community can't forecast, or rather have little empirical evidence that it can, which puts the questions on the whole exercise. The good news is that several alternatives exist. I have tried to explore these in order to avoid forecasting altogether and therefore by adding fundamental components into growth estimation, the procedure demonstrated robust results. Even if one ignores the inconvenient truth of our inability to forecast, one will still get derailed by problems with the discount rate, beta, risk premiums and growth. I have aimed to base such estimates on already established financial academic research and attempted to stay within the scope of their theoretical boundaries.

1. DCF based valuation methodology has proven to deliver most robust results in terms of its predictive share price value capacity in comparison to the methodologies examined in this thesis. This implies that the market uses the DCF to value the Integrated Oil & Gas companies.
    - The three stage hybrid model, which is based on short term analyst consensus forecasts in addition to medium term company fundamental growth and empirically derived terminal growth rates demonstrates most robust results as discussed in the DCF section of the thesis.
    - Implied growth dictated by the price change expectations in accordance to the WTI Crude futures curve does not provide consistent results as the change of state from contango to backwardation can swing the growth assumption from positive to negative, altering the value significantly in either direction.

2. The Sum of The Parts multiples based valuation offers mixed results in terms of consistency for assigning value relative to actual market dictated share price, but the approach tends to systematically identify undervaluation in the upstream side of the business relative to pure play peer valuations by each sector.
   - In addition, the approach is less efficient and cumbersome in terms of data availability, as some of the required assumptions and inputs are not easily estimable or biblically disclosed by the companies.
3. The Real Options based valuation methodology, although theoretically most robust compared to all methodologies examined in terms of estimating the value of the companies and in particular the upstream proved to be most empirically unsupportive due the gross valuation gap between the seemingly low share price and exceedingly large value in the companies as measured by the models based on real time oil prices.
   - The valuation methodology using Real Options with already discounted inputs, based on real life oil prices finds significant value to the unproven and undeveloped reserves for the majors.
   - Similarly, there appears to be a significant discount to market based oil prices when equating the option value to current share price, implying that the market assumes 18-28$/Boe of reserve value per barrel as opposed to the WTI Crude Oil and Brent Crude trading at 112-114$/bbl today. Although the current Oil prices my by some be viewed as excessive, nevertheless there is clear evidence that the real option based methodology versus the market share prices significantly overvalues the companies.
4. Back tested Stock selection results point to the conclusion that inverse growth and value parameters are most relevant stock selection criteria. More specifically, the P/E current and forward looking basis is a good metric for relatively valuating and selecting Oil & Gas companies compared to their peers. In addition to value factors, inverse growth and profitability factors also demonstrate robust explanatory forces for risk adjusted excess returns.

## 6. Strategic Implications

There are numerous strategic implications for key stake holders based on the findings of this thesis. I have classified the stakeholders into three categories, the Shareholders, the Management and the State. In the appendix section I include strategic implications on the state and its regulator capacity in more detail.

## 6.1 Diversification

Given that value mismatch was found in the SoP valuation across segments versus an integrated entity, raises a number of questions regarding the logic and value added from being overly integrated. As discussed by Rumelt (1974) two key questions emerge concerning this matter: "Is a by-product a separate business or part of the same business which produces it? Under what conditions should the firm that has integrated itself forward into a wide variety of manufacturing activities be considered diversified? To that extent it was defined that vertically integrated firms had 95% of their sales from in a single end product. Those in which the sales of all intermediate and end products associated with vertical chain comprised less than 70 % of total revenues were treated as either Related and Unrelated businesses"[20]. With that in mind below I list the key strategic implications of this study for the key stakeholders of the industry.

## 6.2 Strategic Implications for the Shareholder

- Shareholders of Integrated Oil & Gas Companies use DCF valuation if they want to have some sense of value to the companies in the light of market assigned valuation. Thus the market uses the DCF.
- Shareholders should select stocks with low P/E, P/FY1E, P/FY2E, P/B and P/CF ratios in
  - In addition, Shareholders are better off buying companies with lower and negative growth but with solid returns on capital invested as opposed to buying high growth integrated companies as demonstrated by the back tests.
- Shareholders should also demand low debt to equity ratios as well as lower cash positions if the want to see capital gains in the market.
- Integrated Oil & Gas companies offer attractive investment opportunities if they were to unlocked for there separate value of the companies, especially due to the significant undervaluation of upstream assets by the market.
- Investors should demand more diversification rather than integration. This will ensure longer term stability of future cash flows at the expense of enormous current cash balances.
- Shareholders should claim higher dividends from the companies as well as more incentives for new mega projects on behalf of the state.

## 6.3 Strategic Implications for the Management of the Companies

- Increased integration will only heighten the barriers to diversification and therefore management should pay attention to the notion that although "integration may provide temporary improvements in cost efficiencies, size and market share, the end result and risk can be that they end up invested in stagnating, falling profitability industry

[20] Rumelt, R. 974. Strategy, Structure, and Economic Performance, Harvard Business School, Boston.

segments"[21]. Unless these firms can adapt to the new technologies, new types of competition and new forms of organization they will become railroads of the future, necessary but weak and inefficient.

- Reduce the amount of Cash on Balance sheets.
- Either increase Capex or Pay out dividend as during inflationary periods holding cash is negative for shareholders and that money should be invested to generate returns.
- Given so many evolving technologies and the paradigm shift facing the industry, companies should look to further diversify and thus increase their proportional spending into renewable and alternative source of energy projects as opposed to largely focusing on upstream which the market undervalues and downstream which is improving efficiency in less long term sustainable assets.
- Aim to deliver high return on capital on a sustainable growth basis. As Integrated Oil & Gas companies are not growth companies and should not be expected to be.
- The market now anticipates that the return on capital achieved by the sector is likely to decline at a faster rate than may previously have been feared. This creates a need for stable income projects.
- Low debt to equity ratios also shine a voice of confidence and lead to superior shareholder absolute returns, both in the short term as well as the long term.
- Companies should be focusing on forward year earnings stability rather than excessive growth.
- Management should not care about analyst revisions or expectations as long as the earnings numbers are overly volatile.
- Management should consider that the market undervalues the upstream segment across most methodologies and values with a premium the invested capital to new and emerging mega project technologies as well as Renewable segments.
- The economic reality facing the Integrated Oil & Gas is that as the mega projects developments and costs are incurred and profitability and sustainability of these technologies becomes visible, they will carry into the group premium valuation and provide steady and predictable earnings and return on capital. The way to unlock value would be to either spin off the technology units thereafter if they will be up for sale or resort to corporate raids with the aim of forcefully unlocking value of premium to these assets and thus arbitraging the shares of existing companies.

[21] Rumelt, R. 974. Strategy, Structure, and Economic Performance, Harvard Business School, Boston

## 6.4 Strategic Implications for the State

- The Integrated Oil & Gas companies should be facilitated to unlock existing value and generate new capital value by means of efficient fuel provision for the economy as well as the environment. Therefore, these entities must be encouraged by the state to invest in new sustainable technologies while being mindful about letting markets operate freely. At the same time, the state should aim to discourage corporate entrenchment and unproductive defence of its existing market shares by these entities, as such practices result in frequent growth of inefficiency as easily visible by falling returns on capital as well as falling valuations. The dilemma is that new technologies are capital intensive in their nature, thereby increasing the need for large scale investors yet at the same time demand for new investment into existing technology expansion is also at stake. The capitalist foundations of modern democracy aspiring world would imply that the company would opt to invest into the highest NPV project, which in majority of cases ends up diverting capital expenditures into expansion of current capacity and improvement of existing technologies, and correctly so as demonstrated by the DCF reliability in terms of market value.
- IMF and the World Bank. Gave 3rd world countries their national debt loans, and they are the ones making more money.
- The need for diversification of sources of energy resources for a given nation state rase the following questions; What industries and technologies should be promoted in order to achieve successful diversification in terms of a sustainable and plentiful energy supply? The economic reply would be simply that industries that are most compatible with their respective factor endowments and comparative advantages. As when viewed in this manner, a dynamic approach based on significant boosting of education and technological development would allow for annihilation of the natural resource constraints altogether, both for the importing as well as the exporting countries. Here the interests of commodity endowed countries in form of exports and commodity constrained countries of importer are aligned. Although at first glance, it may seem intuitive to see the advantages of being an oil exporter in a high price environment, the potential pitfalls in the aftermath of these revenues are as detrimental for the state as they are detrimental for a corporate entity, which cyclically and periodically re visits verge of bankruptcy and periods of repetitive stagnation in growth post high prices. In particular, for a state in which high corporate market share concentration in the energy sector exists, particularly if the state is an importer of the commodity,

- Similarly if the state is an exporter of the commodity like crude oil, the common path of building infrastructure projects in excessive manner, may lead to incapacity of the maintenance of these projects when the exporting revenues decline, which can have a much more rapid impact on the economy then the slow rises in exporting commodities. In essence, the role of the state is to provide a guide in terms of use of oil revenues if a country is exporting and use of other revenues if the country is import dependant for its forms of energy, to achieve optimum growth of the economy as well as systematic diversification without undue inflationary jeopardy. In addition, encouragement of savings by the diversified skill pool of the labour force will lead to higher efficiency in which the savings are reinvested. The common pitfall of the deployment of excessive capital outside of the capacity of the internal economy is that it can often become concentrated either in a single currency denomination or even worse a dominant asset class. It can further be stipulated that if a county inefficiently allocates its wealth and knowledge distribution within the economy from resource exports, concentrates its current revenues in low yielding low return assets abroad, should the price of the resource fall rapidly, the nation begins to sacrifice the wealth and even indebts the future generations. Similarly if a nation is energy import dependant because the dynamic technological diversification is not in place, then that nation is already excusing its comparative advantage by depleting current technological wealth base and begins the process of inflationary budget deficits and is already in process of indebting future generations, if the state does not act to stop this. The question then for the import dependant countries then becomes what should be the nature of intervention and how should state strategy be executed. Over the history of commodity trade, subsides have played an important role of being a tool for economic vision and strategy for the state. The value from a well conceived capital subsidy program as based on concrete analyses, limited duration, focused on country's comparative advantage is hard to overvalue. At the same time, an ill conceived operational subsidy program, without a clear time horizon and indiscriminate across relative comparative advantage priorities, initiated by the state can have effects of vast devastation on the economy as well the nation state as a whole.
- As it currently stands, Oil & Gas industry is playing a key role in of the importing as well as the exporting and processing countries of this world. In both the developed and developing world, the industry is at peak profits and profitability, severely clustered with the result of national champions and integrations into foreign policies of the nation sates. The state should therefore encourage the companies by providing temporary tax

incentives to reduce the pressures of capital intensity and thus create a more competitive setting for it s energy independence priorities.

## 7. Recommendations & Further Research

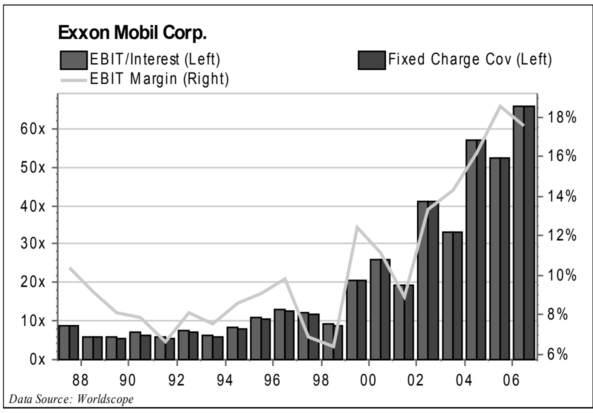
It holds that recognized interdependence is equivalent to tacit collusion which results in market power, monopoly behaviour, supply restrictions, and high prices. This is interesting to explore further as, the traditional view concentration measures can predict the conduct and behaviour of firms.

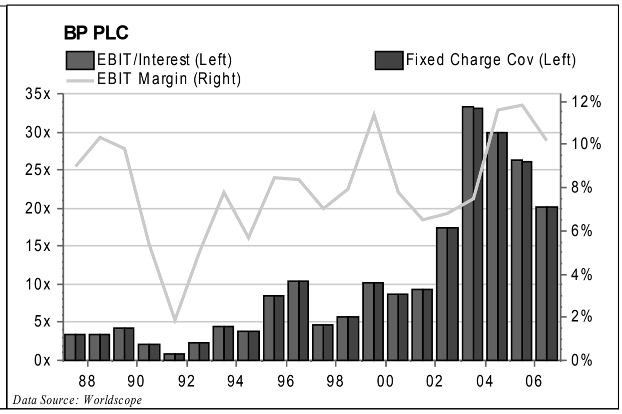
Financial theory should be based on financial history and under that perspective it would be interesting to see what the results would be for new ratios to be back tested against the share price such as the USD $ of Cash flow per MBTU, USD$ Cost Per MBTU as well as Reserve Replacement ratios similar to amount of carbon dioxide produced per barrel of production and refining.

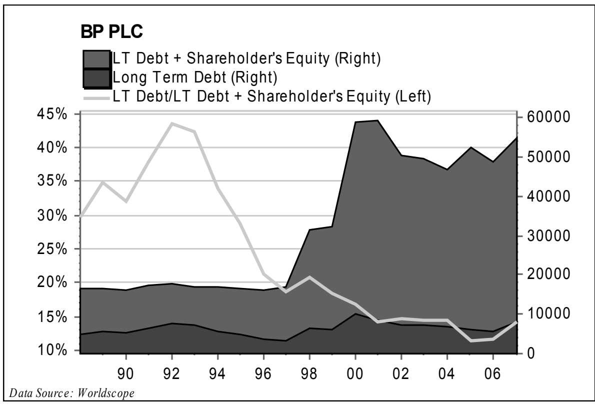
Further studies can be done on how to identify an oil neutral dynamic long short integrated oil and gas model. In addition it would add value to research and to building stock selection model with dynamic factor weighting systems as opposed constant weights as used here.

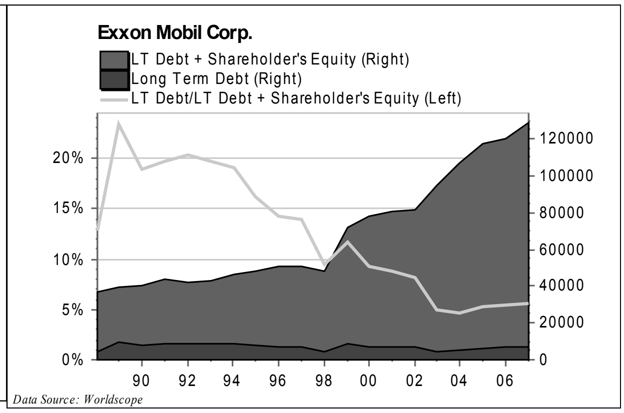
# Appendix

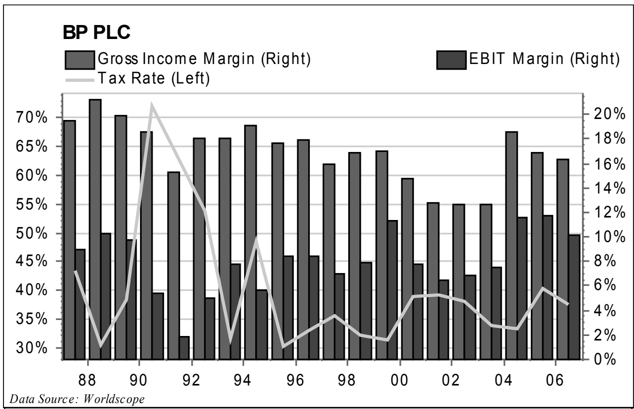
## I. DCF

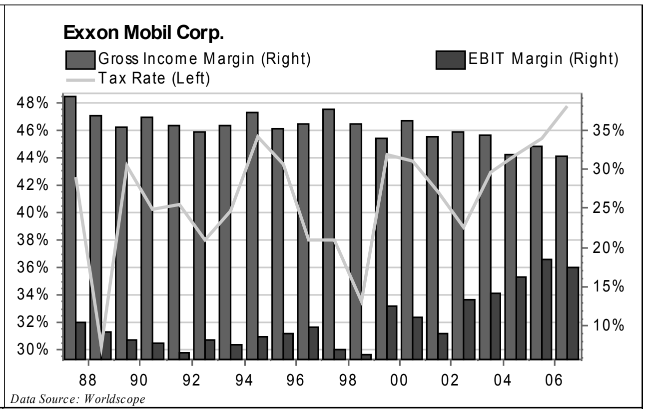


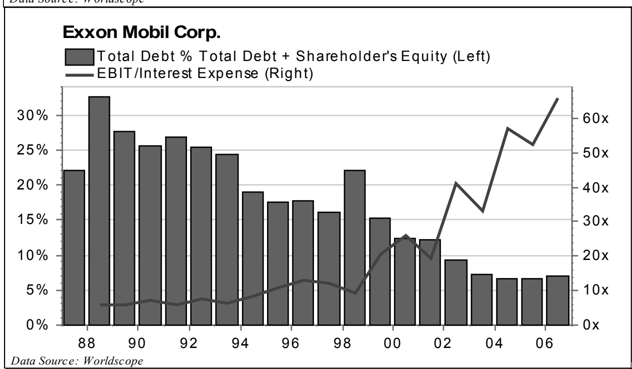



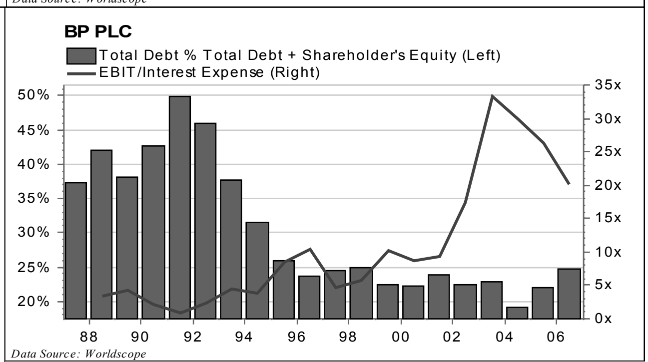



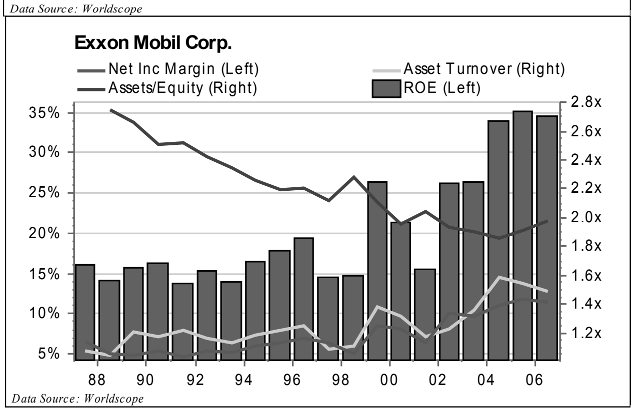



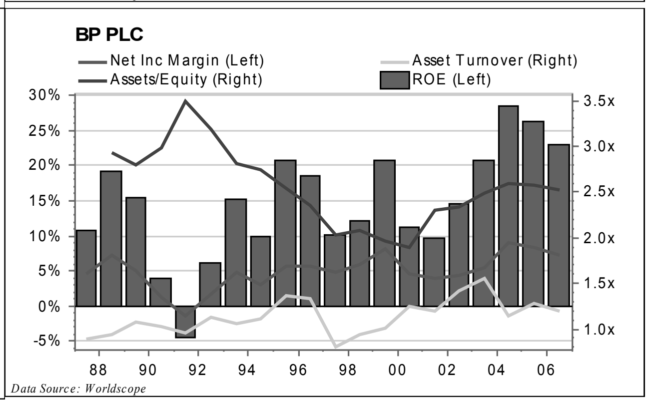

BP PLC
Gross Income Margin (Right)
EBIT Margin (Right)
Tax Rate (Left)
Data Source: Worldscope


Exxon Mobil Corp.
Gross Income Margin (Right)
EBIT Margin (Right)
Tax Rate (Left)
Data Source: Worldscope


Exxon Mobil Corp.
Total Debt % Total Debt + Shareholder's Equity (Left)
EBIT/Interest Expense (Right)
Data Source: Worldscope


BP PLC
Total Debt % Total Debt + Shareholder's Equity (Left)
EBIT/Interest Expense (Right)
Data Source: Worldscope


Exxon Mobil Corp.
Net Inc Margin (Left)
Asset Turnover (Right)
Assets/Equity (Right)
ROE (Left)
Data Source: Worldscope


BP PLC
Net Inc Margin (Left)
Asset Turnover (Right)
Assets/Equity (Right)
ROE (Left)
Data Source: Worldscope

## II. Sum of Parts and Relative Valuation

| Industry Snapshot | Avg | Median | BP PLC | Exxon Mobil Corp. |
|---|---|---|---|---|
| **Size** | | | | |
| Market Value | 55,103.5 | 17,958.6 | 165,329.8 | 392,770.5 |
| Enterprise Value | 59,510.1 | 22,977.9 | 187,474.8 | 372,118.5 |
| Sales | 76,361.8 | 25,564.8 | 281,025.3 | 358,600.0 |
| EBITDA | 14,514.4 | 3,517.0 | 39,347.4 | 75,228.0 |
| EBIT | 11,348.4 | 2,694.8 | 28,549.7 | 62,978.0 |
| Operating Income | 10,047.3 | 2,419.5 | 26,648.3 | 57,655.0 |
| Net Income | 6,566.9 | 1,659.7 | 20,600.2 | 40,610.0 |
| EPS | 5.06 | 3.82 | 1.07 | 7.28 |
| Assets | 60,657.1 | 20,242.0 | 236,076.4 | 240,631.0 |
| Cash & ST Investments | 3,381.4 | 665.9 | 9,883.0 | 34,500.0 |
| LT Debt | 4,864.4 | 2,643.9 | 15,651.0 | 7,183.0 |
| Total Debt | 6,971.5 | 3,759.5 | 31,045.0 | 9,566.0 |
| Capital Expenditures | 5,471.3 | 1,723.2 | 17,620.6 | 15,387.0 |
| Net Operating Cash Flow | 8,792.4 | 2,392.5 | 24,418.8 | 52,002.0 |
| Annual Dividend | 1.28 | 0.77 | 0.47 | 1.50 |
| Shares - Basic | 1,958.4 | 721.2 | 19,163.4 | 5,517.0 |
| Shares - Diluted | 2,578.0 | 938.2 | 19,326.9 | 5,577.0 |
| **Valuation** | | | | |
| LTM Price to Earnings | 30.7 | 6.9 | 7.3 | 9.4 |
| LTM EPS | 6.52 | 4.07 | 1.24 | 8.08 |
| FY1 Price to Earnings | 9.1 | 7.2 | 5.8 | 8.1 |
| FY1 EPS | 5.53 | 3.80 | 1.53 | 9.30 |
| FY2 Price to Earnings | 9.2 | 7.5 | 5.8 | 7.6 |
| FY2 EPS | 6.66 | 4.08 | 1.51 | 9.98 |
| NTM Price to Earnings | 9.0 | 7.3 | 5.8 | 7.7 |
| NTM EPS | 5.60 | 4.00 | 1.51 | 9.81 |
| Price to Book | 1.9 | 1.5 | 1.8 | 3.1 |
| Book Value per Share | 31.85 | 21.10 | 5.11 | 24.03 |
| Price to Sales | 0.7 | 0.5 | 0.5 | 0.9 |
| Sales per Share | 109.55 | 64.78 | 16.75 | 84.10 |
| Price to Cash Flow | 6.2 | 5.0 | 4.9 | 7.4 |
| Cash Flow per Share | 7.75 | 5.87 | 1.84 | 10.21 |
| Price to Free Cash Flow | 37.2 | 27.1 | 41.1 | 14.0 |
| Free CF per Share | 0.37 | 0.69 | 0.24 | 5.38 |
| Enterprise to Sales | 1.0 | 0.8 | 0.7 | 1.0 |
| Enterprise to EBITDA | 5.8 | 5.0 | 5.3 | 4.9 |
| Enterprise to EBIT | 8.2 | 6.8 | 7.3 | 5.9 |
| Dividend Yield | 3.3 | 3.1 | 5.2 | 2.0 |

# III. Real Options

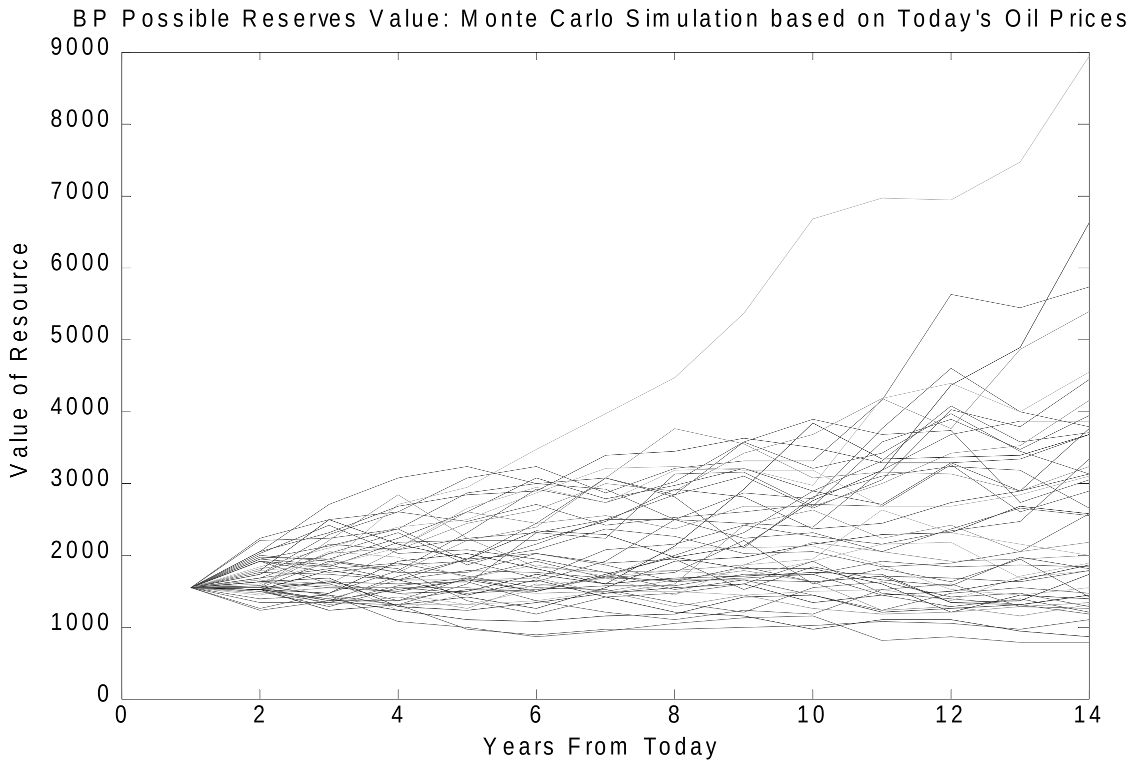
## III.I BP Plc, Matlab Output for the companies P2-P1

### BP Plc = 710 Billion Pounds

Price of BP Possible = Monte Carlo

T = 1.0e+003 *
Matlab Code:

```
r = 0.041; sigma = 0.1429; div = 0.0367;
T = 13.5; S0 = 1538; K = 1600;
dt =1;
N = round(T/dt);
nu = r - div.^2/2;
z = nu*dt+sigma*sqrt(dt)*randn(N-1,50);
cz = [ones(1,50) ;
cumprod(exp(z))];
ST = S0*cz;
plot(ST)
payoff = max(ST(end,:)-K,0);
expected_payoff = mean(payoff);
c = exp(-r*T)*expected_payoff;
```



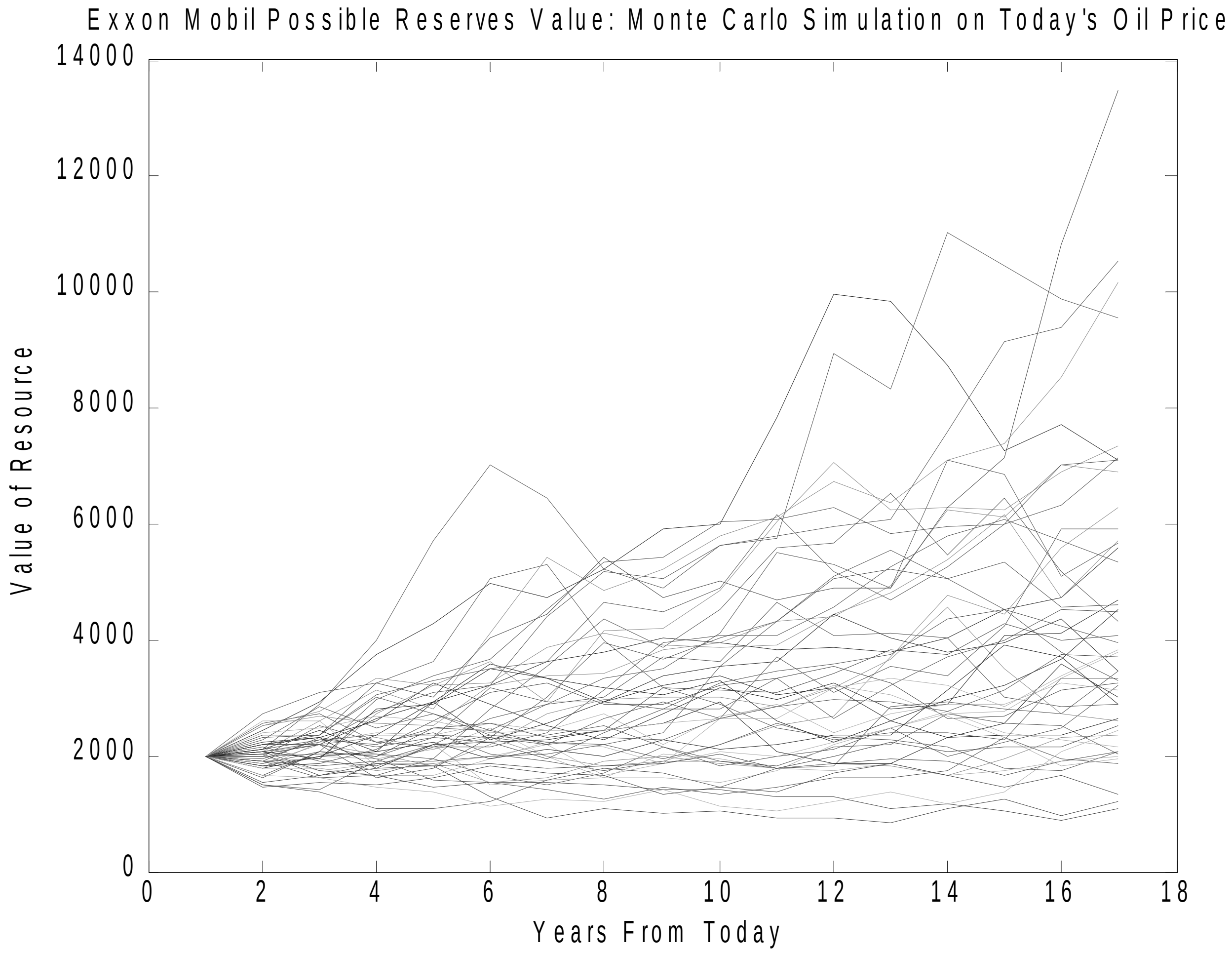
## III.II Exxon Mobil Corp, Matlab Output for the companies P2-P1

**Exxon Mobil Plc. C = 1,125 Billion Dollars**

Price of Exxon Possible = Monte Carlo

ST = 1.0e+004 *

```
r = 0.041; sigma = 0.1429; div = 0.0146;
T = 16.7; S0 = 1990; K = 2068;
dt =1;
N = round(T/dt);
nu = r - div.^2/2;
z = nu*dt+sigma*sqrt(dt)*randn(N-1,50);
cz = [ones(1,50) ;
cumprod(exp(z))];
ST = S0*cz;
plot(ST)
payoff = max(ST(end,:)-K,0);
expected_payoff = mean(payoff);
c = exp(-r*T)*expected_payoff;
```



```
function price = mcmodel_e(S0,K,r,sigma,T,c_p)

% MCMODEL_E Calculates the price of either an European Call or Put Option
% (** CONTAINS AN ERROR **)
% Uses Monte Carlo simulations to model the equation of the form
% c = exp(-rT)*E[max(ST-K,0)]
% where ST is the stock price at maturity and is calculated using
% Geometric Brownian Motion and c is the price of an european call option.
% Along similar lines, the price of an european put option is calculated
% from p = exp(-rT)*E[max(K-ST,0)].
%
% Input variables
%   S0: Initial Stock Price
%   K : Strike Price
%   r : Risk free rate of return
%   sigma: Volatility
%   T : Time to maturity
%   c_p: if c_p=1 we calculate the call price; if c_p=2 we calculate the
%   sell price; otherwise we do nothing
% See also round cumprod randn exp plot mean max

paths = 49;

% Calculate incremental time and step size
dt = 1/252; % 1 trading day
steps = round(T/dt);

% Calculate simulated returns
nu = r - sigma.^2/2;
z = nu*dt+sigma*sqrt(dt)*randn(steps,paths);
cz = [ones(1,49) ; cumprod(exp(z))]; % simulated returns

% Calculate stock prices
ST = S0*cz;
plot(ST)

if c_p==1
    price=call_option;
elseif c_p==2
    price=put_option;
else
    price=0;
end

    function c = call_option
        % Calculate the call option price
        payoff = max(ST(end,:)-K,0);
        expected_payoff = mean(payof); % Expected payoff
        c = exp(-r*T)*expected_payoff;
    end

    function p = put_option
        % Calculate the put option price
        payoff = max(K-ST(end,:),0);
        expected_payoff = mean(payoff);
        p = exp(-r*T)*expected_payoff;
    end
end
```

### III.III Matlab Code Continued

```
% Real Option Path Calculates the price of an European Call Option of P2-P1.
%
% Uses Monte Carlo simulations to model the equation of the form
% c = exp(-rT)*E(max(ST-K,0))
% where ST is the stock price at maturity and is calculated using
% Geometric Brownian Motion as follows:

% Initialize parameters
r = regional interest rate; sigma = oil price volatility;
T = duration of the reserve life; S0 = current P1; K = Potential Unrisked;
paths = 49;

% Calculate incremental time and step size
dt = 1; % 1 trading year
steps = round(T/dt);

% Calculate simulated returns
nu = r - sigma.^2/2;
z = nu*dt+sigma*sqrt(dt)*randn(steps,paths);
[N,M]=size(cumprod(exp(z)));
% Calculates the price of an European Call Option

% Calculate simulated returns
nu = r - sigma.^2/2;
z = nu*dt+sigma*sqrt(dt)*randn(steps,paths);
[N,M]=size(cumprod(exp(z)));
cz = [ones(1,49) ; cumprod(exp(z))];  % simulated returns

% Calculate stock prices
ST = S0*cz;
plot(ST)

% Calculate the option price
payoff = max(ST(end,:)-K,0);
expected_payoff = mean(payoff); % Expected payoff
c = exp(-r*T)*expected_payoff; % simulated returns

% Calculate stock prices
ST = S0*cz;
plot(ST)

% Calculate the option price
payoff = max(ST(end,:)-K,0);
expected_payoff = mean(payoff); % Expected payoff
c = exp(-r*T)*expected_payoff;
```

# IV Historical Back tests

Key Financial Factors

- Return on Equity (ROE)
  - Net income / Average Stockholders' Equity
- Return on Assets (ROA)
  - {Net Income + [Interest Expense·(1-Tax Rate)]} / Average Total Assets
- Return on Sales (Profit Margin)
  - {Net Income + [Interest Expense·(1-Tax Rate)]} / Net Sales
- Common Equity Leverage
  - Net income / {Net Income + [Interest Expense·(1-Tax Rate)]}
- Capital Structure Leverage
  - Average Total Assets / Average Stockholders' Equity
- Debt / Equity Ratio
  - Average Total Liabilities / Average Stockholders' Equity
- Long-Term Debt Ratio
  - Long-term Liabilities / Total Assets
- Current Ratio
  - Current Liabilities / Current Assets
- Quick Ratio
  - (Cash + Marketable Securities + Net Accounts Reveivable) / Current Liabilities
- Interest Coverage
  - (Net Income + Tax Expense + Interest Expense) / Interest Expense
- Accounts Payable Turnover
  - Cost of Goods Sold / Average Accounts Payable
- Receivables Turnover
  - Net Credit Sales / Average Accounts Receivable
- Inventory Turnover
  - Cost of Goods Sold / Average Inventory
- Fixed Assets Turnover
  - Sales / Average Fixed Assets
- Total Asset Turnover
  - Sales / Average Total Assets
- Earnings per Share
  - Net Income / Average Number of Common Shares Outstanding
- Price / Earnings (P/E) Ratio
  - Market Price per Share / Earnings per Share
- Dividend Yield Ratio
  - Dividends per Share / Market Price per Share
- Stock Price Return
  - {Market Price (1) – Market Price (0) + Dividends} / Market Price (0)
  -

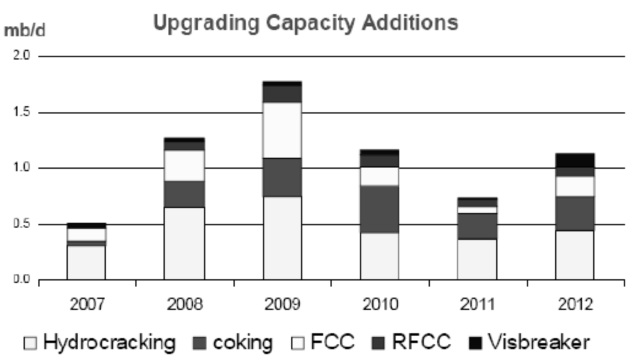
# VI. Industry Background

## VI.I Refining and Marketing (Downstream)

Part of the problem in valuing the downstream side of the business is the genuinely appalling level of disclosure and hence visibility around most companies' downstream profits. All told it is very difficult to have an accurate perception of quite where the profits achieved by each company's downstream operations are, or are not, being made. The result is that analysis's tend to rely on refining margin indicators as a gauge of business health. Yet as the split in income between refining, marketing, gas & power and chemicals is quite diverse across the segment of the business. And with a lag in the pass-through of a falling oil price likely if anything to prove supportive of marketer's margins, the segment aims to serve as a natural hedge to the upstream business. Although in the DCF analysis no distinction is made between the two sectors in terms of assumptions and it is still worthwhile to give oversight to the segment.

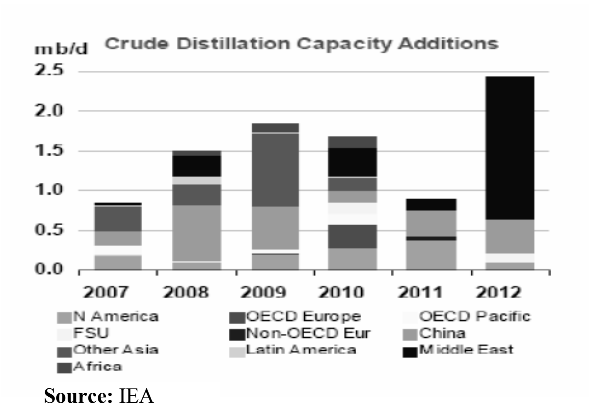
Refining is the process of converting crude oil into usable products. Crude oil is a mixture of hundreds of different types of hydrocarbons with carbon chains of different lengths. These can be separated through refining. The shortest chain hydrocarbons are gases (under five carbon atoms); chains containing five to 18 carbon atoms are liquids; and chains of 19 or more carbon atoms generally form solids at room temperature. Oil refining produces a wide variety of products that are prevalent in many every day uses: gasoline for motor vehicles; kerosene; jet fuel; diesel and heating oil to name just a few. Petroleum products are also used in the manufacture of rubber, nylon and plastics.

**Figure:** World Upgrading Capacity




**Source:** IEA

**Figure:** World Distillation Capacity



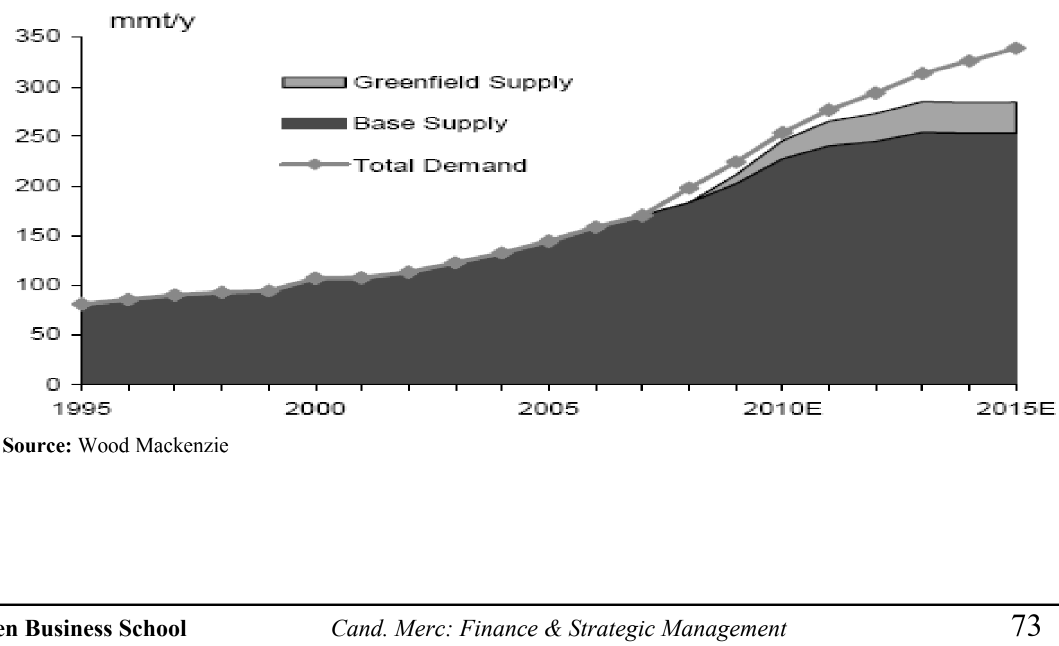

**Source:** IEA

### VI.II LNG, Gas to Liquids, Oil Sands and the future segments

Liquefied Natural Gas is a liquid formed when natural gas is cooled to -162°, or LNG. It is clear, odourless, non-toxic and non-corrosive. Liquefaction takes place when natural gas is cooled under high pressure, condensed, and then reduced in pressure for storage. The resulting liquid is 1/600th of the volume of natural gas, and about half as dense as water. Purified LNG is usually composed of 90% methane and small amounts of ethane, propane, butane and heavier alkenes. The history of natural gas liquefaction dates back to the 19th Century. Commercial LNG plants were built in West Virginia in 1912 and Ohio in 1941. The first LNG tanker, the Methane Pioneer, transported LNG from Louisiana to the UK in 1959, demonstrating the viability of long-range transport. In 1964, Algeria became the first continuous large-scale exporter. LNG's primary benefit is its ease of transportation and density of storage. It can be transported efficiently over long distances where pipelines are not an option. Specially designed seagoing vessels incorporate double hulls and specialized storage tanks. At the receiving terminal, LNG can be stored or reheated to return to gaseous form and distributed via pipeline.

The demand for LNG has been rising significantly during this decade. Earthquakes in Japan and China have disrupted domestic nuclear of hydro power capabilities which has necessitated both countries to increase LNG imports. Droughts in Spain as well as the emergence of new demand centres in Kuwait, Singapore, Chile and Argentina are now competing for US summer LMG imports. Short supply has polarized returns, driving shipping & regas often below the cost of capital, yet upstream returns to exceed 50% IRR. Strong international demand plus a security of supply and environmental premium in Asia and Europe has left international prices set by the marginal price of demand, pushing long-term contracts to straight line oil parity, with implied pricing of USD17/mmBtu at USD100/bbl oil.

**Figure V.II:** World LNG Supply/Demand Outlook




**Source:** Wood Mackenzie

The importance of LNG and its future role in the energy industry can not be stressed enough. LNG provides the vehicle for a global intertwined and interconnected natural gas market. This is the first step to the global electricity market as opposed to regional, soon to lead to global electricity price equilibrium, as any inequality will be arbitraged by traders. Although at current date the market is far from spot on a large scale, some cross Atlantic and Asia arbitrages are done, the market tends to be long term charter based contract with duration of over ten years for each new vessel new build. This has a key implication for the valuation of Integrated Oil & Gas companies, that today LNG aspect of the company can be very easily modelled under the DCF methodology as the cash flows are fixed for the next decade or so for many major project, leaving only the discounting to be done. This also implies that any other from of evaluation would distort the value of this segment until the market turns truly spot and contract durations reduce in the time horizon.

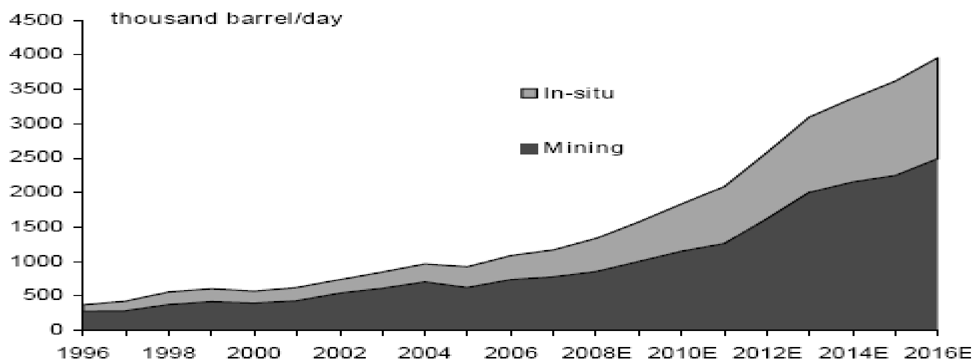
Gas-to-liquids (GTL) and coal-to-liquids (CTL) refer to the technologies that convert natural gas or coal into synthetic petroleum products in the form of clean-burning liquid fuels. There are two leading technologies for converting coal into liquid fuels. The first one is direct liquefaction: a highly efficient process in which coal is dissolved in a solvent at high temperature and pressure. The liquid produced is further refined to achieve high grade fuel characteristics. Indirect liquefaction is the second method. Coal is gasified to form a mixture of hydrogen and carbon monoxide (syngas) which are condensed using a catalyst. Ultra-clean, high quality products can then be produced by the Fischer-Tropsch process.

The implications of these technologies on the company valuation are that the DCF based valuation process becomes more predictable over the near to medium term, as the time duration of these contacts if long. In addition, these projects are very important for future cashgeneration sources of the firms in questions.

Oil sands is a generic term used to describe a heavy, viscous form of crude oil that is found mixed with sand, clay and water. Deposits are known to exist in many parts of the world, but the largest proved oil sands resources are in Alberta, Canada, and in the Orinoco area of Venezuela. Some of the earliest records of commercial oil sands activity are associated with the Pechelbronn oil-field in France where oil sands mining began as early as 1735. In Canada, the first large-scale production of oil from the Athabasca oil sands was launched by Suncor in 1967, followed by Syncrude in 1972. During the 1980s, oil prices declined to very low levels, resulting in considerable retrenchment in the oil industry. With the rise in oil prices this decade, numerous projects are under development or in planning. The bitumen contained in oil sands in Canada is extracted and processed using two main methods: The bitumen extracted from the oil sands is very heavy and viscous. Once extracted, lighter hydrocarbons can be added to the bitumen by the oil sands producer in order to be further processed or upgraded into a form of synthetic crude oil (SCO) that is less viscous. After that, it can be sold to a traditional oil refinery

In-situ: This method of extraction relies on the injection of steam (or more recently, chemicals) to extract the petroleum without the need for mining. According to CAPP, approximately 80% of the oils sands resources in Alberta are more than 50 meters deep (recoverable reserves of 140 billion barrels). The two most common forms of insitu recovery are Steam Assisted Gravity Drainage (SAGD) and the Cyclic Steam (CS) process. After extraction, the bitumen is upgraded in the same way that mining bitumen is processed. Thus as more and more energy intensive and cost inefficient tese projects are today, first it encourages more spending on technology and encourages investment into other forms of energy resource collection. Although such product and project mainly exist in Canada and US continental and present short term and medium term solutions to energy independence, in the long term it just leads to costly version of production and far from environmentally impact less. Below you can see the estimated growth in production from us Canada's Oil Sands. It is clear to see the high hopes and growth potential. Thereby implying that these projects will be around for next 50 years.

**Figure V.III:** Canadian Oil Sands Production Outlook




**Source:** Wood Mackenzie

### VI.III Renewable Energy

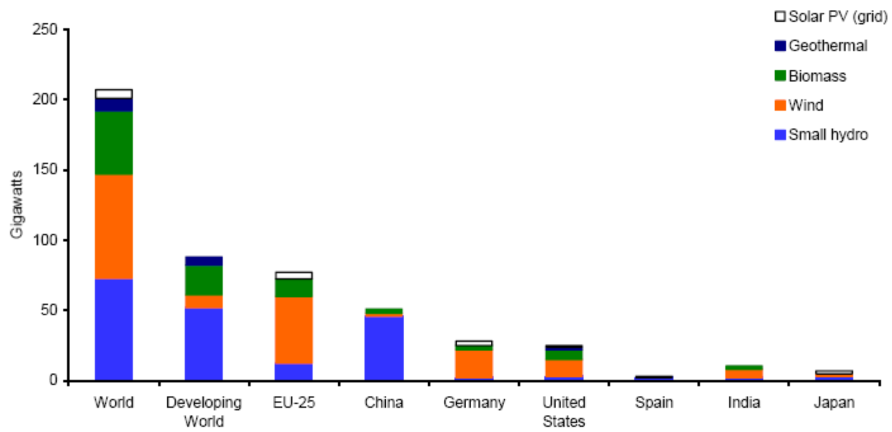
Renewable energy is beginning to play a larger role in both the overall energy composition on end user demand as well as capital expenditure budgets of Integrated Oil & Gas Companies. Although both proportions compared to total are still below 5% on worldwide average basis, their presence is growing at en ever increasing rate each year. For more details as to the drivers and potential implications of renewable energy please see appendix section on Renewable Energy. In short, however, Renewable energy is produced from sustainable resources which are naturally replenished, such as rain, wind, sunlight, oceanic streams, geothermal heat and biomass. In order to get rid of the intermittency inherent in Renewables, storage capacities and integration to the electricity's transportation network are essential, not even taking into account the potential of smart grids in the future.

The most prominent of Renewables is Hydropower as it is the most commonly used form of all renewable energy sources for electricity generation. Hydropower generates electricity by harnessing or directing moving water. Typically, water flowing through a penstock or a pipe, turns and pushes against the blades in a turbine to spin a generator to produce electricity. Hydropower has been used for thousands of years to turn stones for grinding grains and consequently it is one of the oldest harnessed sources of energy. However, it did not become widely used until the 20th Century when the technology to transmit electricity over long distances was developed. The problem with hydropower, however, is that it Is regionally constrained, depending on the water and natruaral habitat around it.

Wind power I already a part of the asset base for some Integrated Oil Gas companies like BP Plc and uses wind turbines to generate electricity. The power output of a turbine increases dramatically as wind speed increases. Areas where winds are more constant and stronger, such as high altitude sites and offshore regions, are both more expensive locations for wind farms. Wind energy has also been used by people since ancient times as a source of power to grind grains and other materials. Solar power which is perhaps the most rapidly growing renewable form of energy is describe as the conversion of solar energy into other forms of energy, such as heat and electricity. Solar energy can be converted into electricity using photovoltaic (PV) devices or solar power plants. Photovoltaic generates electricity directly from sunlight. Whereas, Solar power plants can also generate electricity indirectly using thermal collectors to focus the sun's rays to heat fluid at a high temperature. The heated fluid then produces steam that is used to operate a turbine and generate electricity. British astronomer John Herschel used a solar thermal collector box to cook food during an expedition to Africa in the 1830s. Geothermal energy is the energy derived from the hot interior of the earth and is quite popular in Australia and Iceland,

and given current geothermal drilling technology largely dependant on the region in which it is produced. It is a renewable energy because heat is continuously produced inside the earth by the slow decay of radioactive particles. Water heated by the geothermal energy rises naturally to the surface via fissures in the earth's crust at hot springs and geysers. In the near future we will witness Enhanced Geothermal Technology which is meant to tap into to the geothermal power in any given point of the planet. Heated underground steam or water are tapped and brought to the surface to operate steam turbines and generate electricity, a practise common in Iceland. This too is a relevant technology and is aggressively pursued by Arrow Energy of Australia which is in large owned by Royal Dutch Shell. Biomass energy is generated from non-fossilized materials derived from plants. The main sources of biomass energy are wood and wood waste, followed by energy from municipal solid waste (MSW) and alcohol fuels. Biomass in the form of organic waste can be converted through gasification to produce a biogas (normally methane). The biogas is then burnt to produce energy. When using biomass as a renewable source of energy it is absolutely necessary to consider the durability of the source via land management practises.

In terms of larges use and production for these technologies, China can easily be claimed to be the world's largest producer of energy using renewable resources. In 2007, about 820 megawatts of solar PV were produced in China, second only to Japan. Canada, the largest producer of hydropower in the world, produces about 3.1 billion kilowatt hours of hydropower per year, followed by the United States. China is the world leader in total renewable energy consumption, followed by the United States and Canada. However, the United States consumes the most non-hydro renewable energy, consuming twice as much non-hydro renewable energy as Germany and more than three times as much as Japan. This demonstrates that there is a very large international market development strictly for renewable energy. Given already some of the existing subsidiaries and tariffs make the ventures profitable and stable, the future should bring of its integration into the world of Integrated Oil & Gas, or result in the obsolition of the industry.




Source: REN21 Renewables 2007 Global Status Report

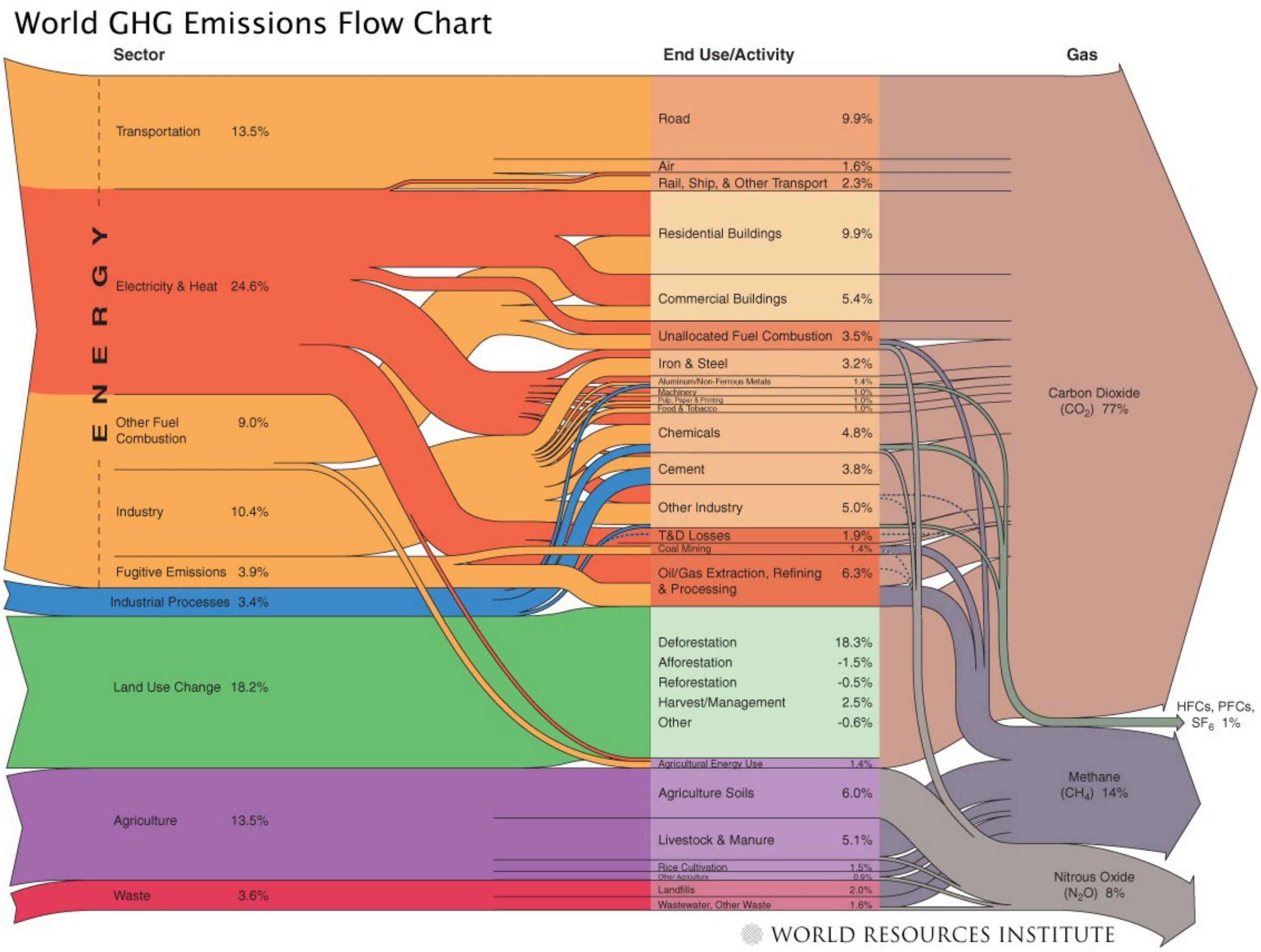
## VI.IV Carbon Emissions and Regulatory Overview

In the future, Carbon Emissions and the footprint left behind by the industry and its end users will play an ever increasing role as carbon legislation, political, social as well economic requisites become imbedded into the business doing. For that purpose it is extremely important to provide a due overview of the carbon world and its background.

$CO_2$ is the molecular formula for carbon dioxide, an atmospheric gas comprising one carbon and two oxygen atoms. $CO_2$ was first recognized as a gas distinct from air in the 17th Century by the Flemish chemist Jan Baptist van Helmont, who noticed it as a product of combustion after burning charcoal. $CO_2$ is one of the greenhouse gases (GHGs) that contribute to the natural greenhouse effect, the process by which solar energy is trapped within the Earth's atmosphere. In recent decades, concern has grown across the international scientific community over the increasing concentration of GHGs within the atmosphere. Industrialisation over the past 250 years has been held responsible for the rising levels of carbon in the atmosphere. Antarctic ice-core samples indicate that $CO_2$ concentrations in the atmosphere were fairly constant at around 280 parts per million (ppm) until the Industrial Revolution, but that since 1800 there has been a steady increase in $CO_2$ concentrations up to today's level of 375ppm. This concentration continues to increase at the rate of approximately 1.5ppm per annum. A similar trend has been observed with concentrations of other GHGs. The concern is that the increase in GHG concentration levels has intensified the natural warming effect of existing GHGs in the atmosphere, and increased the average temperature of the Earth by approximately 0.6°C between 1850 and 2000. The International Panel on Climate Change (IPCC), a UN body set up in 1988 to improve understanding of global warming, estimates that if the current rate of increase in GHG emissions in general, and $CO_2$ in particular, is not arrested, the Earth's average temperature will rise by between 1.8°C and 4°C by 2100, with increasingly severe and potentially catastrophic consequences for the planet. Emissions trading as a response to climate change: Kyoto and the EU-ETS The recommendations of the IPCC and the United Nations Framework Convention on Climate Change (UNFCCC) are to slow the rate of increase in and then reduce GHG emissions. In adopting this stance the UNFCCC has identified six GHGs. It is these that the 1997 Kyoto Protocol commits its signatories to reducing relative to their 1990 emissions levels. The six gases are ranked in terms of an index that measures their global warming potential (GWP) relative to carbon dioxide. So, carbon dioxide has a GWP of 1, methane of 23, and so on, all the way up to sulphur hexafluoride, which is 22,200 times more powerful than carbon dioxide in terms of its impact on the Earth's temperature when released into the atmosphere

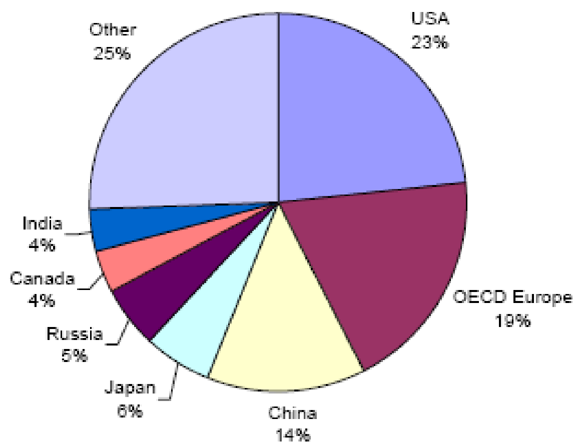
Below I provide a an Emissions Flow chart in terms of the carbon footprint in the large scale emission contributors of the world to provide an overview of where the problems lie and where future opportunities may arise, whether that be for Integrated Oil & Gas companies or small players.

**Figure V.IV:** World GHG Emissions Chart




It is not too difficult to draw the connecting dots between green house gas emissions and power and electricity generation. Meaning if the world truly wants to tackle the GHG problem, we need to re-address our way of power generation firstly via reassessing the sources, in terms of what sources are used for inputs and how the generation process takes place as opposed to taxing the end users. Although it is easy by some politicians to assign blame on transport companies and utilities, it is essential deal with the source of the problem rather than symptoms, no matter how unpopular or expensive they may be in the similar fashion that the Health Cares sector is often aggressively guided by Governments and NGO's in terms of emissions regulations and not the destruction economics of energy business. By the source here I mean whether Oil & gas companies should continue producing Oil & Gas to feed current generation capacity or should they start switching directly to electricity generation from the alternative sources sell that directly to utilities as opposed to raw material inputs such as petroleum based products and gas, because sooner or later this switch will be either commercially achieved or enforced.

Power generation accounts for 32% of the expected growth in global gas demand by 2015. With respect to Oil & particularly Gas, Power generation consumes 11% of worldwide gas production and unsurprisingly the US and Europe are very significant, responsible for 42% of all MWh generated worldwide. Globally, gas accounts for 20% of power generation, with coal delivering 41%, Renewables 18%, nuclear 15% and fuel oil 6%. Coal dominates power generation in China, Australia, the US, and supplies 30% of Europe's current electricity requirements, as shown in the following chart.




The key argument I want to bring is that the governments have to start playing a much more responsible role in terms of providing regulatory oversight and guidance to the energy industry, not through taxes and nationalisation, but through incentives to develop cleaner energy and through providing strict and clear regulatory requirements and targets, similar to the health care industry. The Kyoto Protocol and the carbon trading schemes should be the first steps to this direction and not the long term objectives as they currently are viewed by some countries. Furthermore, I would argue that a World Energy Organisation should be formed under the UN mandate to, recommend, support, oversees, regulate and enforce country specific regulatory compliance in terms of sustainable energy charter which I propose below. First however, I would like to provide a brief overview of the current steps taken by the world which are note worthy.

The Kyoto Protocol established a framework for international emissions trading, enabling industrialized countries known as Annex-1 countries under the UNFCCC terminology to trade emissions allowances both between themselves and with developing countries known as Annex-B countries. Kyoto established three main types of carbon credits, all of which are denominated in units of one tonne of CO2 equivalent (CO2e):

1. Assigned Amount Units, or AAUs (these are the units of compliance for Annex-1 countries with emissions limits under Kyoto, whereas Annex-B countries do not have limits under Kyoto and so do not have AAUs either);
2. Certified Emission Reductions, or CERs (these are the carbon credits generated under the Clean Development Mechanism, or CDM, a flexible project mechanism designed to incentivize clean- infrastructure projects in Annex-B countries);
3. Emission Reductions Units, or ERUs (these are the carbon credits generated under the Joint Implementation, or JI, mechanism, a flexible project mechanism designed to incentivize clean-infrastructure projects in Annex-1 countries).

The CDM enables projects in developing countries to sell CERs to both governments and companies in developed countries, and has so far been much more important than the JI mechanism in generating credits. CERs that are bought direct from projects are known as primary CERs, while CERs bought on a guaranteed basis from market intermediaries are known as secondary CERs. Figure 2 shows the prices for primary and secondary CERs over the past two years. As part of its strategy for enabling European-Union Member States to comply with their Kyoto targets, the EU established an emissions-trading scheme (ETS) in 2005 for heavy industry covering about 42% of all GHG emissions in the EU. Phase 1 of the ETS operated over 2005-07, Phase 2 is concurrent with the Kyoto compliance period over 2008-12, and Phase 3 will run over 2013-20. The carbon credits traded in the EU-ETS are known as European Unit Allowances (EUAs). In Phase 1 EUAs collapsed to zero, but action by the European Commission to enforce tougher national allocation plans in Phase 2 have meant EUA prices have been rising steadily for the past eighteen months

Such measures ensure continuous pressure as well as motivation for the industry and the free market to develop more cost efficient and environmentally sustainable technologies. Infact the nations and corporations that are willing to enforce the strictest measures will be the ones with more skilled and productive labour force for the future.

For the Longer term, growing powerhouse like China arguably needs to diversify away from coal — its coal reserve life is a mere 45 years versus 234 for the US and 500 years for Russia (source:

BP statistical review 2007), but for now China's priority is maintaining strong GDP growth, and cheap local coal has a clear advantage when the alternative is importing LNG at oil price parity.

The European Union Allowance (**EUA**) is the commodity created by the ETS whereby one EUA permits the emission of one tonne of CO2 within the phase issued. Accordingly, the number of allowances in the scheme matches the desired emission target in a phase. Directive 2003/87/EC (the ETS Directive) dictates that 95% of EUAs are allocated free of charge in Phase I and 90% in Phase II. As one EUA is required for each tonne of CO2 emitted, through the cost of obtaining EUAs, the ETS effectively causes CO2 emissions to be priced into production. EUAs are traded and currently have a 2012 forward price of €27/t, versus a 3Q08 price of €26/t.

### VI.V Carbon costs. Europe today, the US tomorrow

Integrated Oil & Gas companies have not only began to internally assume the costs of carbon credits but already beging to factor in the carbon costs for future programs and projects. These already have an explicit cost in Europe, and other regions seem destined to follow suit; Australia plans to introduce emissions trading in 2010 and both US presidential candidates support targeting material greenhouse gas (GHG) emission cuts via a cap-and-trade scheme.

### VI.VI Carbon Emissions Kyoto and cap-and-trade.

The driver behind carbon emission charges is of course concern over the effect a growing consensus believe greenhouse gas emissions (mainly CO2 and methane) are having on the climate. The Kyoto Protocol, adopted in December 1997 and effective from February 2005 commits signatory nations to reduce greenhouse gas emissions by a collective 5.2% versus 1990 levels (implying a 29% cut versus the expected 2010 level). The debate continues as to whether 1) global warming is occurring, 2) if so, just how much is due to the actions of humans, and 3) if required, what the best path is to deal with the issue. However, the intensity of the debate has abated over the last two years as consensus has moved towards accepting that there is a man-made problem and that cap-and-trade is at least a good starting point to a solution. The US remains notable by being the only developed nation in the world to have not yet ratified the treaty. Given the growing unemployment rate, high energy costs and declining production base, the U.S has every incentive to embrace the longer term social, economic and political rewards that would follow from a step like ratification of the Kyoto Protocol.

## VI.VII Carbon Emissions Future prospects for the global carbon market

The outlook for carbon markets globally is best considered on three levels:

1. EU-ETS
2. The prospects for a new international agreement to succeed Kyoto after 2012
3. Policy developments in other industrialized jurisdictions to: (i) The EU-ETS: Phase 3 of the ETS still under debate

The ETS remains by far the largest driver of the global carbon market at the moment accounting for 78% of total turnover in 2007 ($50bn out of $64bn), and for up to 90% when EU purchasing of CERs is taken into account, Figure 4 The EU-ETS is also the market that has the highest degree of future certainty, in that we know it will exist beyond 2012, and that Phase 3 will run over 2013-20. The rules governing the operation of the ETS are currently being revised under a process known as the ETS Review, which formally began in January 2008 with the recommendations from the European Commission. The main recommendations made by the European Commission in its Review are as follows: the cap by 2020 be 21% below the actual level of 2005 emissions for EU-ETS installations (i.e. a cap of 1,720Mt by 2020). However, it also recommends that the cap be reduced progressively over this period, rather than reduced in one go in 2013 and then held constant over the whole of Phase 3. - if no new international agreement is reached the use of CERs/ERUs in Phase 3 will be limited to the CERs/ERUs eligible for use in Phase 2 of the EU ETS as part of the limits fixed on each installation but not actually used by the end of 2012.

- There will be unlimited banking between Phase 2 and Phase 3
- The Commission wants to see very much higher levels of auctioning in Phase 3, with 100% of all allowances for the power-generation sector already auctioned as of 2013, and a phased reduction for the other sectors such that by 2020 there are no more free allowances for any installations.

In addition, 13 north-eastern states in the US have formed a regional trading scheme known as the regional Greenhouse-Gas Initiative, or RGGI. Eventually this may encompass the whole of the United States.

## VI.VIII Dawn of the Digital Electric Age

The rational for adding this section to thesis is based on the similar conundrum of faced by the academic, empirical and why should investors care what analyst think about the best form of carbon regulation, when it will be the politicians who eventually implement it? Because these are the very experts politicians will call on when designing their legislation. While interest groups will also undoubtedly have a large say in regulation, they are unlikely to come up with new ideas which help shape future regulation. The new ideas will come from the analysts and the regulations based on these ideas will be critical to the business plans of the companies we invest in.

### VI.VIV Role of the State and Regulation

The populist proposal of higher taxes on oil companies during record profits and its thoughtlessness is worth dismissing immidately. A higher corporate tax rate may encourage a company to spend more on SG&A in order to reduce its taxable income, the proposal between the state and the firm should be along the line that would enforce either a higher cpaex into specific segments during periods of high oil pricing follwed with tax incentives. For hypothetical purposes one can assume that it would be a simplistic tax that would say something like if you sell a barrel of oil for $120, we, the government, are going to encourage you to spend $40 regardless of where the oil came from. That could mean that as a company you pay the same tax regardless of your extraction costs, and that would serve to reduce exploration and expenditures for any project that has higher extraction costs. The rational act that a state can provide instead is to offer an incentive to invest into project which has uncertain returns on capital today and in fact reduce the current tax burden on the companies toady.

This should be used to encourage a Coherent Energy Policy, encourage More Efficient Energy, more Unconventional Development (Gas) Incentives, more of New Generation Of Generators as well as a Broad Energy Efficiency initiative for the, Transportation Industry, Efficient Transmission and Storage and Evolution of Building Design as first steps to a cleaner and more energy efficient as wel profitable future.

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