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# Optimal Bets in Oil-Related Stocks:

*-A Quantitative Approach*

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**ABSTRACT**

This thesis examines how implied cost of equity from fundamental valuations affect optimal allocation for a marginal investor, net of costs. We find Black-Litterman long-only restricted portfolio incorporating implied cost of equity outperform peer-group benchmark by 0.22 larger monthly information ratio. Moreover, a non-short restricted portfolio constructed on implied earnings yield outperform peer-group index by 0.12 larger monthly information ratio. Simple historic allocation models with and without covariance shrinkage perform poorly and get outperformed by peer-index in the non-short restricted case by 0.10 and 0.64 larger monthly information ratio, respectively.

# PREFACE

This dissertation completes our Master of Science in Financial Economics at the Norwegian School of Economics (NHH) and several persons have contributed academically and with support during this thesis.

Firstly, we would like to thank our supervisor, Jens Sørlie Kværner, for prolific discussions on shaping a choice of topic fulfilling our interests of research and essential input during the writing process. His academic advices have significantly improved the quality of the thesis. Further, we would like to thank Roar Ådland, professor of Shipping Economics at NHH, and Rystad Energy, which has provided access to not publicly attainable data on Clarkson's and Rystad Cube, respectively, and thus enabled an analysis otherwise not possible. In addition, we would like to thank SpareBank 1 Markets for valuable guidance regarding the Bloomberg terminal and access to IHS-Petrodata, the GNU project for making the free Software Environment, R, available and accessible to us, as well as Emil Petersen in Six X-Clear for sharing of costs and restrictions related to shorting of stocks at the Oslo Stock Exchange.

Other than this, we would like to thank the finance department at NHH for the challenging, but encouraging and inspiring Master programme. The theoretical framework for our analysis is based on knowledge we have attained through both the corporate finance and investment management courses at this school, which has truly been decisive for our interest in finance and choice of career path after we finalize our education. In retrospect, the process has been demanding, although extremely enriching and rewarding as we have gained insight into the oil sub-sectors and advanced portfolio models.

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## 1. **Introduction**

In late June 2014, the oil price began decreasing from USD120. After the Saudi-led change in OPEC`s strategy to defend market share regardless of price in November, the oil price plummeted to below USD50. Stock prices in oil and oil-related companies followed, reaching decade-low levels during the summer of 2015. Under Kindleberger (1978) and Minsky's (1972) definition of financial crisis, the recent oil-price drop is within scope and the lemons problem (Akerlof, 1970) may arise as a result. Myers and Majluf (1984) and Greenwald, Stiglitz and Weiss (1984) explain how investors are unable to distinguish between good and bad equity issuers and they show that the price they will pay for shares will reflect the average quality of the issuers. The result is high-quality firms receive a lower price for their shares compared to their fair market value, while low-quality firms receive a price above their fair market value. Under such conditions, Black & Litterman (1990) introduced a quantitative model where practitioners can actively lay abnormal returns and blend it with CAPM equilibrium returns on a sample of stocks in an efficient way. In the wake of this, several predominant academics, including Meucci (2006), have developed extensions.

We produce long and short tangency portfolios for a marginal investor in the Black-Litterman framework, with the implied cost of equity derived from in-debt analysis of five sub-sectors, and extensive excel valuation models of 19 companies. We use PESTEL to evaluate the external factors affecting the environment in the sub-sectors and Porter in order to determine the competition and thus the operational margins. On the basis of this, we use a combination of VRIN and financial analysis to value each stock. As for the models, we also apply an inverse P/E model to duplicate the average expectations of the market participants and an Historic model with Single-Index Covariance to smooth the parametric estimation of covariance. In addition, we apply pure historic data to represent "least effort" way of designing the portfolios on the same equities. The performance is measured in a one-period framework against several benchmark portfolios and *we apply trading- and lending costs to make comparison across portfolios and benchmarks meaningful*. The market is represented by OSEBX. In addition, we use the Energy Index (OSLENX) to measure peer group performance. Moreover, we use Markowitz optimization for the main result. Lastly, we extend our thesis with Meucci's Copula-Opinion Pooling for non-normal returns, which is used in a CVaR optimizer accounting for asymmetries.

We find the Sharpe Ratio of OSEBX and OSLENX superior to the constructed portfolios. The reason for a high Sharpe ratio is the market capitalization size of Statoil in OSEBX, and in the energy index. The corresponding large monthly Sharpe ratio of 0.26 of Statoil thus explains the performance. Both the Black-Litterman and the inverse P/E or earnings yield model are superior to OSLENX on the information ratio criteria for both long and short strategies.

Black-Litterman's long portfolio produces the overall highest monthly information ratio of 0.23 regardless of short-restrictions in the optimization. According to Treynor and Black (1973), alpha bets add risk-adjusted value to an efficient portfolio as they open for equilibrium breach to some stocks in the investment universe. This supports the value of information and quantitatively model exercise of the Black-Litterman framework. The posterior portfolio contains a blend of the prior equilibrium returns and the implied cost of equity dictated by Bayesian Statistics. The results emphasize the information value of our valuations as the posterior Black-Litterman portfolio outperforms the prior portfolio.

The results are also evidential for good performance of the implied market expectations, as the short inverse P/E portfolio bear second highest monthly information ratio of 0.13. A high positive allocation to Farstad, which is a high-performer in the out-of-sample period, drives the information ratio. Extreme portfolio weights under this target allocation make the results highly sensitive. Nevertheless, the market implied expectations beat the simplest models, Historic and the Single-Index model.

We find the performance of the simplest historic models to be poor with information ratios and Sharpe ratios, which are low in comparison with the other models. Our findings is supported by Levy and Roll`s (2008) paper on historic optimal Mean-Variance portfolio weights. According to the paper, historic mean-variance portfolio weights are not satisfying guidance for future optimal weights as the noise factor in historic returns control the resulting portfolio weights.

The rest of this thesis is organized as follows. In the next section, we briefly introduce the most important concepts of theory. In the proceeding, we present the chosen equities and examine the data basis. In section 4, we conduct strategic analyses and valuations on the equities, which is preliminary for the portfolio construction presented in section 5. Lastly, in Extensions in section 6, we apply portfolio allocation in a CVaR-framework.

## 2. Data

The selection of equities for the active portfolio in oil-related sub-sectors was carried out screening first on size in order to reduce noise and then on turnover volumes to mitigate liquidity issues. Finally, we screen on available consensus estimates in order to estimate inverse P/E.

Relevant data for portfolio modeling are monthly prices, adjusted for reverse splits, splits and dividends. Moreover, we have set the investment horizon to ensure statistical inference, as some of the companies have limited time on the stock exchange, which gave us 80 data points in the period 01.02.2009-01.09.2015 (6.67 years). The Oslo Børs Benchmark Index ("OSEBX") and Oslo Børs Energy Index ("OSELNX") are included as benchmarks. In addition, we use the Norwegian 3-month zero coupon ("3M-NIBOR") as a proxy for the risk-free rate. The returns are structured as arithmetic log-returns[1], as arithmetic returns are favored when optimizing portfolios and logarithmic returns when modeling time series because it allows us to sum weighted averages across equities and sum sub-intervals, respectively (Hu and Kercheva, 2007). We summarize key data in table 1.

Drilling, supply and small cap oil stocks have decreased the last 18 months, making averages negative. The downswing has been substantial for the rest of the equities as well, but not enough to make the means negative. Moreover, subsea- and some seismic equities keep stand against OSEBX return. The peer benchmark OSLENX performs positive, but worse than the diversified alternative OSEBX, and it is less volatile than the stocks. We find the equity standard deviations larger than OSEBX, except for Statoil. In addition, the covariance between the assets is high on average, although extremes are observed in both directions. Looking at correlation structure in the intra-sub-sectors compared to average correlations across all sectors strengthen the view of no large differences. We observe drilling, subsea and seismic correlations in line with the cross-sectional average around 0.21, with supply and oil somewhat higher at 0.33 and 0.27, respectively. We refer to Appendix 1 for Historic correlation matrix. We count over 50% of the stocks to have a one-way movement of more than 70% in one month, which are spread uniformly across all sub-sectors. The interpretation should be done with precautions with Mean-Variance preferences, as tail risk may give rise to extreme losses.

[1] Arithmetic log-returns are given by, $[\sum_{t=1}^{N} \ln(1 + x_t)]/N$

*Table 1 – Prior key data (01.02.2009-01.09.2015)*

| Company | Expected Excess return* | | | Standard Deviation** | | Sharpe Ratio | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Historic/ SIC | EY | BL | Historic/ SIC/ EY | BL*** | Historic | SIC | EY | BL |
| **Oil** | | | | | | | | | |
| Statoil (STL) | 0.27 | 0.43 | 0.94 | 0.05 | 0.05 | 0.05 | 0.02 | 0.08 | 0.18 |
| DNO International (DNO) | -1.59 | 0.85 | 1.38 | 0.20 | 0.20 | -0.08 | -0.06 | 0.04 | 0.07 |
| Det Norske Oljeselskap (DETNOR) | -0.92 | 0.71 | 1.38 | 0.21 | 0.21 | -0.04 | -0.04 | 0.03 | 0.06 |
| Panoro Energy (PEN) | -2.40 | 1.93 | 2.95 | 0.14 | 0.14 | -0.17 | -0.15 | 0.14 | 0.21 |
| **Weighted Average** | **0.20** | **0.45** | **0.96** | **0.06** | **0.06** | **0.05** | **0.01** | **0.08** | **0.17** |
| **Seismic** | | | | | | | | | |
| TGS-NOPEC Geophysical (TGS) | 2.38 | 0.39 | 1.01 | 0.10 | 0.10 | 0.23 | 0.18 | 0.04 | 0.10 |
| Petroleum Geo-services (PGS) | -1.45 | 0.94 | 0.91 | 0.11 | 0.11 | -0.14 | -0.11 | 0.09 | 0.09 |
| Spectrum (SPU) | 2.29 | 0.76 | 0.77 | 0.20 | 0.20 | 0.11 | 0.22 | 0.04 | 0.04 |
| **Weighted Average** | **1.29** | **0.57** | **0.97** | **0.11** | **0.11** | **0.12** | **0.10** | **0.05** | **0.09** |
| **Subsea** | | | | | | | | | |
| Subsea 7 (SUBC) | 2.04 | 0.49 | 1.35 | 0.20 | 0.20 | 0.10 | 0.13 | 0.02 | 0.07 |
| Aker ASA (AKER) | 1.63 | 1.04 | 1.75 | 0.09 | 0.09 | 0.18 | 0.08 | 0.11 | 0.19 |
| Aker Solutions (AKSO) | 1.84 | 0.63 | 1.32 | 0.26 | 0.27 | 0.07 | 0.10 | 0.02 | 0.05 |
| **Weighted Average** | **1.89** | **0.66** | **1.45** | **0.19** | **0.19** | **0.11** | **0.11** | **0.05** | **0.10** |
| **Drilling** | | | | | | | | | |
| Seadrill (SDRL) | -0.03 | 2.05 | 2.00 | 0.11 | 0.11 | 0.00 | 0.00 | 0.19 | 0.19 |
| Fred Olsen Energy (FOE) | -1.73 | 2.59 | 1.12 | 0.11 | 0.11 | -0.16 | -0.10 | 0.24 | 0.10 |
| Songa Offshore (SONG) | -2.79 | 0.53 | 1.17 | 0.17 | 0.17 | -0.16 | -0.21 | 0.03 | 0.07 |
| Sevan Drilling (SEVDR) | -2.66 | 11.60 | 2.51 | 0.17 | 0.17 | -0.16 | -0.25 | 0.70 | 0.15 |
| **Weighted Average** | **-0.28** | **2.13** | **1.91** | **0.11** | **0.11** | **-0.02** | **-0.02** | **0.20** | **0.18** |
| **Supply** | | | | | | | | | |
| Prosafe (PRS) | 1.04 | 2.19 | 1.34 | 0.13 | 0.13 | 0.08 | 0.10 | 0.17 | 0.10 |
| Siem Offshore (SIOFF) | -2.96 | 4.69 | 1.46 | 0.16 | 0.16 | -0.18 | -0.24 | 0.29 | 0.09 |
| Solstad Offshore (SOFF) | -0.64 | 3.44 | 1.28 | 0.12 | 0.12 | -0.05 | -0.06 | 0.29 | 0.11 |
| Farstad Shipping (FAR) | -0.52 | 10.22 | 1.50 | 0.16 | 0.16 | -0.03 | -0.03 | 0.63 | 0.09 |
| Deep Sea Supply (DESSC) | -1.81 | 1.60 | 1.39 | 0.19 | 0.19 | -0.10 | -0.14 | 0.08 | 0.07 |
| **Weighted Average** | **-0.11** | **3.28** | **1.37** | **0.14** | **0.14** | **0.00** | **0.00** | **0.23** | **0.10** |
| **Total Weighted Average** | **0.36** | **0.63** | **1.07** | **0.08** | **0.08** | **0.05** | **0.02** | **0.09** | **0.16** |
| **OSELENX** | **0.33** | | | **0.05** | | **0.06** | | | |
| **OSEBX** | **1.18** | | | **0.05** | | **0.23** | | | |

*The numbers are based on monthly returns series (including standard deviation – Std.Dev). *Excess Kurtosis is kurtosis minus 3. An excess kurtosis of 0 is conformant with the Normal distribution. **Sector Weighted Averages*

Examining higher moments, we note high and varying excess kurtosis for all stocks, which makes the distributions deviate from normal distributions with more observations around center and in the far-outlier tails of the distribution. Moreover, the measured skewness indicates some asymmetry. In general, the distributions are minimal pulled towards the right side, making the tail on the left side larger. Thus, the higher movements indicate rejection of normal properties, where models relying on normal assumptions may be complemented with models incorporating tail-risk.

# 3. Methodology

In this chapter, we first present the fundamental valuation methodology and then the different models on portfolio theory.

*Framework for the Fundamental Valuation*

A company's strategic position is determined by its strategic advantage, or ability to generate returns above the hurdle rate (Koller et al., 2010). We believe a company achieves a strategic advantage by either operating in an industry with an inherent strategic advantage or by possessing resources, which gives the company an advantage over its competitors.

To determine whether a company possesses an external benefit, we first analyze the macroeconomic factors affecting the industry with PESTEL, before analyzing the competitive situation applying Porter. For the supply/demand analysis, we perform thorough research on key drivers within each sub-sector. To determine whether the companies' possesses an internal advantage, we map the key resources they are in possession of with a VRIN framework, and then compare them with the resources of the competing companies in the industry. If a company possesses resources competitors do not have access to, we consider whether these resources gives the company a strategic advantage. In the final step of the analysis we use the aforementioned research to prepare a future budget to estimate the companies' future cash flows. We extract an implicit future rate of return on the basis of our FCFE estimates from the future budget and the market value of each company today - i.e., which required rate of return on equity, based on our FCFE estimates, yield the prevailing market value of the companies'.

## 3.1 Strategic Analysis

Strategy focuses on the utilization of a company's unique resources to determine if it has a competitive advantage and involves internal and external analysis of the firm (Hamberg, 2014). We believe it is difficult to determine the value of a company without understanding the strategic reason why it earns a higher return on invested capital than its competitors.

### *3.1.1* PESTEL Analysis

A PESTEL analysis is used to evaluate an industry's strategic position by analyzing the external factors affecting the environment the industries (Johnson et al., 2011). The PESTEL framework provides a comprehensive list of possible impacts on an industry's strategic success or failure. We therefore believe it is important to identify the industry's key drivers for change and focus on these drivers, which will be the factors with greatest impact on the industry. By analyzing how these factors affect the environment the industry operates in and how these factors are changing, we are able to evaluate the industry's strategic position.

### 3.1.2 Porters Five Forces

Michael Porters strategy framework assesses the competitiveness in an industry based on five forces and is undertaken from the perspective of a company already operating in the industry (Porter, 1979). Even though each company in all industries are unique, the forces driving performance and profitability will not be uncommon to all companies (Henry, 2011). These five forces are only helpful to identify the competitive environment and profit potential in an industry. It is therefore important to build competitive advantage through strategy to mitigate or change the pressure of these forces to achieve superior profitability.

### 3.1.3 VRIO Analysis

A VRIO analysis analyzes a company's strategic position in an industry and looks at its resources and then compares these with its competitors (Johnson et al., 2011). To evaluate whether the resources a company possess is a source of competitive advantage, the framework analyzes the resources based on if they are valuable, rare, imitable or organized.

## 3.2 Valuation Methodology

### 3.2.1 The Flow-to-Equity Method

In this thesis, we apply the Flow-to-Equity method ("FTE"). *"The Law of One Price implies that the price of a security should equal the present value of the expected cash flows an investor will receive from owning it"* (Berk and DeMarzo, 2014). Based on this law, we believe FTE, which show the expected cash flow an equity investor will receive from owning a stock, represent the appropriate valuation method. As most of the companies in this thesis have complex capital structures (Rauh and Sufi, 2010) where the amortization schedule is not always predictable, the FTE method offers an advantage (Tergeson, 2001). The disadvantages with FTE are the need to compute a company's debt capacity to determine interest and net debt before the capital budgeting decision. Then, the weighted average cost of capital is easier to apply (Miles and Ezzell, 1980) However, if a company does not maintain a constant debt-to-equity ratio, but the debt amortization schedule is predictable, the adjusted present value approach is easier to apply (Myers, 2001).

The free cash flow to firm ("FCFF") expresses the net amount of cash available to all investors. It shows a company's profitability after capital expenditures, reinvestments and changes in working capital. Using earnings before interest and tax as the starting point, we subtract tax, add back non-cash operating expense such as depreciation and subtract investments in invested capital to arrive at the FCFF.

$$FCFF = EBIT\ (1 - t_c) + Dep. - Capex - \Delta NWC \tag{3.2}$$

Where, *EBIT* is earnings before interest and taxes, *Tc* is the corporate tax rate, *Capex* is capital expenditures and *NWC* is net working capital. However, the FTE method discounts the free cash flow to equity ("FCFE") at the cost of equity to obtain the market value of equity and differs from FCFF by after-tax interest expenses and cash flow from net issuance or repurchase of debt - i.e., principal repayments minus proceeds from issuance of new debt.

$$FCFE = FCFF - Interest\ expenses * (1 - t_c) + Increases\ in\ net\ debt \tag{3.3}$$

The FTE method discounts yearly cash flows plus an estimate of terminal value ($V_t$) (Bodie et al., 2010). In the following equation, we use the Gordon growth model ("GGM") to express the value beyond the explicit forecast period and discount at the cost of equity, $k_e$.

$$Intrinsic\ Value\ of\ Equity = \sum_1^t \frac{FCFEt}{(1 + K_e)^t} + \frac{Vt}{(1 + K_e)^t} \tag{3.4}$$

where,

$$Vt = FCFE_{t+1} / (K_e - g)$$

As noted by the formula above, the FCFE are discounted using the equity cost of capital determined by the Capital Asset Pricing Model ("CAPM").

*Cost of Equity*

We use the CAPM developed by Lintner (1965) and Sharpe (1964) to estimate the cost of equity throughout this thesis. According to this model, the required excess return of an asset relative to the market excess return is proportional to the systematic risk of the asset relative to the market (Vault, 2005).

$$E(r_i) = r_f + \beta_i\ x\ (E(r_{mkt}) - r_f) \tag{3.5}$$

Where, $r_f$ is risk-free rate, $\beta_i$ is beta and $r_{mkt}$ is the market risk premium. Beta measures the variations between asset- and general market movements as opposed to idiosyncratic factors.

$$\beta_i = \frac{\sigma_{i,mkt}}{\sigma^2_{mkt}} \tag{3.6}$$

Where $\sigma_{i,mkt}$ is the covariance between the i'$th$ asset- and the market return, and $\sigma^2_{mkt}$ is the market variance. The market risk premium is the expected excess return on the market portfolio and assumes individuals are rational and base their investment decision on rational selection. Moreover, as the model also assumes a risk-free return is always available in the market, a rational investor will only invest in the risky asset if he receives a risk premium.

$$Market\ Risk\ Premium^2 = E(r_m) = E(r_{mkt}) - r_f \tag{3.7}$$

Merton (1980) recommends a long time frame to reduce estimation error as it takes years of data to produce accurate estimates of $E(r_m)$. However, $E(r_m)$ is likely to be closer to recent historical numbers[3]. According to Welch and Goyal (2008), as investor's risk aversion has not changed, historic risk premiums give a good estimate of future risk premiums.

**Terminal Value**

The FTE method is a two-periodic model and includes an explicit forecast period and a terminal value. The discounted terminal value approximates the net present value of cash flows in steady state. This estimate is crucial as the major portion of firm value often lies in the terminal value. Out of the two methods pointed out by Pignataro (2013), we apply the multiple method in this thesis. According to this method, a firm is worth a multiple of future earnings or book value in the terminal period and we assume an industry median multiple in this thesis. We apply the mid-cycle exit multiple as using a multiple from the bottom or top of the cycle, undervalues and overvalues a company, respectively. Moreover, we use the price-to-earnings ("P/E") multiple, as it is based on a company in steady state with constant industry debt-to-equity ratio and constant growth in future cash flows and return on equity.

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[2] See Fama and French (2002), Siegel (2004), Pastor et al. (2008) for an alternative approach for estimating market $r_m$.

[3] Welch I. (2000), Graham J. & Harvey C. (2008) and Welch I. & Goyal A. (2008)

### 3.2.2 Relative Valuation

In relative valuation, the capitalized results represent an estimate of future cash flows and are based on the arbitrage pricing theory (Boye and Dahl, 1997). The relative valuation in this thesis is intended as a supplement to test the plausibility of our FCFE and we use the guideline public companies method ("GPCM"). The GPCM method derives the market value of a company from publicly traded peers in the similar line of business (Gaughan, 2011). We use forward multiples in this thesis, as unlike historical multiples, forward-looking multiples are consistent with the law of one price. Moreover, forward-looking estimates are normalized, meaning they better reflect long-term cash flows. Therefore, when conducting the GPCM method, we do not predict long-term future estimates for growth, profitability or cost of capital (Palepu and Healy, 2008). The first stage is to choose a measure for value, which can be a performance measure. The next step is to find a set of peers with similar outlook for long-term growth and return. Once a list of peers is collected, the final step is to apply the median multiple from the table to the company being valued.

## 3.3 Portfolio Theory

### 3.3.1 Mean-Variance Optimization

According to the classical Modern Portfolio Theory ("MPT"), portfolio diversification drives the maximum possible return for a given level of risk (Harry Markowitz 1952). MPT aims to maximize the Sharpe ratio for a given selection of assets. The optimization process leverage from quadratic programming can be expressed as

$$\max_{w} w^T\mu - \frac{\lambda}{2} w^T \Sigma w \qquad (3.11)$$

$$s.t. \quad \sum_{n=1}^{N} w_n = 1,\ Ax \quad \leq\geq b$$

where $\mu$ is E(r), $w^T$ are the initial positon of N assets, $\Sigma$ is the covariance matrix, $\lambda$ is the risk aversion coefficient and $Ax \leq\geq b$ is a general constraint. $A$ is an *M* X *N* matrix with *M* rows equal the constraints and *N* columns equal assets and $b$ is a *1* X *N* vector of limits. The problem can be solved by Lagrange methods and results in optimal allocation under the linear equality constraint. This result yields the tangency portfolio, which is the portfolio with highest risk adjusted return for all possible combinations of the assets available for the optimization. See Appendix 2 for illustrations, MPT assumptions and further insight.

### 3.3.2 Sharpe Ratio

Sharpe ratio is a measure of performance for evaluation and the objective of optimization. Moreover, Sharpe ratio is often referred to as a measure of relative "reward to variability" (Sharpe 1966, 1975). According to the definition, Sharpe ratio express excess returns over risk free rate divided by the standard deviation of the distribution.

$$SR_i = \frac{\mu_i - r_f}{\sigma_i} \tag{3.12}$$

### 3.3.3 Information-Ratio

The information ratio ("IR") is a common measure to evaluate asset managers and measures active returns relative to active risk taken, i.e. manager's ability to generate excess return compared to a benchmark, relative to the risk taken to generate the active part of return.

$$IR_p = \frac{\widehat{\mu_p} - \widehat{u_b}}{\sigma[\widehat{x_p} - \widehat{x_b}]} \tag{3.13}$$

Where $\widehat{\mu_p}$ and $\widehat{u_b}$is portfolio- and benchmark return, and $\sigma[\widehat{x_p} - \widehat{x_b}]$ is the variance of the difference return. In a CAPM world we can write $\frac{\alpha_p}{\sigma_\varepsilon(p)} = \frac{\widehat{\mu_p} - rf + - \beta_p(\widehat{u_b} - rf)}{[\sigma_p^2 - {\beta_p}^2 \sigma_b^2]^{0.5}}$.IR will capture selection *(α)* capabilities stripped for market risk *(β)*.

### 3.3.4 The Single Index-Implied Covariance Matrix

Estimating covariance matrices is a hot topic in portfolio selection due to the inherent flaws of the sample covariance. In portfolio optimization, volatile covariance tends to result in unstable portfolio weights, which may give rise to high asset turnover when applied to out-of-sample data (Ledoit and Wolf, 2003). However, we avoid this problem by exploiting the structure of CAPM theory and estimate the covariance matrix with less parameters than in the unstructured case, *Σ*[4], thus having a smoothing effect. Sharpe (1963) introduced the single-index model, in which the covariance matrix is given

$$\Phi = \beta\beta^T\sigma_m^2 + \Omega_\epsilon$$

where $\beta = (\beta_1, \ldots, \beta_n)^T$ is *N* X *1* and $\sigma_m^2$ is the variance of the market. Estimator for Φ is

[4] With 19 stocks in the sample we estimate 21 parameters (19 betas, market premium and variance). With standard covariance we estimate 209 parameters (19 expected returns and variances and 171 covariance's).

$$\widehat{\Phi} = BB^T\hat{\sigma}_m^2 + \widehat{\Omega}_\epsilon \tag{3.14}$$

where $B = (b_1, \ldots, b_n)^T$ and $b_1$ is the least squares estimator for $\beta_i$ and $\widehat{\Omega}_\epsilon = diag(\sigma_{1,\epsilon}^2, \ldots, \sigma_{1,N}^2)$, which has basis in the OLS-residuals. $\beta_i$'s have equivalent interpretation as under CAPM, although allowance for $\alpha$ may produce minor differences.

### 3.3.5 The Black-Litterman Model

The Black-Litterman ("BL") model has its roots in academic recognized theory[5] as the model propose a method of taking practitioner's market views into account and combine it with Markowitz mean-variance optimization framework. Including variance-covariance and expectations of returns, parameters such as view portfolios, confidence level of view portfolios and uncertainty on the reference model are needed. The motivation for developing this model was to offset some of the flaws to traditional mean-variance models such as unstable behavior in portfolio weights due to parameter sensitivity, specification of expected returns for all assets in the investment universe and illogical and highly concentrated portfolios (He and Litterman, 1999). The model is assembled using Bayesian statistics to combine the subjective views created on expected return on assets in the portfolio with the market equilibrium returns of all the assets in the investment universe. This leads to a new posterior estimate of expected return.

*Expected Returns in Equilibrium*

The BL model is reliant upon general equilibrium theory, i.e. if the aggregated portfolio is at equilibrium the sub-portfolios are the same. The investor is categorized with a quadratic utility function, where the equilibrium problem is reduced to CAPM and assumptions. Thus, the unconstrained optimization on expected equilibrium returns yields weights corresponding to the market portfolio[6]. Then, we are able to back out the equilibrium returns by a reversed optimization process. Mathematically, we arrive at the FOC of $\max_w w^T\mu - \frac{\lambda}{2}w^T\Sigma w$ by substituting optimal weights and collect equilibrium excess return vector $\Pi$.

$$w = (\lambda\Sigma)^{-1}\mu \rightarrow \lambda\,\Sigma w_{mkt} = \Pi, \tag{3.15}$$

because if $\mu$ does equal $\Pi$ , $w$ will equal $w_{mkt}$.

[5] Sharpe (1964, 1966, 1974), Markowitz (1952) Black (1989), Black et al (1991, 1992)

[6] When CAPM holds, the tangency portfolio in a MV framework will be equivalent to the market weights.

There are $N$ assets in the market, where $w_{mkt}$ is the market weights. The expected excess return of the $N$'th asset in the market $M$ is $\mu$, a normal distributed random variable with mean of $\overline{\mu}$ and covariance matrix, $\Sigma$.

$$\overline{\mu} = \Pi + \varepsilon_t, \text{ where } \varepsilon \text{ is } N \sim (0, \tau\Sigma) \quad (3.16)$$

Where $\lambda$ is defined as in chapter 3.3.1. Academics have various views regarding $\lambda$. He and Litterman (1999) argue the average risk aversion across world markets is 2.5 and Litterman suggest calculating the implicit risk aversion based on a benchmark index. We use the latter as we believe short term risk preferences are more convenient in this thesis.

$$\lambda = \frac{\mu_{mkt} - r_f}{w_{mkt}^T \Sigma w_{mkt}} = \frac{SR_{mkt}}{\sigma_{mkt}} \quad (3.17)$$

*Views*

An optimization process according to BL - with defined views on any of the portfolio's assets - will return the market equilibrium portfolio in addition to a weighted sum of the portfolios the investor has views. The views are created based on different expectations between investor and $\Pi$. They can be given linearly in both absolute performance and relative performance of assets. We apply only absolute performance views in this thesis. Confidence levels are attached, through $\tau$ to add certainty to the estimates. All else equal, reduced confidence level will offset declining portfolio weights for an outperforming asset. Absolute performance estimate is illustrated by; $P_1$ will be tilted in an optimal portfolio if expected return is larger than equilibrium return. The portfolio weight will be lower in the opposite case.

Below, we present the diagonal pick matrix ($P$) $K$ x $N$, where the number of views, $K$ is equal to the number of assets, $N$. Satchell and Scowcroft (2000) use an equal weighted scheme. Weightings are proportional to 1 divided by the number of assets outperforming or underperforming. We use the same method to reduce importance of company size.

$$P = \begin{bmatrix} P_{1,1} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & P_{K,N} \end{bmatrix} \quad (3.18)$$

Mathematically the views can be deduced from a view vector ($Q$) *K X 1*.

$$Q + \varepsilon = \begin{bmatrix} Q_1 \\ \vdots \\ Q_k \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \vdots \\ \varepsilon_k \end{bmatrix} \quad (3.19)$$

The error terms ($\varepsilon$) are IID and normally distributed with zero mean and covariance matrix of $\Omega$. Due to the independence assumption, the covariance's are zero, and therefore results in the diagonal matrix $\Omega$.

$$\Omega = \begin{bmatrix} \omega_1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & \omega_k \end{bmatrix} \tag{3.20}$$

$\omega$ is uncertainty corresponding with each view inversely related to confidences, as increased variance will decrease confidences and vice versa. He and Litterman (1999) use a method where they set $\Omega$ proportional to variance of the prior. This method is mostly applied in a canonical framework, therefore is used in this thesis.

$$\Omega = P\tau\Sigma P^T \tag{3.21}$$

Doing it this way makes the combined return vector of excess returns indifferent of $\tau$, although $\tau$ works as a scaling factor on the variance of the views. Implicit to this assumption on the division of variance between matrix $\Omega$ and the parameter $\tau$ equals the historical variance-covariance matrix of the view portfolio. Therefore, $\tau$ has to be seen as level of confidence level to the view estimate of returns. A simple but effective method is calculating $\tau$, relies on the fact that the variance of a mean estimation is contrary directional to the sample size. Therefore, under quadratic unbiased estimation

$$\tau = \frac{1}{T-N} \tag{3.22}$$

where $T$ is number of samples and $N$ is number of assets. As $T$ is often significant larger than $N$, the model puts more confident in the views.

*Combined Return Vector*

We put together the elements in the last sub-chapter and present the posterior expected return and posterior covariance matrix of the BL-model.

$$\mu_{BL} = [(\tau\Sigma)^{-1} + P^T\,\Omega^{-1}P\,]^{-1}\,[(\tau\Sigma)^{-1}\Pi + \,P^T\Omega^{-1}\,Q] \tag{3.23}$$

$$\Sigma_{BL} = [(\tau\Sigma)^{-1} + P^T\,\Omega^{-1}P\,]^{-1} \tag{3.24}$$

$\mu_{BL}$ and $\Sigma_{BL}$ lies closer to the unknown parameter, $\mu$ with higher precision than either the prior or the conditional view distribution. The proof of the BL-formula follows in Appendix 3. We affirm the normal distributional assumption still holds.

# 4. Applications

In the following chapter of this thesis, we first use PESTEL and Porter in the E&P industry to analyse the strategic environment and to determine the operational margins. We argue the price formation of oil is the key external factor affecting the environment in oil service and apply only Porter to these sub-sectors. Next, we investigate the supply-demand balance for oil and sub-sectors and perform differentiation analysis on underlying economic conditions on equity level using VRIN and extensive research. Finally, the resulting valuations are then expressed as views in terms of implied cost of equity.

## 4.1 Industry Analysis

### 4.1.1 The Oil Market

**PESTEL**

*Political Aspects*

We view the political aspects to have significant influence on the E&P industry. Many countries have substantial impact on the players in the industry, as they primarily possess the ownership rights of both oil and gas resources. By controlling these reserves, governments can sell E&P concessions to several companies, which allow them to favor national companies and exclude foreign ones. A prominent organization is the Organization of Petroleum Exporting Countries ("OPEC"), which controls more than 80% of the world's proven oil reserves (OPEC Annual Statistical Bullet, 2015). After the Saudi-led change in OPEC`s strategy to defend market share regardless of price, we view its geopolitical influence as enhanced and likely to increase as oil reserves diminish.

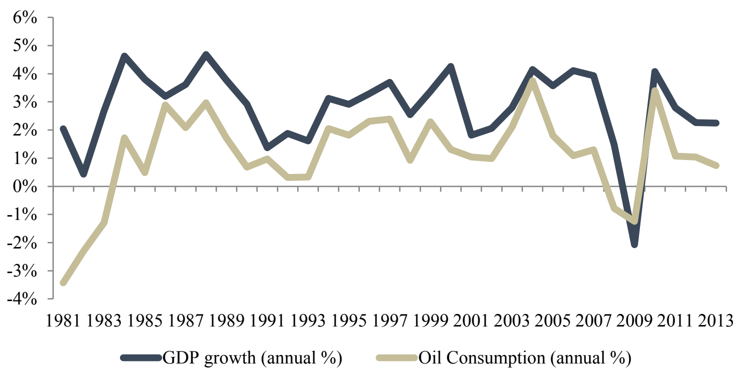
We also consider internal political and broader geopolitical risks such as the Arabic Spring in 2011 as disruptive for E&P investments, despite strong economic incentives and favorable policies in many countries. All such geopolitical tensions and resistance negatively affect value creation in the E&P industry.

Government's willingness to participate in the policies aimed at reducing carbon dioxide emissions, will greatly impact the petroleum industry and we believe the global adoption process of renewable energy will reduce E&P companies' profitability and adversely affect growth opportunities.

*Economical Aspects*

As illustrated in figure 1, the E&P industry is very interdependent with the development in the world economy – here shown by the annual percentage change in Gross Domestic Product ("GDP") growth compared to annual percentage change in oil consumption. The main reason is because economic growth, prosperity and increasing population largely drive oil consumption and demand for oil. A positive aspect for E&P companies is the short run inelastic oil demand. The time between an oil price change to a respond in the consumer and business market is long because most industries and transportation facilities uses oil as a source of energy. As the global economy is dependent on continuous supply of oil at a fair price, *we believe the improvement in the world economy is crucial for the development of the E&P industry*.

*Figure 1 – Annual GDP and oil consumption correlation*




Another important economic aspect affecting the E&P industry *is the value of the dollar* as oil prices are globally denoted in this currency. A Norwegian oil producer selling oil in dollars are exposed to currency risk between the Norwegian Krone ("NOK") and the dollar. The stronger dollar rate typically results in a lower oil price per barrel. Oil market participants push the price of oil lower as Statoil is entitled to minimum the same price of oil as before in NOK, after exchanging dollars into NOK. We therefore believe a good management of the US economy should provide some stability for both oil prices and profitability within the E&P sector.

*Social Aspects*

Social aspects determine the preferences of societies where E&P companies operate and affect the companies partly through their image. As social considerations and increased political focus enforces greener fuel alternatives, and the cost of its production is competitive, we believe the economic climate will be less favorable for E&P companies.

*Technological Aspects*

As new reserves are found in deeper water and in more challenging environments, which are sometimes not economically feasible to exploit with the current technology, the E&P industry is continuously investing in research and development ("R&D"). With modern technology, up to 50% of the proven oil can be recovered and with technological breakthrough in locating reservoirs, exploring those at a low cost or at a higher recovery rate, we believe E&P companies can achieve competitive advantage. In other parts of the value chain, where some E&P companies are integrated, technological development such as more efficient oil transport through underwater pipelines can improve E&P companies' margin. We believe technology will have thorough impact on the future development of the E&P industry in general and the long-term sustainability in particular. In fact, periods of sustained high oil prices have encouraged technological development and the development of high-cost fields. Hence, the cost of the marginal barrel has increased because of more expensive technology. We therefore argue that high oil prices increases costs and not the other way around.

*Environmental Aspects*

Environmental aspects are increasingly affecting E&P companies and their profitability. Over the past decades, many E&P companies have been involved in environmental catastrophes and held responsible for incidents such as oil spills. Stronger governmental focus towards environmental friendly solutions entails heavy capital expenditures in more advanced technology in an attempt to reduce pollution to a minimum. All these provisions and expenditures serve as a burden for E&P companies' profitability.

*Legal Aspects*

Legal aspects perform an important role in shaping the E&P industry. E&P companies face large upfront concession fees and other royalties and taxes, which are relatively high compared to other commercial activities. We believe the major legal concerns affecting E&P companies steam from compliance with regulations related to the environment. Current and proposed international, national and local climate agreements, fuel conditions, etc. will naturally have effect on both the production and profitability of many E&P companies.

**Porters Five Forces**

*Threats of New Entrants*

We believe the threat of new entrants is low due to high barriers to entry. According to Wood Mackenzie (2015), Norway's Johan Sverdrup costs USD31bn to develop. Not all new entrants can support the large capital requirements associated with up-front investments required for the development of oil reserves or setting up production facilities. Due to the increased unit cost, which according to the International Energy Agency (IEA, 2008) rose 90% between 2000 and 2007, another barrier to entry are economies of scale. Only large E&P companies and refineries positioned to take advantage of both economies of scale and scope survives and prevents new players to gain ground due to the risk. Disadvantages for potential new entrants also originate from national government policies, which favor local E&P companies. As the state owns oil and reserves, some tend to give access to commodities to national companies.

*Bargaining Power of Buyers*

There is no product differentiation as oil is a commodity where the price is determined by the equilibrium relationship between supply and demand. The willingness to pay is the only bargaining power potential buyers possess. Large oil consuming countries like US, the EU, China and Japan - which account for more than 50% of global oil consumption (OPEC, 2015) - can however exert bargaining power towards E&P companies due to their consumption and quantity demanded.

*Bargaining Power of Suppliers*

Oil producing countries, which are the suppliers of oil, possess bargaining power. Oil is a rare and limited resource and without government's willingness to cooperate with E&P companies to exploit it, the oil-related companies have no livelihood in the industry. As more than 80% of the world's proven oil reserves are located in OPEC countries (OPEC Annual Statistical Bullet, 2015), which nationalized oil production in their countries from large international E&P companies - they possess bargaining power to E&P companies. As a result, OPEC`s bargaining power is evident when granting oil field concession rights to E&P companies.

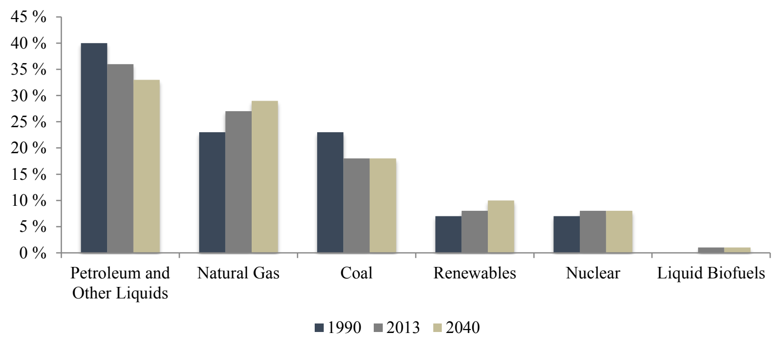
According to Porretto (2009), oil rich countries were strict to foreign E&P companies when the oil price was high and above USD100/bl. After the Saudi-led change in OPEC`s strategy caused the oil price to decrease, the bargaining power misbalance changed. With oil prices below USD40/bl., some OPEC countries find oil fields uneconomical to develop by their national E&P companies and are turning to major international companies to reduce break-even costs to balance fiscal budgets.

As large E&P companies represent volume buyers from unconsolidated sub-sectors it increases the bargaining power. This has become evident the last 12 months where the fall in oil prices has led to reduced E&P spending, re-negotiations of existing contracts and postponed activities, causing profit to vanish in oil service.

*Threats of Substitute Products and Services*

As illustrated in figure 2 below, petroleum and other liquids are estimated to account for 33% of global energy consumption in 2040 due to being cost efficient compared to the other fuel types (EIA, 2015). As the oil value chain adapts to the low oil price environment, we believe more sophisticated exploration technologies will emerge and offset increased depletion costs, and cause oil to be a competitive sources of energy.

*Figure 2 – Global Energy Consumption by fuel types*




Based on the EIA outlook, we find renewables as the threat of substitute as increased natural gas market share is positive for E&P companies, coal being a relatively expensive alternative for electricity generation due to environmental regulations and strong political agenda towards downscaling nuclear programs. Renewable energy sources are forecasted to increase from a market share of 8% in 2013 to 10% in 2040. Even though the global adaption process will be time consuming, the government's willingness to change its energy habits in favor of renewable energy sources should be considered as a threat, also in the short run.

*Intensity of Rivalry among Competitors in the Industry*

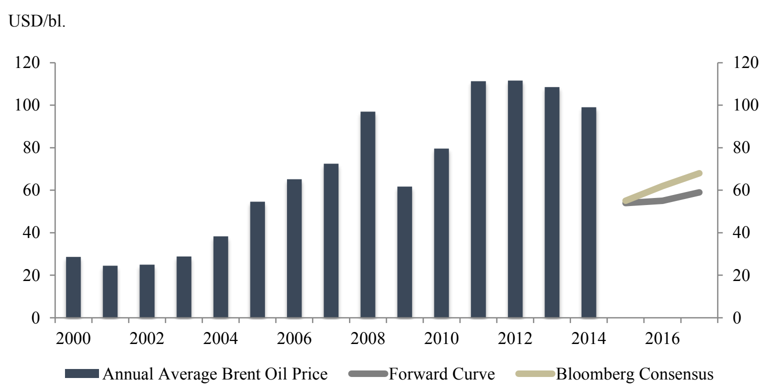
The competition in the industry is high, which mainly finds its explanation in fierce need to replace drying reservoirs and is described as having few major and strong participants and few smaller players with less influence. According to Weston et al. (2001), this has forced some major oil producers to opt for mergers and acquisitions and alliances, which increases the concentration. Some national E&P companies in the OPEC consortium have put less R&D on technology and are effectively operating as cartels, which reduce rivalry among these companies. The slow industry growth also intensifies competition among E&P companies.

High exit barriers lead to intensive battling between the companies in the industry in spite of below average or even negative rates of return. As relinquishment of field concession rights is easily done as a result of the increased interest from E&P companies to strengthen or diversify asset portfolios with new fields, exit barriers are less present in the upstream segment of the industry as compared to downstream. Other factors affecting the competition among E&P companies are high fixed costs and lack of product differentiation, as oil and gas both are commodity products.

### 4.1.2 The Price Formation of Oil

As illustrated in figure 3 below, after a sharp decline from an average USD99/bl. in 2014, Bloomberg consensus[7] expects Brent to average at USD55/bl. in 2015, USD62/bl. in 2016 and USD68/bl. in 2017, whereas the forward curve imply prices of USD54/bl., USD55/bl., and USD59/bl. in 2015, 2016 and 2017, respectively. In addition to the shrinking supply surplus going forward, an oil price increase is supported by cost-of-supply reasoning - i.e. the marginal cost of extracting one additional barrel is higher than the current price, with US shale having a marginal cost of USD68/bl. (Rystad Energy, 2015).

*Figure 3 – Annual average Brent oil price history and future estimates*

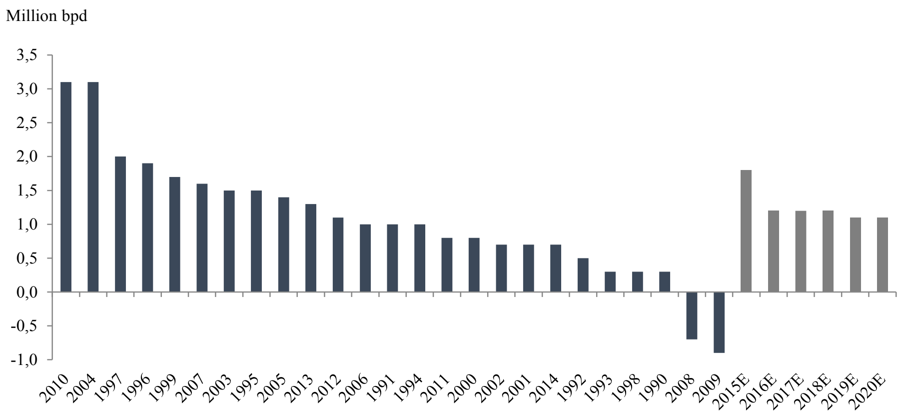



[7] Consensus estimates on forward oil prices from a collection of oil analyst across the globe.

*Demand*

The EIA estimates global oil demand growth of 1.8m barrels per day ("bpd") in 2015. Demand growth in 2016 is expected to return to the long-term normal level of 1.2m bpd. As shown in figure 4 and in Appendix 4, global oil demand growth is at the highest since 2010, which we believe is supported by lower oil prices. Americas demand growth this year is 0.4m bpd, with sharply escalating gasoline demand as the key driver. China and Other Asia (India, Indonesia, Malaysia, Philippines, Singapore and Thailand) are also important drivers of growth, showing resilient demand despite some weakness in the macroeconomic picture.

*Figure 4 – Annual global oil demand growth history and future estimates*



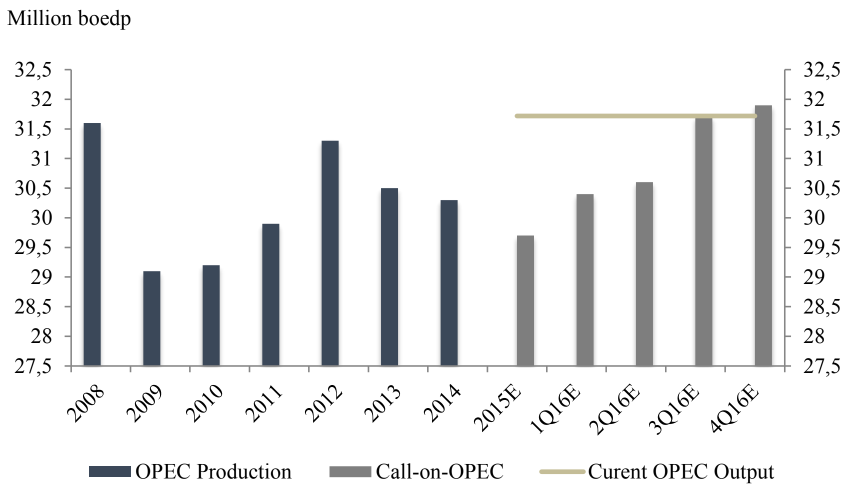

The correlation between year-over-year ("YoY") GDP growth and oil consumption in our dataset between 1987 and 2014 showed *0.82*, with an explanatory variable ($R^2$) of 0.67. According to the International Monetary Fund (IMF, 2015), the world GDP is expected to grow 3.72% on average in the period 2015 to 2020, above the historical average of 3.5%. Based on this, we believe the consumption assumptions above is reasonable as low oil prices and interest rates in Europe and in US, and growth in China and Other Asia will help boost demand for oil.

*Supply*

The EIA sees non-OPEC supply decline by 0.5m bpd in 2016, down from a 1.2m bpd increase this year. As we can see from Appendix 5, the main change in supply is US production, estimated to drop by 0.2m bpd in 2016, compared to a 0.8m bpd growth in 2015. Production is set to drop in most non-OPEC countries as oil companies prioritize value over volume in the current oil price environment.

As illustrated in figure 5 below, the EIA estimates a Call-on-OPEC – the crude oil OPEC need to produce to balance supply-demand - of 29.7m barrels of oil equivalent per day ("boepd") on average this year, implying a current oversupply of 2m boepd, with September OPEC production of 31.7m boepd. Call-on-OPEC rises going forward, with oil demand growth at 1.2m bpd and non-OPEC supply estimated to drop by 0.5m bpd in 2016. Assuming OPEC production at the current level going forward, physical market balance is set for the second half of 2016.

*Figure 5 – Call-on-OPEC and current OPEC production of 31.72m bpd*

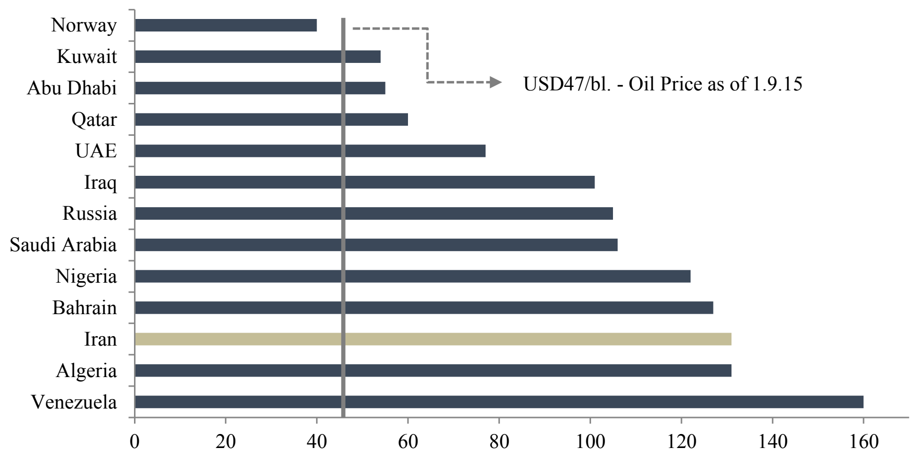



With stable global oil demand from figure 4, the oil market is supply driven with two risks: a) additional Iran barrels on sanctions lifting and b) the resilience of US shale production.

*a. Iran Sanctions Lifting*

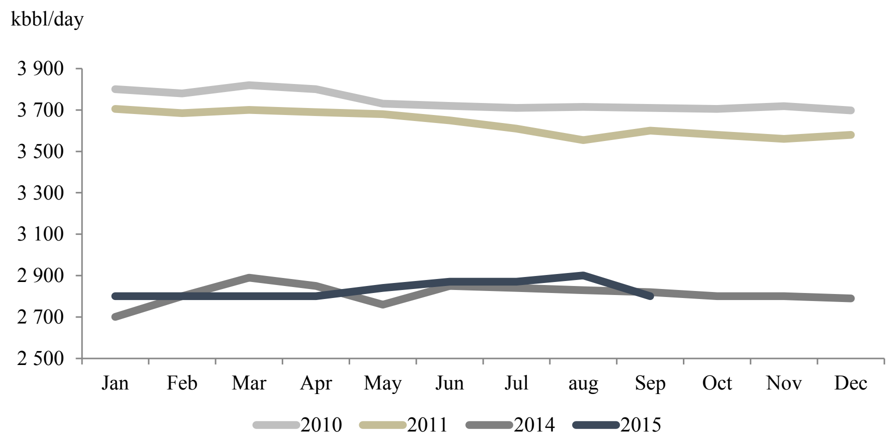
On October 18, the world powers and Iran agreed to begin meeting their commitments from the June 2015 agreement. The day when sanctions are lifted will according to US officials take two months, implying additional Iran barrels are set for early 2016 if commitments are met. Figure 6, which show the government budget break-even in Brent crude oil price terms given the current output, reveilles Iran require a price of USD130/bl. to balance 2015 budgets (The Telegraph, 2015). With long-term forward curve of USD59/bl., Iran have strong incentives to supply as much oil as possible to reduce budget deficits.

*Figure 6 – Government budget break-even in Brent crude oil price terms given current output*




As illustrated in figure 7, production capacity in Iran before the sanctions was reported at 3.5-3.8m bpd, 1m boepd above the current output. Moreover, floating storage is estimated to 40m barrels or 0.2m bpd in six months (Euronav, 2015). As the Iranian oil minister estimates 0.5m boepd can be supplied within a week and 1m boepd within six months from the sanctions are lifted, we believe the physical market equilibrium will be delayed if sanctions were to be lifted. Refer to Appendix 6 for detailed numbers.

*Figure 7 – Iran oil production before sanctions (2010 and 2011) and after (2014 and 2015)*




### b. *US Oil Production*

As illustrated in figure 8 below, the Baker Hughes US oilrig count stopped declining and showed a weekly increase in the month-end June to July 2015, while the US oil production increased. This suggests US oil production has become more cost efficient. Despite cost deflation and higher productivity, recent supply data disproves the trend from July and US shale production is forced out of the market by high OPEC production with an estimated 2016 supply growth of -0.2m bpd.

*Figure 8 – U.S. Crude oil production and oilrig count.*

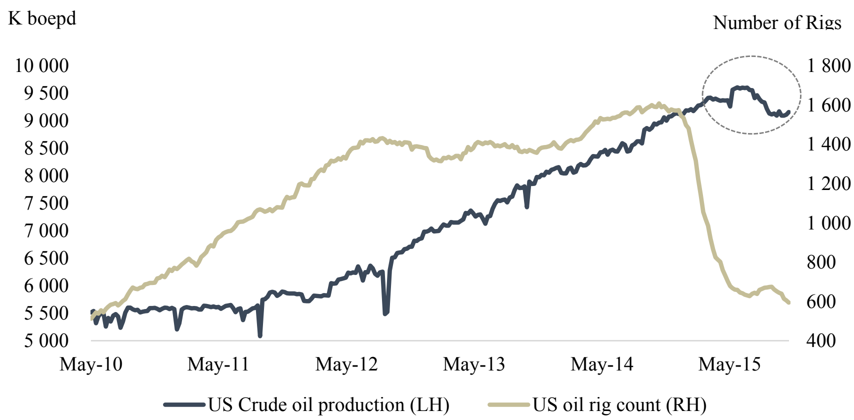
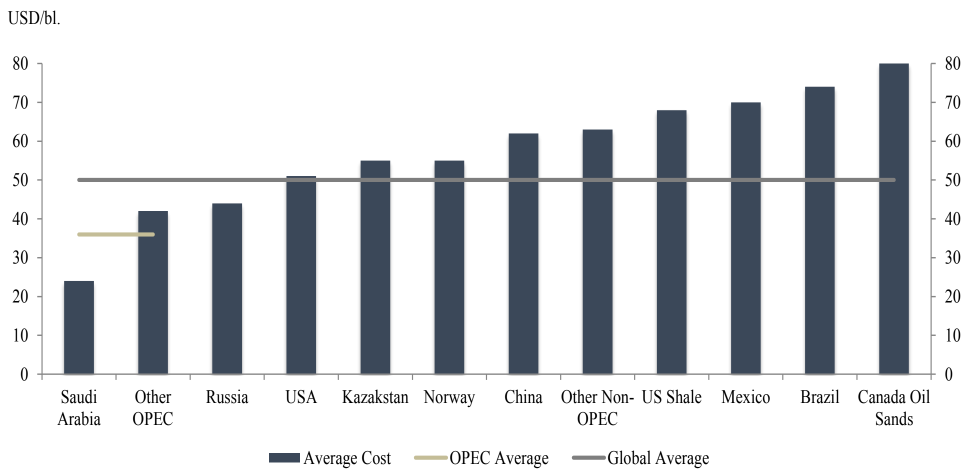



Figure 9 below show the global cost curve (excluding dividends or interest payments). With an average break-even level of USD68/bl., below the world average at USD50/bl., US shale production is struggling to cope in the current oil price environment (Rystad, 2015). With redetermination of credit line ongoing in 4Q15 and oil price hedges running out, we believe US production will continue to decrease.

*Figure 9 – Global Brent break-even cost curve (excluding dividends or interest payments)*



### 4.1.3 The Oil Service Market – a Strategic Review

Oil service is a generic term, which includes four sub-sectors: seismic, subsea, offshore drilling and offshore supply. Seismic techniques use shock waves sent beneath the seabed, to image rock formations for identification and production optimization of oil and gas reserves. Subsea relates to the equipment, technology and methods employed in offshore oil and gas developments. Offshore drilling is a mechanical process where a wellbore is drilled below the seabed by a rig and where offshore supply refers to supply vessels used to transport supplies between the supply base and the rigs. We refer to Appendix 7 for a detailed overview.

**Porters Five Forces**

*Threats of New Entrants*

Capital to purchase rigs and offshore supply vessels are in principal the only barriers to entry in these sub-sectors. Although supply vessels in general and rigs in particular are expensive, banks give high leverage on favorable terms. With long-term contract coverage, leverage is often a high percentage of the purchase price (Kaldestad and Møller, 2011). Due to the large capital expenditures required for high tech supply vessels and large rigs, both sub-sectors are industries with high fixed costs. We think this should increase the barriers to entry, in a scenario where the expected returns are unattractive. With a mobile rig and supply fleet, no broad infrastructural changes necessary and several rigs and supply vessels off contract, the cost of switching supplier is low. The result of low to medium barriers to entry is a fragmented market with the risk of contracting during upswings.

The biggest entry barrier in the subsea sub-sector is the buyer switching cost. More established companies such as Subsea 7, Technip and Saipem offer a complete service package throughout a projects lifetime, which many E&P companies prefer. The product differentiation is also high as each project is tailor made for the customer. This creates a strong relationship between the customer and the supplier, which is hard to break for a new entrant. The subsea industry is also capital-intensive, which requires strong financial resources.

As seismic surveys are more demanding and contracts to this sub-sector are awarded based on track record (i.e. reliability) and reputation, seismic have high barriers to entry. Acquiring a seismic contract or sell seismic surveys is essential for entering this market. For new entrants with lack of resources, experience and established network, acquiring these contracts will be difficult.

*Bargaining Power of Buyers*

The balance of power and negotiation leverage have shifted towards buyers, i.e. E&P companies, as the sub-sectors are flooded with ample capacity. Many oil service companies offer the same service, which leads buyers to seek lower prices and better contract terms. In Brazil, Petrobras is cancelling tenders and pushing renegotiation of existing charterers. 23% of the listed offshore supply fleet is contracted to Petrobras, which means a supply company often delivers all their services to few, large and powerful customers. As drilling companies build their business model more or less exclusively on long-term contracts, customers gain high bargaining power, due to tenders being a necessity for drillers' survival.

The bargaining power of seismic companies against E&P companies is somewhat mixed. E&P companies' willingness to pay is high as without seismic surveys, there will be no product. But it is low as the seismic companies are very dependent on the E&P companies in order to attain profitability. Large E&P companies will not be dependent on only one seismic company, as competitors will be competing to do work with these companies in order to attain profitability.

Customers have limited choices in subsea and end up paying more for the choices available. As E&P companies require special customizations, they are also less likely to switch to producers who have difficulty meeting their demands.

*Bargaining Power of Suppliers*

The main suppliers within oil service are the shipyards – i.e. where rigs and vessels are repaired and built. The switching costs between suppliers in both the drilling and offshore supply industries are low, which is reflected in these companies' habit to order newbuildings from various shipyards, depending on preferences (quality, price and reliability) at the time of order. Even though the subsea and seismic vessels are custom made and are both expensive and time consuming to build, there are many national and international shipyards. The power of suppliers is, in our view, not likely to increase as many shipyards still offer variety of solutions.

*Threats of Substitute Products and Services*

The only threat of substitute would be if on a large scale the world changed its primary source of energy from oil to renewable energy sources. In the drilling industry, we see only substitute in subsea constructions and vice versa. As subsea constructions are restricted to extraordinary projects with reservoir discovery close to land (i.e. Snøhvit outside of Hammerfest), platforms fixed to the seabed are the preferred solution and subsea constructions are thus not viable in most cities. When oil and gas resources in shallow waters have been developed, offshore production will come from deep water where platforms fixed to the seabed is not an alternative. In the seismic space, marine seismic surveys and electromagnetic techniques are the most commonly used. We argue threat from alternative seismic techniques is low as for instance Electromagnetic GeoServices, which uses its proprietary electromagnetic technology to support E&P companies in their search for offshore oil and gas, has struggled to get adopted by market participants since the IPO in 2007.

*Intensity of Rivalry among Competitors in the Industry*

High exit barriers is a troublesome situation for rig and supply companies. Although a rig or supply company goes bankrupt, the capacity is normally not withdrawn from the market as the buyer will often achieve greater profitability by allowing the rig or the supply vessel to be in the market rather than sending them for scrapping (Kaldestad and Møller, 2011).

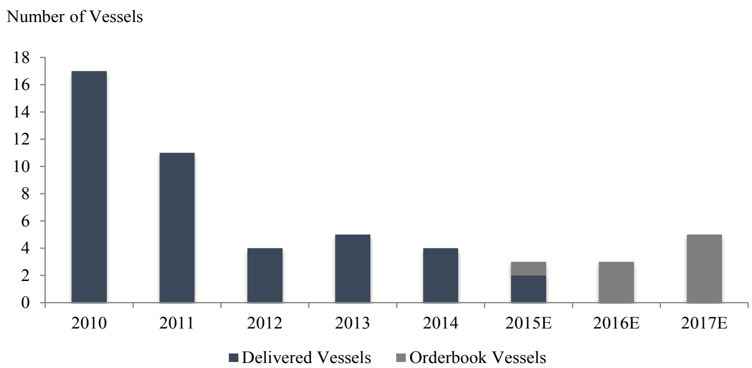
In an industry with high fragmentation where there are numerous small and medium sized operators, there is a high intensity of competition. The 10 largest owners within the drilling sector accounts for 43% of the total rig fleet, with a number of smaller and medium sized fleets operating and where these have few incentive to scrap rigs. Tidewater, the largest player in the offshore supply market, holds only 10% of the global fleet and the 10 largest players accounts for just above 30% of the fleet. For companies operating in a fragmented market, an investment in a new vessel or rig will probably prove significant. This points towards disruptions in the supply-demand balance, leading to overcapacity and declining charter rates.

Even though new subsea entrants such as Ocean Installer and EMAS AMC have won contracts from international operators like Statoil and Shell, the three established contractors Saipem, Technip and Subsea 7 hold the dominance of the subsea market. Since there are few competitors and high product differention, the subsea industry can be interpreted as a differentiated oligopoly where a high level of cooperation between players characterizes the industry. It can be challenging for a company to meet the customers' high demand for advanced technology and special expertise, which the cooperation between the firms in the industry solves. According to Nordea (2015), the subsea fleet is down 12%, with each company taken its fair share. Year to date (YTD), supply in seismic is down by 32% measured by the number of vessels. With more actions taken, the intensity of rivalry among competitors in these two sub-sectors is less compared to drilling and supply.

### 4.1.4 The Seismic Market

The health of the seismic segment has historically been a reliable indicator of the future health of the entire upstream E&P sector, with a correlation between annual Brent oil price and seismic revenues of *0.96* in the period 1999 to 2014. When commodity prices are consistently high, drilling stops and reduces seismic budgets. When commodity prices are low, seismic budgets disappear along with most other budgets. Interestingly and as shown in the delivery schedule in figure 10, orders from seismic companies started to slow down before the downturn.

*Figure 10 – Overview of the seismic order book delivery schedule*




*Supply*

According to Clarkson's (2015), the seismic fleet consists currently of 50 3D seismic vessels, in which there are estimated to be 43 in 2017. However, the seismic fleet has become more productive. In 2014, an average 3D seismic vessel acquired 25 sqkm per day (assuming 82% utilization[8] in line with historical numbers), up from 12 sqkm per day in 1996 according to PGS. Moreover, PGS expects the market in 2015 to be 370,000 sqkm. Keeping vessel productivity and utilization unchanged from 2014 would imply a need of 48-49 3D seismic vessels, below the current fleet. We argue PGS estimates to be too optimistic. The reduction of 17.5% in seismic activity in 2015 reported by PGS is less than the decline in global exploration spending YTD of 36%. Assuming seismic spending declines in line with the overall exploration spending imply a need for 37 vessels in 2015, 13 vessels or 26% less than the current fleet or a reduction of six vessels from the estimated 2017 levels.

[8] The proportion of available time that a seismic vessel is operating

*Demand*

According to a data sample extracted from Bloomberg, the correlation between exploration spending and seismic spending has been 0.8 from 2000 to 2014. Two years in the sample stand out. In 2000 several E&P companies merged[9]. All this M&A activity caused seismic spending to decline 3% as E&P companies were focused internally. After the financial crisis hit in September 2008, E&P companies reduced seismic spending. While exploration spending grew by 35% in 2008, seismic spending grew by "only" 17%. Excluding these two outliers, the correlation between exploration spending and seismic spending increases to *0.92*.

In late December 2013, Mexico`s President Enrique Pena Nieto signed the constitutional change ending Pemex`s 75 year monopoly in Mexico (The Guardian, 2013). Although the reform will keep reserves a property of the Mexican state – and Pemex being the sole operator – we view a liberalization of the Mexican energy sector as positive. There has so far unfortunately been limited seismic activity on the Mexican shelf. There are currently no 3D seismic vessels off Mexico compared to six on the US side according to Marine Traffic (2015), as the strict contract terms dampen the E&P companies` appetite to explore the shelf.

Exploration spending is coming down, mainly due to significant decline in Brent oil price. But exploration spending was already being reduced when Brent was at USD110/bl. While exploration is important for E&P companies, the industry is currently spending more on dividend and capex than what it is generating in operational cash flow. According to Bloomberg consenus, only 24 % of offshore E&P companies run positive cash flow post dividend. With increased cash flow and stronger priority from shareholders to dividends, we believe exploration spending will have to be cut to maintain dividend payments and improve cash flow going forward, negatively affecting seismic.

### 4.1.5 The Subsea Market

According to Subsea 7 (2015), the scale and complexity of Subsea Umbilical, Riser and Flowline ("SURF") projects continue to grow as new reserves are found in deeper water and in more challenging environments. YTD, SURF order intake is down 72% compared to same period last year. Although some subsea equipment contracts ("SPS") are continuing to be

[9] Norsk Hydro bought Saga in June 1999, TotalFina merged with ELF in September, and Exxon merged with Mobile in November, whereas Chevron merged with Texaco in October 2000.

awarded, SPS companies have announced orders worth only USD2.1bn YTD – down 56% compared to last year.

*Demand*

Last year, E&P companies started a cash flow fix in order to restore free cash flow, following overspending since 2009. We have seen signs of the lengths E&P companies are prepared to cut costs as sanctioned projects are put on hold. DNB Markets estimate contracts worth more than USD5.0bn have been terminated over the past year and our tracking of cancelled or postponed projects in table 2 indicate an increased uptick during 2015. The most common explanation for delayed projects is too low oil price.

*Table 2 – Tracking of delayed, terminated and postponed oil and oil service projects*

| Date | Name | Capex involved (USDbn) | Operator | Geography | Reason |
|---|---|---|---|---|---|
| Jul-15 | Buzzard Phase 2 | NA | Nexen Petroleum | UK North Sea | Exploring cheaper solutions |
| Jun-15 | Parque Dos Doces | NA | Petrobras | Brazil | Dry well |
| Jun-15 | Trestakk | NA | Statoil | Norway | Postponed from 2018 to 3Q19 - low oil price |
| May-15 | Chissonga | 3.1 | Maersk Oil | Angola | Project being re-tendered |
| Apr-15 | Bonga Southwest | 12 | Shell | Nigeria | FID Delayed to 2016 - SURF bids too high |
| Apr-15 | Zinia Phase 2 | | Total | Angola | FID Delayed to 2016 |
| Mar-15 | Tommeliten Alpha | 2.1 | ConocoPhillips | Norway | Low oil price |
| Mar-15 | Sepat | 1 | Petronas | Malaysia | Gas project delayed due to low oil price |
| Feb-15 | Pierre River | 6.5 | Shell | Canada | Described as long-term opportunity (oil sands) |
| Feb-15 | Sunrise | | Woodside | Timor-Leste | Dispute between Timor-Leste and Australia |
| Jan-15 | Arrow LNG | 28 | Shell | Australia | Project is off the table |
| Jan-15 | Kitimat | | Chevron | Canada | Chevron slowing spending |
| Jan-15 | Mariana | 1.8 | PTTEP | Canada | Oil sand project - oil price too low |
| Jan-15 | Foster Creek Phase H | 1.1 | Cenovus Energy | Canada | Oil sand project - oil price too low |
| Jan-15 | Christina Lake Phase G | 2.5 | Cenovus Energy | Canada | Oil sand project - oil price too low |
| Jan-15 | GTL Plant, Lousiana | 11 | Sasol | US | Investments delayed due to lower oil price |
| Jan-15 | Leviathan | 6.5 | Noble Energy | Israel | Dispute with Israel anti-trust authorities |
| Jan-15 | Karaana Petrochemical Project | 6.5 | Qatar Petroleum | Watar | Commercial unfeasible in current climate |
| Jan-15 | MacKay Rover 2 Expansion | 0.8 | Suncor Energy | Canada | Oil sand project - oil price too low |
| Jan-15 | Kirby North Phase 1 | 1.8 | CNR | Canada | Oil sand project - oil price too low |
| Jan-15 | Carmon Creek | 4 | Shell | Canada | Oil sand project - oil price too low |
| Dec-14 | White Rose Extension | 3.7 | Husky Energy | Canada | Delayed by at least a year |
| Dec-14 | Vette | 1.4 | Premier Oil | Norway | No PDO when Brent is below USD50/bl. |
| Dec-14 | Sea Lion | 2 | Premier Oil | Falklands | FID delayed from late 2015 to mid 2016 |
| Dec-14 | Narrow Lae | 1.8 | Cenovus Energy | Canada | Oil sand project - oil price too low |
| Dec-14 | Pacific North West LNG Terminal | 36 | Petronas | Canada | FID delayed - construction costs too high |
| Dec-14 | Kudu | 2 | Namcor | Namibia | Tullow transfer to Namcor |
| Oct-14 | Ayastil-Tekel | 1.7 | Pemex | Mexico | Budget controls |
| Sep-14 | Zidane | 1.7 | RWE | NCS North Sea | PDO delayed due to weak economics |
| Aug-14 | Gendalo Gehem | 12 | Chevron | Indonesia | Lack of clarity on PSC |
| Jun-14 | Bonaparte LNG Project | 4.2 | GDF Suez | Australia | Poor expected returns |
| May-14 | Joslyn | 11 | Total | Canada | Not sufficient economics |
| Apr-14 | South Ndola | 3 | Chevron | Angola | Too expensive |
| Mar-14 | Valhall West Flank | 4.2 | BP | NCS North Sea | Cost concerns |
| Feb-14 | Peik | 0.8 | Centrica | NCS North Sea | Unsustainable economics |
| Jan-14 | Kristin Ga s Export | 0.3 | Statoil | NCS North Sea | Unsustainable economics |
| Dec-13 | GTL | 12.5 | Shell | US | Development costs and uncertainty on oil prices |
| Nov-13 | Bressay | 5.5 | Statoil | UK North Sea | Re-evalue the development concept |
| Nov-13 | Rosebank | 7 | Chevron | UK West of Shetland | Blames poor economics |
| Oct-13 | Snorre 2040 | 6.7 | Statoil | NCS North Sea | FID delayed to 4Q17 |
| Jun-13 | Shtokman | 30 | Gazprom | Russian Barent Sea | Delayed to future generations (US shale) |
| Jun-13 | Johan Castberg | 13.1 | Statoil | NCS Barents Sea | FID postponed to 2017 |
| Apr-13 | Mad Dog Phase 2 | 10 | BP | US GoM | Project re-design |
| Apr-13 | Browse | 45 | Woodside | Australia | FID decision delayed until mid-2016 |
| Mar-13 | Voyageur | 10.2 | Total/Suncor Energy | Canada | Oil sands project no longer economic feasible |
| Feb-13 | Hadrian North | | Exxon/Mobile | US GoM | Under review due to uncertainty on reservoir |
| Feb-13 | Fram | | Shell | UK North Sea | Unexpected well results |
| Nov-12 | Linnorm | | Shell | Norwegian North Sea | Escalating costs |

Subsea spending is in our view basically a function of oil price and thus exploration spending. According to a data sample extracted from Bloomberg, the correlation between average yearly Brent oil price and annual subsea revenues has been *0.96* from 1996 to 2014. The main input factor for the subsea market going forward will be development of oil price and changes in exploration spending. Should the oil price increase or decrease significantly more than implied by the forward curve, it would represent upside and downside risk, respectively.

Our tracking of global exploration spending budgets in table 3 below indicate a decline of 36% in 2015 compared to 2014 – the biggest reduction ever recorded in the data sample – and shows no sign of increased demand for subsea spending. According to IR in Statoil, subsea represents a small portion of exploration spending in the range of 15% to 20%. Zero of the major E&P companies report increased exploration spending.

*Table 3 – Tracking of global exploration spending budgets*

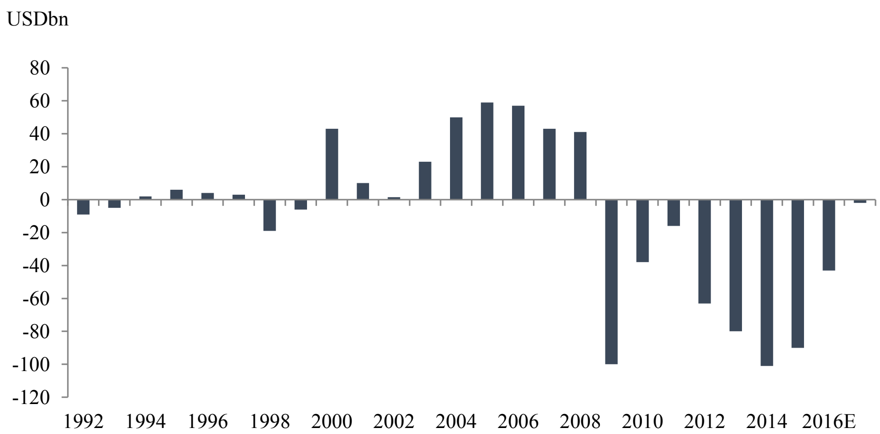
| | Exploration Spending (USDm) | | 2015 | |
|---|---|---|---|---|
| **Company** | **2014** | **2015** | **Change (USD)** | **Change (%)** |
| **Majors** | | | | |
| BP | | | | |
| BG Group | 1 649 | 1 650 | 1 | 0% |
| Chevron | 3 385 | 3 000 | -385 | -11% |
| ConocoPhillips | 2 250 | 1 500 | -750 | -33% |
| Eni | 1 857 | 1 326 | -531 | -29% |
| ExxonMobil | 2 446 | | | |
| Shell | 6 802 | | | |
| Statoil | 3 500 | 3 200 | -300 | -9% |
| Total | 2 800 | 1 960 | -840 | -30% |
| **Sum** | **24 689** | **12 636** | **-2 805** | **-19%** |
| | | | | |
| **Independents** | | | | |
| Anadarko Petroleum | 900 | 560 | -340 | -38% |
| Apache Corp | | | | |
| Hess | 550 | 400 | -150 | -27% |
| Kosmos Energy | 175 | 300 | 125 | 71% |
| Lundin Petroleum | 680 | 470 | -210 | -31% |
| Marathon Oil Corp | 500 | 232 | -268 | -54% |
| Noble Energy | 450 | 145 | -305 | -68% |
| Premier Oil | | | | |
| Repsol | 1 846 | 1 200 | -646 | -35% |
| Talisman Energy | | | | |
| Tullow Oil | 720 | 200 | -520 | -72% |
| **Sum** | **5 821** | **3 507** | **-2 314** | **-40%** |
| | | | | |
| **South and Latin Americ** | | | | |
| Ecopetrol | 1 802 | 600 | -1 202 | -67% |
| Gran Tierra | | | | |
| Paccific Rubiales Energy | 700 | 226 | -474 | -68% |
| Pemex | | | | |
| Petrobras | 4 680 | 2 393 | -2 287 | -49% |
| **Sum** | **7 182** | **3 219** | **-3 963** | **-55%** |
| | | | | |
| **Russia** | | | | |
| Rosneft | | | | |
| | | | | |
| **Asia Pacific** | | | | |
| CNOOC | 3 863 | 2 522 | -1 341 | -35% |
| Pertamina E&P | | | | |
| PTT E&P | | | | |
| Santos | | | | |
| Woodside Petroleum | 410 | 500 | 90 | 22% |
| **Sum** | **4 273** | **3 022** | **-1 251** | **-29%** |
| | | | | |
| **World Total** | **41 965** | **22 384** | **-10 333** | **-36%** |

### 4.1.6 The Drilling Market

*Demand*

The most important leading indicator for the drilling market is the oil price, via its effect on the E&P spending. According to Pareto (2015), historical correlations – in normal markets – suggest USD1/bl. equates to +/- 1% on E&P spending. In our sample of 43 listed E&P companies extracted from Bloomberg, they have not run their operations with positive cash flow after dividends and capex since 2008. We expect the sector to continue operating negative cash flow in the years ahead. The free cash flow post dividend estimates in figure 11 are based on our tracking of capex for global E&P spending from table 4 below, which points towards a decline of 23% in 2015 vs. 2014 and down 6% in 2016.

*Figure 11 – E&P companies' free cash flow post dividend*




Few E&P companies have given updated guidance on 2016 spending yet. BG Group will spend roughly 6% less than 2015, Total guiding a 15% cut in 2016 and Freeport McMoran cutting 29%. With Brent forward curve of USD55/bl. in 2016 and Chevron recently guiding for 2016 capex of USD25bn to USD28bn, 25% lower than 2015 spending, we argue 2016 E&P spending risk and thus demand development is on the downside. Six companies have given updated guidance for 2017 E&P spending. On average they cut spending by 9% in 2017 compared to 2016.

*Table 4 – Tracking of capex for global exploration and production spending among E&P companies*

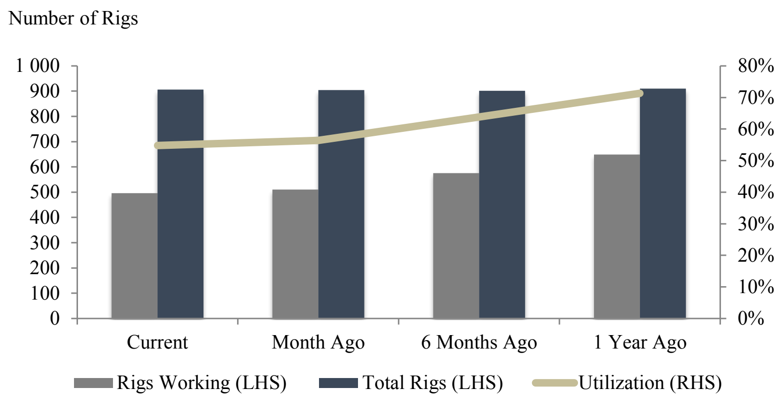
| | E&P budget (USDm) | | | 2015 | |
|---|---|---|---|---|---|
| **Company** | **2014** | **2015** | **2016** | **Change (USD)** | **Change (%)** |
| **Majors** | | | | | |
| BP | 19 772 | 16 628 | 21 000 | -3 144 | -16% |
| BG Group | 9 387 | 6 490 | | -2 897 | -31% |
| Chevron | 35 800 | 31 600 | 26 500 | -4 200 | -12% |
| ConocoPhillips | 17 100 | 11 500 | 11 500 | -5 600 | -33% |
| Eni | 13 981 | 12 024 | 12 600 | -1 957 | -14% |
| ExxonMobil | 32 340 | 27 045 | 27 045 | -5 295 | -16% |
| Shell | 32 286 | 27 270 | 31 815 | -5 016 | -16% |
| Statoil | 18 000 | 15 750 | | -2 250 | -13% |
| Total | 20 800 | 19 900 | 17 000 | -900 | -4% |
| **Sum** | **199 466** | **168 207** | **147 460** | **-31 259** | **-16%** |
| | | | | | |
| **Independents** | | | | | |
| Anadarko Petroleum | 7 740 | 5 106 | | -2 634 | -34% |
| Apache Corp | 8 500 | 3 800 | | -4 700 | -55% |
| Hess | 5 626 | 4 400 | | -1 226 | -22% |
| Kosmos Energy | 575 | 800 | | 225 | 39% |
| Lundin Petroleum | 2 100 | 1 450 | | -650 | -31% |
| Marathon Oil Corp | 5 487 | 3 421 | | -2 066 | -38% |
| Noble Energy | 4 700 | 2 900 | 5 720 | -1 800 | -38% |
| Premier Oil | 1 196 | 750 | | -446 | -37% |
| Repsol | 3 777 | 2 700 | | -1 077 | -29% |
| Talisman Energy | 3 063 | | | | |
| Tullow Oil | 2 100 | 1 900 | | -200 | -10% |
| **Sum** | **44 864** | **27 227** | **5 720** | **-14 574** | **-32%** |
| | | | | | |
| **North America** | | | | | |
| Antero Resources | 2 850 | 1 750 | | -1 100 | -39% |
| Bill Barrett Corp | 546 | 320 | 250 | -226 | -41% |
| Canadian Natural Resources | 6 992 | 5 182 | | -1 810 | -26% |
| Chesapeake Energy | 5 139 | 3 250 | | -1 889 | -37% |
| Clayton Williams | 404 | 107 | | -297 | -74% |
| Continental Resources | 4 550 | 2 375 | | -2 175 | -48% |
| Decon Enery | 5 355 | 4 250 | | -1 105 | -21% |
| Encana | 2 550 | 2 100 | | -450 | -18% |
| Energplus | 751 | 480 | | -271 | -36% |
| EOG | 7 200 | 4 400 | | -2 800 | -39% |
| EXCO Resources | 367 | 222 | | -145 | -40% |
| Forest Oil | 278 | | | | |
| Freeport-McMoRan E&P | 2 752 | 2 800 | 2 000 | 48 | 2% |
| Halcon Resources | 1 482 | 395 | | -1 087 | -73% |
| Husky Energy | 3 900 | 1 851 | | -2 049 | -53% |
| Imperial Oil | 4 503 | 2 777 | | -1 726 | -38% |
| Nexen | | | | | |
| Newfield Exploration | 2 017 | 1 171 | 1 700 | -846 | -42% |
| Occidental Petroleum | 7 650 | 4 500 | | -3 150 | -41% |
| Pioneer Natural Resources | 3 000 | 1 600 | | -1 400 | -47% |
| Range Resources | 1 435 | 870 | | -565 | -39% |
| Rosetta Resources | 1 200 | 750 | | -450 | -38% |
| Sandridge Energy | 1 508 | 700 | | -808 | -54% |
| Soutwestern Energy | 2 260 | 2 500 | 2 900 | 240 | 11% |
| Suncor Energy | 5 997 | 4 629 | | -1 368 | -23% |
| Unit Corporation | 718 | 309 | | -409 | -57% |
| Whiting Petroleum Corp | 2 800 | 1 800 | | -1 000 | -36% |
| **Sum** | **78 204** | **51 088** | **6 850** | **-26 838** | **-34%** |
| | | | | | |
| **South and Latin Americ** | | | | | |
| Ecopetrol | 6 890 | 4 600 | 5 250 | -2 290 | -33% |
| Gran Tierra | 465 | 184 | | -281 | -60% |
| Paccific Rubiales Energy | 2 300 | 1 200 | | -1 100 | -48% |
| Pemex | 23 400 | 20 709 | | -2 691 | -12% |
| Petrobras | 25 500 | 18 750 | | -6 750 | -26% |
| **Sum** | **58 555** | **45 443** | **5 250** | **-13 112** | **-22%** |
| | | | | | |
| **Russia** | | | | | |
| Rosneft | 11 928 | 10 735 | | -1 193 | -10% |
| | | | | | |
| **Asia Pacific** | | | | | |
| CNOOC | 17 365 | 11 770 | | -5 595 | -32% |
| Pertamina E&P | | | | | |
| PTT E&P | 3 455 | 2 550 | 3 437 | -905 | -26% |
| Santos | 3 175 | 1 660 | | -1 515 | -48% |
| Woodside Petroleum | 971 | 1 120 | | 149 | 15% |
| **Sum** | **24 966** | **17 100** | | **-7 866** | **-32%** |
| | | | | | |
| **World Total** | **417 983** | **319 800** | | **-94 842** | **-23%** |

As illustrated in figure 12, which show the overall rig utilization[10] development over the last year for the competitive rig fleet, *utilization rate is a leading indicator for demand and activity in the offshore drilling industry* (Ringelund et al., 2015 and Osmundsen et al., 2012). There are

[10] Calculated as the ratio of working rigs to the number of available rigs.

ongoing discussions between operators and contractors regarding terms in existing drilling contracts. National oil companies such as Saudi Aramco and Pemex are aggressive in re-negotiating day rates, while international oil companies re-deliver rigs and pay 65-80% of remaining backlog due to the cost saving from other spread costs (Songa, 2015). Based on our tracking of E&P spending, we argue demand will decrease further and negatively impact the utilization rate going forward. Due to lower utilization rates, we expect day rates to decline, which in turn will lead to accelerating stacking and scrapping activity.

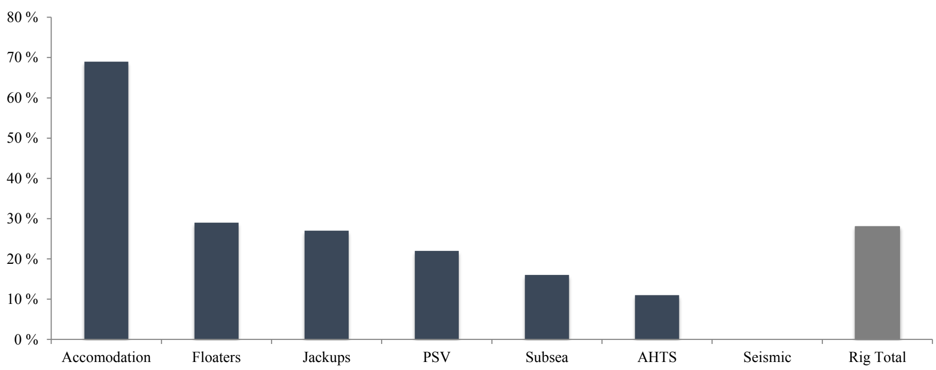
*Figure 12 – Overall offshore rig utilization*




*Supply*

The drilling sub-sector is suffering from a combination of contracting demand and supply growth. As illustrated in figure 13 below, the current rig order book implies a growth in the rig fleet of 27% as a percentage of the current fleet (Clarkson's, 2015). According to IHS-Petrodata (2015), the floater fleet is expected to increase from 310 rigs in 2015 to 399 rigs in 2020, whereas the jack up fleet is estimated to increase from 544 to 673 rigs. This translates into an increase of 28% and 24% in the period for the floater and jack up fleet, respectively.

*Figure 13 – Current orderbook as a % of the current fleet*



The relative high fragmentation of ownership within drilling means companies are less incentivized to stack vessels with the aim to improve market balance. The 10 largest owners within the sector accounts for 43% of the total offshore rig fleet, with a number of smaller fleets operating and where these have few incentive to scarp vessels. However, we believe there is scrapping potential in the rig sector due to i) high stacking- and re-activation costs and ii) an old fleet. Offshore drilling is a capital-intensive industry, and cold stacking a floater cost USD10k to USD15k a day, with deactivating and reactivation cost of USD1m and USD5m, respectively. Although the duration of cold stacking can vary, cold-stacked rigs are out of service for a period of time and not considered part of marketable supply (Rigzone, 2015). Rigs will therefore not return to market immediately when rates start move towards cash break-even levels. Nearly half of the rig fleet consists of units above 20 years and large drillers with many old legacy rigs are now retiring and scrapping old rigs despite lower scrap steel values and high exit barriers. According to Ensco management (Ensco, 2015), rigs older than 30 years will be stacked permanently once off contract. We currently track 20 floaters and 45 jack-ups aged more than 30 years going off contract at year-end. We believe stacking and scrapping will continue in the coming quarters. This in turn adds further pressure on already depressed earnings estimates and reduces long-term earnings capacity.

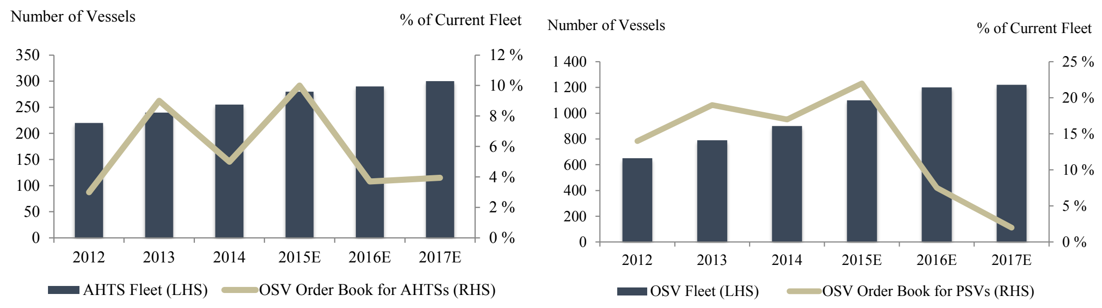
### 4.1.7 The Offshore Supply Market

*Supply*

The offshore supply vessel ("OSV") market, which is production exposed – with 70% of the global fleet engaged in work related to E&P companies` production activities – has been supply driven post 2008, with an overall compounded annual growth rate ("CAGR") of 5% the past ten years. Both the aforementioned growing rig fleet and more vessel intensive deep-water campaigns have absorbed much of this capacity, but it has also resulted in orders for new builds, lagging activity with 12-18m (ICS, 2011). Vessels ordered during the peak in 2013/2014 are entering the market, with 139 Anchor Handling Tug Vessels' ("AHTS") and 266 Platform Supply Vessels ("PSV") currently under construction, comprising 11% and 21.5% of the fleet, respectively. However, slippage remains high, with only 30% of the AHTS` and PSVs scheduled for delivery in 1H15 actually delivered YTD. This is not only due to constrained yard capacity and owners delaying newbuildings, but we believe there will be a number of vessels not entering the market.

As illustrated in figure 14 below, the AHTS market has a low order book compared to PSV, but we believe this is due to major E&P companies shift away from the operation of AHTS to more fuel efficient PSVs when the oil price rose during peak season in 2013/2014. We do not think we will see this continue with low bunker costs. Moreover, AHTS are typically uneconomical to utilize for cargo work due to higher fuel consumption (larger engines) and smaller deck/tank space. The newbuilding in the PSV market are spread between large and mid-size tonnage, with the majority over the past 12 months in the mid-size segment. We believe small PSVs have limited future demand as E&P companies upgrade their size and capability requirements to exploit economies of scale. Despite vessels being cold stacked and retired, we see continued net supply growth in 2016 and 2017, especially in the PSV segment, which is not encouraging (Clarkson's, 2015).

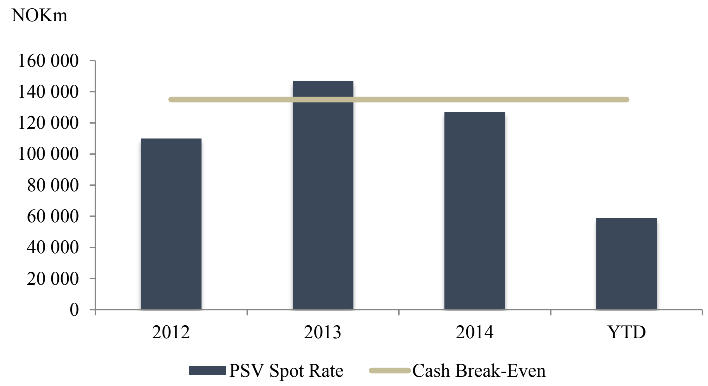
*Figure 14 – AHTS (LHS) and PSV (RHS) fleet and growth in % of the fleet*




*Demand*

*As OSV activity is a derivative of rig activity*, declining drilling and offshore project activity coupled with high supply growth imposes a further strain on utilization and day rates. As shown in figure 15, cash break-even for a modern PSV with 60% loan-to-value ("LTV") and 12-year redemption profile is in the range NOK130k to NOK140k. In comparison, the average North Sea PSV spot rate was NOK157k in 2013, NOK127k in 2014 and NOK58.9k YTD.

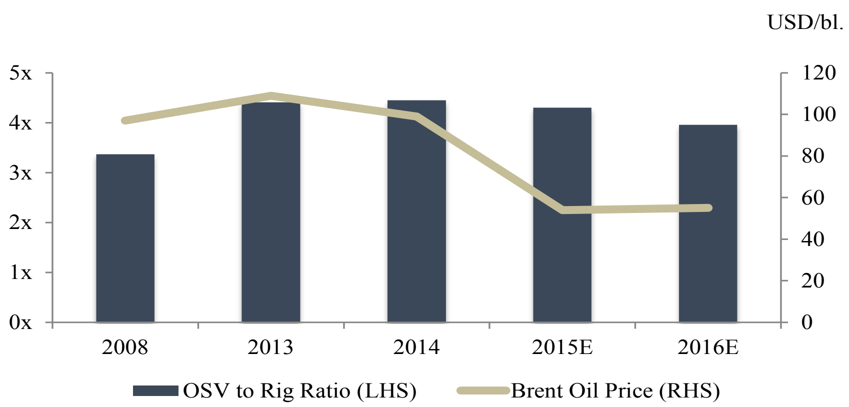
*Figure 15 – PSV spot rate and estimated cash break-even for a modern PSV with 60% loan-to-value and 12-year redemption profile*




Data points from Clarkson's (2015) points to 1-2 year term charter day rates below NOK100k for large modern PSVs compared to operating expenses of NOK75k. Spot rates in the AHTS segment is also below the estimated cash break-even rate. In addition, we believe a demand issue for the AHTS market is the local content requirement in Brazil where owners of Brazilian flagged tonnage block and replace foreign vessels under existing charters (Maritime.no, 2015). Although this clause has been in Petrobras contracts for years, it has not been used until now. A number of foreign flagged vessels on long-term charters have lost their license to operate in Brazilian waters, resulting in relocation to other regions.

*We believe a way to look at the supply/demand situation is to calculate the OSV to rig ratio*. Although several factors such as regional differences, water depths, and vessel size will impact the number of OSVs per rig in different regions, it gives an idea of the market balance. As illustrated in figure 16 below, it currently points towards and excess number of OSVs per rig given the forward Brent oil price curve and the current demand situation.

*Figure 16 – Number of OSVs per rig in relation to the Brent oil price*



There is limited scrapping potential in OSV, although 25% and 19% of the current AHTS and PSV fleet is older than 20 years. OSVs have less retrievable steel limiting the scrap value, which depending on mobilization and the size of the vessel can amount to zero (Aas et al, 2009). In addition, the steel price has plummet alongside the oil price. This creates few incentives for vessel owners to scrap vessels, preferring to cold stack at USD1k/day, ahead of a potential marked recovery. These vessels will return to the market when rates move up. Tidewater, the largest OSV player, holds only 10% of the global OSV fleet and the 10 largest accounts for 30% of the fleet, with a number of smaller fleets operating and where these have few incentive to scrap vessels. We thus expect more vessels to be retired and cold stacked and future earnings potential to decrease.

## 4.2 Company Valuations

### Statoil - Sell

Statoil is Norway`s largest oil company and is 67% owned by the Norwegian government. They have a different approach than European peers with higher exposure to upstream activities, which is a disadvantage a low oil price environment. The main issue in Statoil is dividends. Statoil said it would reduce spending so FCFF covers dividend. This was at oil prices above USD50/bl. For 2016, most capex is committed but there is capex flexibility from 2017, in the range NOK5bn to NOK7bn annually. In a scenario with Brent at USD45/bl. throughout 2016, Statoil will generate negative FCFF for 2015 and 2016 of about NOK45bn. With dividend payment of USD2.8bn, this implies new funds are required during 2H16. On our estimates, Statoil approaches the ceiling of the guided 15-30% gearing threshold with 29.7% NIBD to capital employed by the end of 2016. With a lasting low oil price in 2016, the gearing ratio breaks the 30% threshold. This will force the company to divest more of its asset base or take capex cuts from 2017. With this threshold breach for longer periods, and the absence of oil price recovery would in our opinion put pressure on dividend. Statoil offers a 6% dividend yield compared to a 5-year rolling average of 5.4%. The yield to interest rate spread is at a 9-year high, while the historical yield gap to European peers has closed. Dividends continue to attract investor's attention and after the major Italian E&P company ENI cut dividend in March, the share price dropped 10%. **Conclusion**: Statoil should be one of the last to cut dividend due to its recent cost cuts, lower capital intensity and balance sheet flexibility. However, with dividend yield above historical figures, high upstream exposure and a potential oil price around USD50/bl. beyond 2016, dividend cuts looks inevitable. With Statoil trading at a premium to

10-year average at 16x, 12.9x and 10.1x on 1-, 2-, and 3-year forward earnings, respectively, we view risk/reward as unfavourable.

**Det Norske Oljeselskap – Neutral**

Det Norske Oljeselskap production steams from eight high-quality projects. The most prominent one is the 11.57% share in Johan Sverdrup, which is due on stream in 4Q19 and profitable at or below USD40/bl. according to Wood Mackenzie. The main issue in Det Norske Oljeselskap is financing. On our estimates, Det Norske Oljeselskap is fully financed until Johan Sverdrup first oil. In December 2015, the next redetermination of its borrowing base in the reserve based lending facility ("RBL") takes place, potentially involving a reduction in light of the oil price drop. On the forward curve - which is often used in budgeting - Det Norske Oljeselskap is fully financed even if the borrowing base is reduced to USD2.2bn from the current USD2.9bn set in June (DETNOR, 2015). According to Det Norske Oljeselskap, more liquidity is required if the borrowing base is reduced to USD2.2bn with an oil price at USD48/bl. or below through 2017. We believe the attractive portfolio is valuable for the company in terms of securing liquidity through RBL. It also positions Det Norske Oljeselskap as an acquisition target[11]. However, we do not believe Aker (50% stake) is selling exposure to Sverdrup in the current oil environment. **Conclusion:** As Det Norske Oljeselskap trades at an implied long-term Brent oil price in the low 70s on our FCFE estimates and with no discount to underlying values, we find the risk/reward to be balanced.

**DNO International - Buy**

DNO International ("DNO") is an oil company where most of the value is in the 62% share in the Tawke field in Kurdistan. The oil is primarily exported through a pipeline to Turkey, the rest is sold locally at a lower price. Kurdistan Regional Government (KRG) has nearly not paid the oil companies extracting oil in Kurdistan for its oil. In 2013, KRG did not pay DNO and in December 2014 they got USD21m from KRG. DNO estimates KRG owe the company USD947m, of which USD829m are for exported oil and USD118m are for oil sold locally. The reason why KRG has not paid oil companies for exports is because they have argued with the central government in Baghdad over the distribution of Iraq`s oil revenues, which struggle to

[11] For readings on what determines an potential acquisition target, see: Where M&A Strays and Where it Pays: A survey of the research", *Journal of Applied Corporate Finance*, Fall 2004, pp. 63-76. University of Rochester Roundtable on Corporate M&A and Shareholder Value", *Journal of Applied Corporate Finance*, Fall 2005, pp. 64-84. Dobbs, Nand and Rehm, "Merger Valuation", *The McKinsey Quarterly*, 2005 Special edition, pp. 67-73.

transfer money to KRG partly because of the war with ISIL. However, KRG have also had expenses related to terrorist threats in the area and the development of social functions and governing systems. In August, KRG announced a plan to pay DNO monthly from September to cover their operating costs and increase the amounts so they can pay off the outstanding liabilities from 2016. In September, the Natural Resources Ministry announced to KRG it had authorized the first tranche of regular payments to E&P companies in Kurdistan as USD30m were headed to DNO. We believe KRG realise this is required for further investments in the region. KRG estimates an average production of 600k boepd in 2015. Assuming a monthly KRG budget of USD750m and ignoring KRG revenues from taxes, oil price at USD42/bl. is required to balance the budget. As KRG has managed to improve its financial situation by scaling up independent sales to compensate for budget shortfall from Iraqi, we believe KRG is able to pay DNO. With KRG`s incentives and increasing ability to make payments for running exports, we believe this is a start of rebuilding credibility around regular payments. **Conclusion:** With a market capitalization of USD1.08bn and DNO estimate of USD947m in undiscounted outstanding receivables to KRG, we do not believe export payments is reflected in valuation. When sanctions against Iran are lifted, DNO is well positioned to enter the market and with the expertise and infrastructure in place, Iran entry is also a potential trigger.

**Panoro Energy - Buy**

Panoro Energy is a small oil company with two assets. It owns 30% of the producing Dussafu asset in Gabon and 14% in the Aje field in Nigeria, which is set for production start-up at the end of January 2016. Panoro Energy expects production rates of around 1,100 boepd net to the company (9,000 boepd gross). Despite a tight funding situation with USD13m of USD17.1m cash balance committed to the Aje development, we believe Panoro Energy can establish a debt facility with attractive terms as Aje can serve as collateral. After evaluation of seismic data, Panoro Energy reports gross un-risked resources at the Dussafu prospect in Gabon above 1m barrels and four locations high-graded for potential exploratory drilling in 2016. Panoro Energy can thus farm down some of its stake in Dussafu if terms are attractive. **Conclusion:** We believe start-up at Aje will increase visibility and narrow the discount to underlying values as investors look for on-going production in the current market environment.

**TGS-NOPEC Geophysical Company - Sell**

TGS-NOPEC Geophysical Company ("TGS") remains the seismic company with the best business model to tackle the on-going weak market. The company has no debt and a flexible cost base as it benefits from chartering cheaper seismic vessels from vessel owners. However, as a market leader within multi-client ("MC")[12], which declined by 28% from 1H14 to 1H15, it is indeed affected by the weak market. When a seismic company shoots MC, MC amortization is decided from how well the seismic company expects the survey to sell. There is a time gap between when a survey becomes a non-performer to when a seismic company has to book a write-down to prevent this survey from remaining on the balance sheet. In November 2015, TGS announced USD150m impairment in its MC library. Since 1Q06 TGS has booked an average MC amortization of 42%. In the same period it has sold its MC investments 1.8x. The sales performance would imply an MC amortization of 56%. If MC amortization should have matched sales performance, the EBIT should have been USD846m lower. An impairment of USD846m, above the USD150m booked in November, would be needed in the TGS library to adjust accounting to sales performance using the last ten years as a proxy. In 2012 and 2013 when oil prices were above USD100/bl. and the sales outlook were positive, they invested high amount in MC seismic. They continued with this in 2014, even if E&P companies decreased exploration spending. Now, TGS is stuck with expensive MC libraries on the balance sheet it try to sell to E&P companies, which have less to spend on MC seismic. **Conclusion:** Even though MC impairments are less of an issue as they are non-cash and TGS is a debt free company, investors still look on earnings multiples and price to book metrics within seismic. Therefore, we believe impairments are negative for the share price.

**Petroleum Geo-Services - Sell**

Petroleum Geo-Services ("PGS") have no issues in this market given available financing in Japanese export credit and revolving credit facility, on our estimates. However, we believe the booked MC Library of USD807m is inflated. Since 1Q06, PGS has amortized its MC library with an average MC amortization of 46%, expecting to generate 2.2x on MC investments. Simultaneously, PGS has realized 1.7x sales on their MC investments, implying an MC amortization of 50% would have been needed if amortization were to match sales performance. This would result in USD659m in increased MC amortization, MC book value of USD148m, a discount of 82% compared to current values. **Conclusion:** We expect PGS to report large impairments going forward and are inclined to have a negative view on the stock.

[12] The multi-client library consists of seismic data surveys to be licensed to customers on a nonexclusive basis.

**Spectrum – Sell**

Spectrums MC strategy focus on establishing oil and gas regions and frontier[13] areas with 2D seismic. Spectrums small size makes it vulnerable for quarterly fluctuations and the reduction in exploration spending among E&P companies in frontier areas in particular makes the company even more exposed. Spectrum signed in September 2015 an agreement with the government of Somalia where the company received the exclusive right to acquire up to 28,000 km 2D MC seismic off the coastline. We expect frontier areas like Somalia to see steeper cut backs into 2016 and 2017 than mature areas such as the North Sea and US GoM. Consensus expects Spectrum not to cut dividend and achieve a YoY revenue growth of 24% in 2016. In June, Spectrum announced they had acquired Fugro`s MC library for USD115m, below book value of USD178m. We view the debt repayment schedule of 15 months to be too aggressive given our modelled cash flow in Spectrums and expect a renegotiated structure, as the company will run out of cash in the second half of 2016. **Conclusion:** Based on the too aggressive debt repayment schedule, we assume Spectrum to cut dividend, which in our view is negative for the share price.

**Subsea 7 - Neutral**

As illustrated in table 5 below, investing in Subsea 7 is mainly getting exposure to subsea spending in Petrobras, Total and Statoil. These customers represent more than 50% of contract value announced since 2006.

*Table 5 – SUBC top 10 customers*

| # | Client | SUBC Contract Awards (2006-2014, USDm) | % of Awards | E&P Spending 2015 vs. 2014 | E&P Spending 2016 vs. 2015 |
|---|---|---|---|---|---|
| 1 | Petrobras | 9364 | 30% | -26% | |
| 2 | Total | 3976 | 13% | -4% | -15% |
| 3 | Statoil | 2928 | 9% | -13% | |
| 4 | Shell | 2521 | 8% | -16% | 17% |
| 5 | BP | 2290 | 7% | -16% | 26% |
| 6 | Chevron | 2278 | 7% | -12% | -16% |
| 7 | ExxonMobil | 2005 | 6% | -16% | 0% |
| 8 | Tullow | 500 | 2% | -10% | |
| 9 | ConocoPhillips | 480 | 2% | -33% | 0% |
| 10 | BG | 465 | 1% | -31% | |
| **Average** | | | | **-18%** | **2%** |

The top 10 customers of Subsea 7 have guided an average decline in 2015 E&P spending of 18% compared to 2014, below the industry average of 23%. In 2016, E&P spending is set to increase with 2% for this group on average, which indicate moderate top line expectations for Subsea 7 compared to other sub-sectors. The key markets for Subsea 7 in the same period (2006-

[13] Frontier areas are considered remote regions, far from markets and established infrastructure, and in harsh climates or difficult environments, including water depths in excess of 200 meters (Offshore-mag, 2015).

2014), have been Brazil, North Sea and Angola with 31%, 17% and 15% share of the total contract value, respectively. We therefore believe the key is to look for the three combinations, Petrobras in Brazil, Total in Angola and Statoil in Norway when screening future subsea projects. SpareBank 1 Markets track 91 subsea projects globally. On this list we find 18 projects matching the characteristics, which we view as positive. However, Subsea 7 has currently seven pipe lay support vessels on contract for Petrobras off Brazil. Given the smaller size of Brazilian built vessels, two vessels could potentially be blocked by the Brazilian regulation (Seven Condor and Normand Seven). These vessels contribute with USD81 per vessel per year in estimated revenues for Subsea 7. **Conclusion:** We exclude only one vessel in our SUBC estimate and are inclined to have a neutral view on the stock due to marginally positive project outlook.

**Aker Solutions - Sell**

Historically, Brent oil price and Aker Solutions revenues shows a correlation of 0.87. Spending from the three main clients (Statoil, Petrobras and Total) show a correlation of 0.92 with Aker Solutions revenues. However, there is low correlation between revenues and EBITDA margin. We believe the key to high margins for Aker Solutions is delivering projects as bid. Aker Solutions operates not only within subsea, but has operations within engineering and maintenance, modifications and operations (MMO). The subsea business unit accounted for almost 60% of total revenue and 70% of EBITDA in 2014. The main competitors for Aker Solutions subsea division are FMC Technologies, One Subsea, Drill-Quip and GE Oil & Gas. In 2004, AKSO had subsea revenues of USD1.1bn, above FMC at USD1bn. In 2014, FMC had subsea revenues of USD4.7bn compared to Aker Solutions USD2.7bn. Customers clearly preferred the subsea equipment from FMC. **Conclusion:** We believe this trend will reinforce itself going forward as a larger installed base for its competitors will also drive aftersales. And as aftersales and services have larger margins compared to new equipment, we believe Aker Solutions will underperform compared to peers, which is negative for the share price. Moreover, according to SpareBank 1 Markets, Aker Solutions is deemed as front-runner for subsea equipment contracts in zero of the 91 globally tracked subsea projects.

**Aker - Buy**

Aker is an industrial investment company specialized in the oil and gas, seafood and marine biotechnology sectors and has, among other, 34.8% in Aker Solutions, 34.5% and 50% in Det Norske Oljeselskap. Aker is trading on a 43% discount to net asset values (NAV), above historic median of 38% (Bloomberg, 2015) compared to Investor AB and Kinnevik AB below historic discount to NAV at 8%. **Conclusion:** With a well-diversified portfolio of assets and a cash balance of NOK2.9bn, we believe the company is positioned to acquire cheap assets in the current down cycle and find the discount to peers unwarranted. On our estimates, Aker is able to generate NOK8.7 per share in cash per year pre debt repayments in 2016 and 2017. Pricing on yield in line with historical average of 5%, imply NOK219 per share above the current share price.

**Seadrill - Sell**

Seadrill is well positioned given its high backlog and fleet quality with average age of 8 years, but we are worried about the financial leverage and long-term liquidity shortfall. We think Seadrill have to prioritize strengthening the balance sheet. Steps have already been initiated with cut in dividends prolonged newbuilding capex. We estimate no capital needs before 2017 assuming no un-contracted floaters delivered in 2016, as operating cash flow and cash at hand will cover USD2bn of scheduled debt maturities. Assuming most out of the 14 newbuildings delivered during 2017, we estimate a funding need of USD5.5bn, of which USD4bn related to newbuildings. Without delivery of newbuildings, we end up with a funding gap of USD1.6bn, as new rigs do not add material positive cash flow. Even if Seadrill manages to cancel its Daewoo Shipbuilding & Marine Engineering ("DSME") drillships and the Rigel floater from Jurong Shipyard in Singapore, we expect these yards to contest cancellations, pushing out repayment of potential refund guarantees. **Conclusion:** With an absent and unexpected market recovery into 2017, we think there will be need for a larger equity injection to fund some of the funding gap, which would drive dilution of existing shareholders.

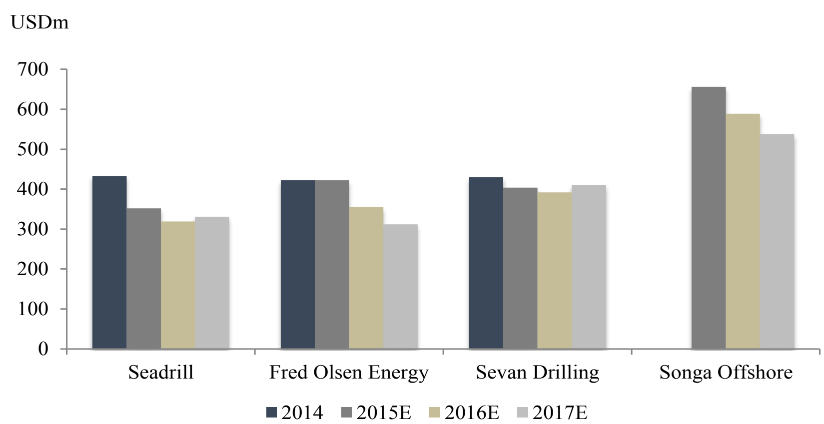
**Fred Olsen Energy - Sell**

With poor order backlog, only two rigs contracted beyond 2017, we view all remaining nine rigs at risk due to the high average fleet age of 25 years in Fred Olsen Energy. Belford, one of Fred Olsen Energy's rigs completed its 100-day yard-stay, as the last special periodic survey (required classification to continue operate the rig) near-term. Our main concern relates to re-deployment of this rig. Bredford, Borgholm and Borgny are stacked and as demand recovery is unlikely, we believe Belford, Byford and Borgsten will be permanently stacked. Byford rolls off contract in 2016, Statoil is expected to release Bideford in early 2017 and Borgsten will struggle to secure more work beyond its Total contract. Moreover, Chevron cancelled Bollsta, a newbuilding scheduled for a 5-year contract on the delayed Rosebank field and Borgland will roll off contract in 1Q17 instead of 4Q17. **Conclusion:** We believe Fred Olsen Energy will become a 1-3 rig company where 7-9 rigs will be cannibalized and struggle to identify positive triggers and see only downside in long-term earnings capacity.

**Songa Offshore - Sell**

With seven floater rigs, where two are newbuildings and three are more than 30 years and off contract during 2016, the financial situations in general and liquidity in particular is the key issue in Songa Offshore. With fully funded NIBD of USD2.7bn matching Bloomberg consensus gross asset value, equity value in Songa Offshore is questionable. Given the debt-loaded balance sheet, we view new equity as the only alternative, which will represent a dilution for existing shareholders. While this will remove near-term liquidity concerns, the capital structure will remain fragile and we think it will force restructuring, including conversion of bond debt to equity, resulting in more dilution. This is further pressured by the need of USD100m in liquidity through 2017 in the wake of the expected release of the three incumbent rigs Trym, Delta and Dee. Trym, Dee and Delta are due for rollovers in 2016, and with low visible demand in Norway, we view redeployment of all rigs unlikely. If work is secured for all rigs we expect cash shortfall in late 2016, as we do not expect potential work to justify the USD75 to USD100m special periodic survey cost for Delta. On top of this comes a potential liability from the dispute with DSME over the price tag of the four Cat-D rigs (World Maritime News, 2015). **Conclusion:** Based on high redeployment risk, near-term liquidity concerns as a result of the high debt per ultra deepwater equivalent from figure 17, we have a negative view on the stock.

*Figure 17 – Debt per ultra-deepwater equivalent*



**Sevan Drilling - Sell**

Sevan Drilling consist of three floater rigs and one floater newbuilding. With an NIBD of USD423m per rig compared to average offshore construction cost mid-2013 of USD500m, we see limited equity value for shareholders, even if we assume cancellation of the newbuilding Developer and repayment of the USD105m refund guarantee. According to Sevan Drilling (2015), the Developer rig remains ready for delivery in China. In light of the 4-step deferral agreement[14] with the shipyard, we think a cancellation is unlikely before late 2017. Delivery of Developer is also unlikely, even if contract is secured, as current day rates would not allow for sufficient debt financing of the remaining USD425m capex. We therefore assume Driller to be stacked, clearly negative for the long-term earnings potential. Moreover, assuming stable operations, the remaining USD160m Seadrill revolving credit facility will allow for sufficient cash until maturity in 4Q16. However, we view the long-term capital structure unsustainable as debt amortization exceeds cash flow generated from three rigs. **Conclusion:** We therefore view debt restructuring imminent and equity injection necessary to get banks on-board - diluting existing shareholders. If the floater rig Driller does not get renewed with Petrobras during 1H16 or corruption probes in Brazil culminates in contract cancellation or financial penalties, debt restructuring will accelerate.

**Prosafe - Sell**

Prosafe is the world's leading owner and operator of accommodation vessels[15]. The company owns and operates 12 semi-submersibles and has three newbuildings under construction. In the current market, there is risk of at least one of the China newbuildings not securing contract during 2016. In such scenario, we estimate Prosafe to breach debt covenants. Moreover, supply outlook remains challenging with an order book of 60% of the current fleet. We believe the fierce competition will trigger stacking and/or crapping. Prosafe also need to fill backlog on 11 out of 15 units in 2017. In combination with low tendering activity and cutback in E&P spending, we expect this to result in a drop in utilization and rates in 2017 at the expense of margins. **Conclusion:** With few positive triggers, we think focus will remain on a weak market and limited earnings visibility beyond 2016. On top comes the counterparty risk and delayed

[14] Delivery of Developer was deferred for 12 months with mutually agreed options, exercisable at 6-month intervals, to extend the delivery date for up to a total of 36 months from October 2014.

[15] Accommodation vessels are used wherever there is a need for additional accommodation, engineering, and construction or storage capacity offshore.

payments related to the five Pemex unites in Mexico, which could culminate in need for new equity or expensive debt when the NOK500m bond matures in 1Q17.

**Siem Offshore - Sell**

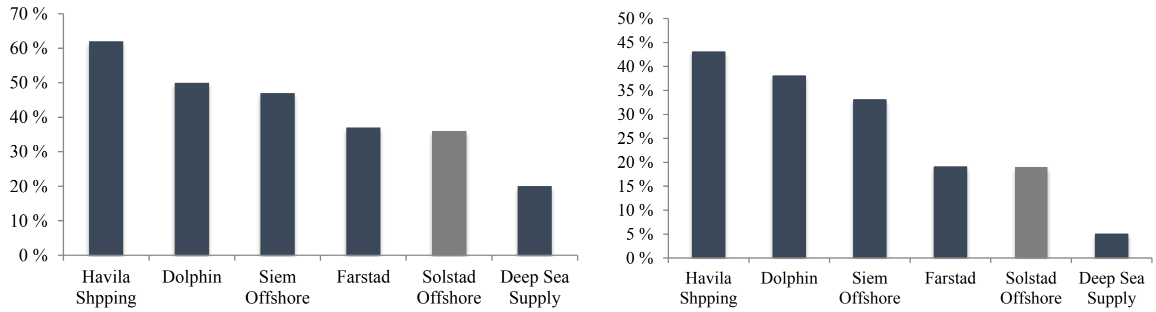
Siem Offshore received approval from its shareholders at an extraordinary general meeting in August 2015 for a rights issue of USD100m, fully underwritten by the largest shareholder Siem Europe Sarl. Siem Offshore also received approval from banks for extension of a NOK2.5bn credit facility for six AHTS newbuildings, which was due to expire in November and easing of certain covenant requirements (TradeWinds, 2015). This highlights the importance a strong owner and illustrates Siem`s willingness to act to weather a downturn. With nine out of ten large AHTS vessels without contract and North Sea and spot rates below opex, we estimate a negative EBITDA contribution from this segment, more AHTSs to be stacked and decreased earnings capacity long-term. **Conclusion:** Based on decreased earnings capacity and as the AHTS segment accounted for 40% of EBITDA in 2014, we are worried whether the steps taken to strengthen the balance sheet is sufficient and have a negative view on the stock.

**Solstad Offshore – Neutral**

45% of the Solstad Offshore fleet consist of construction support vessels (CSC[16]) and the business unit accounted for 60% of EBITDA in 2014. In august 2015, a customer of Solstad Offshore extended the contract for the CSV Normand Installer with minimum 200 days in 2016 and Solstad Offshore signed two new contracts for CSV Normand Baltic, securing 180 days from August. Day rates were undisclosed but Upstream (2015) indicate solid margins on new contracts, which is a positive sign. However, as illustrated in figure 18 below, in terms of contract coverage calculated as number of days, Solstad Offshore is in worse shape. Only 36% and 19% of working days in 2016 and 2017 respectively, is secured YTD, which is clearly negative.

[16] CSCs are used to support complex offshore construction, installation, maintenance and other sophisticated operations (Maritime-connector, 2015). CSV`s are also larger and more specialised than other offshore vessels.

*Figure 18 - Contract coverage calculated as number of days in 2016 (LHS) in 2017 (RHS)*




Solstad Offshore will generate NOK1.65bn in operational cash by 2017 compared to debt amortization of NOK2.5bn, excluding bank balloons and bond debt of in total NOK1.3bn on our estimates. Solstad Offshore has refinanced bank balloons redeeming in 2015, and is in discussions with banks on refinancing the 2016 debt. Assuming Solstad Offshore repay the NOK700m bond in February 2016, Solstad Offshore needs to find a solution to its current debt amortization profile. **Conclusion:** We believe new equity and/or expensive debt in 2017 is likely and believes bondholders of SOFF03 and SOFF04 are better positioned and prefer debt to equity.

**Deep Sea Supply - Buy**

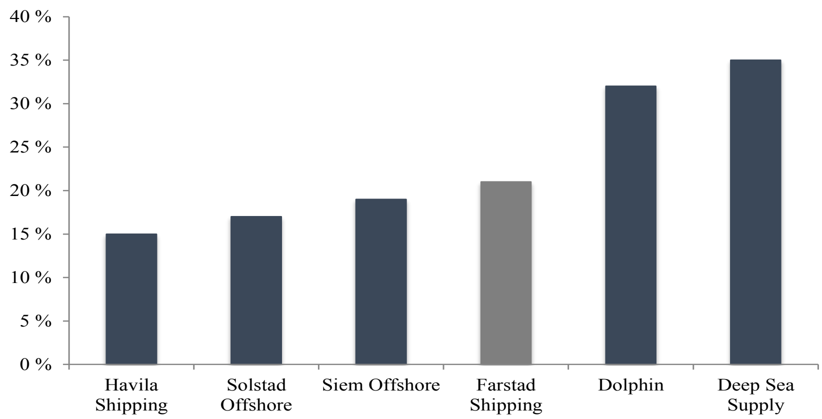
During autumn 2015, a number of Deep Sea Supply contracts have been cancelled, six vessels are blocked in Brazil, 10 PSVs are in lay-up and more vessels will follow. With only 23% of the fleet contracted in 2016 and LTV increasing as asset values continue to slide (Clarkson's, 2015), we see increasing refinancing risk related to the USD117m bank balloon redeeming in October 2016. However, low cash break-even, option-like pricing, and large discount to underlying values supports a positive view on the stock in our opinion. Compared to most other OSV companies, we argue Deep Sea Supply will maintain a comfortable cash balance throughout the current downturn, due to the low cash break-even level compared to peers. Deep Sea Supply has a favourable amortization profile, no newbuilding capex and no bond debt and can therefore bid lower than peers in order to secure utilization on vessels, which we view as a competitive advantage. On our estimates, we assume average PSV and AHTS day rates for Deep Sea Supply vessels to drop 15-20% and expect another three vessels to be laid up from the current level of ten. For the remainder of the fleet we assume utilization of 70%, which imply almost one-third of its vessels will remain idle post contract at full opex level. However, Deep Sea Supply will still maintain a comfortable cash balance in this scenario. **Conclusion:**

Based on a comfortable cash balance even on conservative estimates during this downcycle, we have a positive view on the stock.

**Farstad - Sell**

Petrobras is cancelling tenders and pushing for renegotiation of existing charters. We view this counterparty risk as a material disadvantage for Farstad, which according to figure 19 below, have more than 20% of its fleet contracted to Petrobras. Deep Sea Supply has an advantage in low cash break-even if rates should be lowered and Dolphin enjoys the competitive advantage of having 15-17 vessels with Brazilian flag when competing for new contracts or when negotiating on extensions.

*Figure 19 - % of fleet contracted to Petrobras by company*




Farstad has also a high fleet age compared to peers and is one of the companies within the OSV sub-sector with highest spot exposure. According to Farstad, 17 vessels are currently spot or listed on short-term contracts in the North Sea (5), Singapore or Australia (9), and in Brazil or South America (3). For these vessels we assume a utilization of 20-65% depending on region and age. Deep Sea Supply need to cut dividends to zero in 2016 to avoid adding additional cash, which we view as negative in the current low interest rate environment. Moreover, refinancing risk remains high should vessels in Brazil be block or stacked. **Conclusion:** Based on high fleet age, high spot exposure and large part of the fleet contracted to Petrobras, which is cancelling tenders and pushing for renegotiation, we have a negative view on the stock.

### 4.2.1 Valuation Summary

The main argument for performing a historical financial analysis is to gain insight into the underlying economic conditions in a company so it can be used to prepare an accurate future budget estimating the companies' future cash flows. However, E&P and oil service are both cyclical industries highly dependent on a commodity. As these industries are in the middle of a crisis, we argue historical results over the last years are not comparable to the current market environment or the short-term market outlook. The future cash flow projections in our 19 excel models are therefore based on the market and company analysis in section 4 and 5, not on historical normalized numbers.

In our industry analysis we argue the current downturn will last into 2017 and as E&P and oil service are cyclical industries, we assume the companies on average to reach mid-cycle state in 2020, growing at a constant rate and earning a constant rate of return (Dobbs and Koller, 2005). Therefore, the explicit forecast period in our future cash flow projections last until 2020. However, the FTE model is a two-periodic model, which incorporates an explicit forecast period and a terminal value. We use a mid-cycle median industry exit P/E multiple for each respective sub-sector extracted from Bloomberg (Chadda et al., 2004). We believe using mid-cycle exit multiples is the most appropriate approach as using a multiple from the bottom or top of the economic cycle would undervalue and overvalue the companies, respectively.

In the long-run companies in the same industry typically have similar expected growth rates, profitability and risk and multiples are likely to be relatively homogeneous across companies in an industry, and potentially as reliable as estimating the value based on an explicit forecast of distant cash flows (Bodie et al., 2010). We apply a relative valuation intended as a supplement to the FTE method to determine the target price and believe it will help test the plausibility of the FCFE forecasts. For a cyclical company, earnings at any given time are not a good proxy for future cash flows, in which a normalized figure better represents the company's long-term earnings power. We therefore use a historical mid-cycle median industry P/E multiple to determine the target price.

Findings from the valuation are presented in table x below. Our estimates of the cost of equity is an implicit future cost of equity ("COE") extracted on the basis of our FCFE estimates, which is based on 19 extensive excel models and the strategic and financial analysis above, and the market value of each company today - i.e., which required COE, based on our FCFE estimates, yield the prevailing market value of the companies'.

The markets assessment of cost of equity is calculated on the basis of the one-year forward earnings yield, i.e. the normalized Bloomberg consensus earnings per share for 2016 divided by the current market price per share assuming zero present value of growth opportunities. The earnings yield is used by investment managers to determine optimal asset allocation and is basically the inverse of the P/E ratio. If we assume a firm pays 100% of its earnings in dividends, the share price using GGM with growth (g) equal to zero is

$$P_0 = EPS_1/R_e \tag{3.1}$$

*Table 5 – Results from the valuation (Share price as of 01.09.15)*

| | | | | | Market Pricing Inverse P/E | | Our Estimates of Implied COE** | |
|---|---|---|---|---|---|---|---|---|
| **Company** | **Share Price** | **Rec.*** | **Target Price** | **Upside to Target** | **Yearly** | **Monthly** | **Yearly** | **Monthly** |
| **Oil** | | | | | | | | |
| Statoil (STL) | 142.0 | Sell | 130.0 | -8.5% | 6.0% | 0.50 % | 5.6% | 0.46 % |
| Det Norske Oljeselskap (DETNOR) | 54.1 | Neutral | 55.0 | 1.7% | 11.1% | 0.92 % | 9.5% | 0.79 % |
| DNO International (DNO) | 9.2 | Buy | 15.0 | 63.0% | 9.3% | 0.78 % | 10.3% | 0.86 % |
| Panoro Energy (PEN) | 0.7 | Buy | 2.0 | 185.7% | 23.6% | 1.97 % | 58.5% | 4.87 % |
| **Seismic** | | | | | | | | |
| TGS-NOPEC Geophysical (TGS) | 178.0 | Sell | 155.0 | -12.9% | 5.5% | 0.46 % | 6.9% | 0.57 % |
| Petroleum Geo-services (PGS) | 39.8 | Sell | 37.0 | -7.0% | 12.1% | 1.01 % | 5.0% | 0.42 % |
| Spectrum (SPU) | 31.8 | Sell | 28.0 | -11.9% | 9.9% | 0.83 % | 6.9% | 0.57 % |
| **Subsea** | | | | | | | | |
| Subsea 7 (SUBC) | 69.0 | Neutral | 69.0 | 0.0% | 6.7% | 0.56 % | 11.4% | 0.95 % |
| Aker ASA (AKER) | 173.0 | Buy | 193.0 | 11.6% | 13.3% | 1.11 % | 29.7% | 2.47 % |
| Aker Solutions (AKSO) | 38.0 | Sell | 30.0 | -21.1% | 8.4% | 0.70 % | 5.8% | 0.48 % |
| **Drilling** | | | | | | | | |
| Seadrill (SDRL) | 55.7 | Sell | 40.6 | -27.1% | 25.4% | 2.12 % | 27.8% | 2.31 % |
| Fred Olsen Energy (FOE) | 50.4 | Sell | 25.0 | -50.4% | 31.9% | 2.66 % | 17.2% | 1.44 % |
| Songa Offshore (SONG) | 1.4 | Sell | 0.5 | -64.3% | 7.2% | 0.60 % | 24.4% | 2.03 % |
| Sevan Drilling (SEVDR) | 6.5 | Sell | 5.0 | -23.1% | 140.1% | 11.67 % | 43.5% | 3.62 % |
| **Supply** | | | | | | | | |
| Prosafe (PRS) | 23.0 | Sell | 18.0 | -21.7% | 27.1% | 2.26 % | 18.5% | 1.54 % |
| Siem Offshore (SIOFF) | 1.8 | Neutral | 1.8 | 0.0% | 57.1% | 4.76 % | 7.7% | 0.64 % |
| Solstad Offshore (SOFF) | 31.6 | Neutral | 28.0 | -11.4% | 42.1% | 3.51 % | 25.4% | 2.12 % |
| Farstad Shipping (FAR) | 23.9 | Neutral | 20.0 | -16.3% | 123.5% | 10.29 % | 4.9% | 0.41 % |
| Deep Sea Supply (DESSC) | 2.8 | Buy | 4.0 | 42.9% | 20.0% | 1.67 % | 11.8% | 0.99 % |

**Recommendations. **COE is Cost of Equity.*

## 5. Results

This section evaluates the performance of our four models of portfolio choice. The models are as follows: 1) Historical Return ("Historic"), which is based on estimated parameters directly from the historical return series, 2) Single-Index Covariance Matrix ("SIC"), which combines the historical mean with the Single-index beta-based covariance matrix. 3) Market-Implied Earnings Yield ("EY"), which incorporates expected returns from the inverse market-implied P/E multiple. It uses the historical estimated covariance matrix. 4) Black-Litterman ("BL") which incorporates subjective valuations from the previous section. Moreover, we will analyze the Mean-Variance ("MV") optimal tangency solution dictated by the models in a short restricted- and unrestricted case and employ ex ante and ex post measures of performance. We consistently use monthly figures, except in figure 20 and 21.

### 5.1 Assumptions

*Trading costs*

*We implement total trading costs in our one-period investment horizon*, without rebalancing, to give more accurate comparison across long and short portfolios. The costs consist of two parts, transaction (brokerage) cost and security lending cost. Since the investor in this thesis is a marginal investor, the transaction cost is 0.02%. We could have set 0.01%, but we use 0.02% to punish models that allocate over gross 100% harder (Sparebank 1 Markets, 2015). When investors sell a stock short, the investor is by law obligated to lend stocks from a security pool, administrated by SIX X-Clear[17], which hold the stock meanwhile the stocks are sold short. Thus, security-lending costs apply. We implement Sparebank 1 Markets' costs of NIBOR 3-month + 350 points, with a bottom threshold of 6% minimum yearly rate. Based on today's interest rate level, the lower threshold is reached. Therefore, the monthly (yearly) effective interest rate is 0.49% (6%). In addition, SIX X-Clear prohibits shorting in Spectrum and Sevan Drilling as the stocks have never been rented to the lending pool (Six X-Clear, 2015). We make the same assumption and constrain them in the optimization, $w_{SPU} \geq 0$ , $w_{SEVDR} \geq 0$. We further assume the indices can be traded via an Exchange Traded Fund ("ETF")[18] with costs of 0.01%, to implement risk-adjusted measures net of costs.

[17] SIX X-clear is the Central Clearing Part granting authority by The Financial Supervisory Authority of Norway to regulate clearing, risk management and settlement activities at Oslo Stocks Exchange
[18] ETF is marketable securities tracking an index to achieve the same return and risk profile as the index.

*OSLENX and Statoil constrain*

The Energy Index, OSELNX, consists of 90% Statoil and 10% of companies whose businesses are dominated by minor E&P, seismic, rig, drilling equipment and other energy related service and equipment. In addition, refining and/or transportation companies of oil and gas products are included, yet with a minor stake. Therefore, OSLENX is a good benchmark for comparison bets in oil-related stocks, although we find through the industry analysis, that Statoil is not a bet we want to engage. With insight in Statoil properties from the applied modeling frameworks, we know Statoil has attractive historic risk in a risk-averse MV-framework and equilibrium returns, $\Pi$ in BL, which should yield dominant allocation to Statoil. To limit impact of Statoil on the portfolios, we constrain the optimization problem to allocate maximum 40% in Statoil, $w_{STL} \leq 0.4$.The final portfolio will become more diversified and influenced by the subjective valuation opinions formed on the equities. Although, we are intentionally giving the modeled portfolios a boundary for how alike the portfolios are OSLENX, which may drive major differences in the performance. In addition, OSLENX is not tradable via an ETF, which makes it non-investable unless we structure the index fund our self and maintain continuously market weights through frequent rebalancing. This would trigger large transaction cost, thus drive expected return down. We also acknowledge the complex modeling effort of using the strategy, which is not the objective of this thesis. Nevertheless, we include the Energy index to keep track on our active bet against Statoil.

## 5.2 Single-Index Covariance Matrix

We illustrate the estimated covariance matrix, $\widehat{\Phi}$, by corresponding correlation matrix for comparison of cross-dependencies of assets. We emphasize the simplification will not interrupt the findings. We know all the resulting $\widehat{\Phi}$ is positive, as shown in table 6 below, since none of our estimated β's is negative.

By comparison with historic correlations in Appendix 1, we find the correlation fairly more cross-sectional stable and moderate. As SIC covariance structure only unify covariance in systematic risk taking, we might unintentionally eliminate common risk factors as day rates in supply and drilling or the degree of new oil reservoirs on ultra-deep water demanding services from Subsea-sector, which should drive engineering cost. Nevertheless, since CAPM and efficient investments rule, these occurrences are not systematic risk factors and thus irrelevant, and SIC has legitimacy.

To compare the SIC correlations with the Historic correlations, unsystematic risk contribute to increase correlation relative to the pure market driven correlations we roll out here. Moreover, the average sector correlations are reduced, compared to Historic. We see a reduction of 0.14, 0.02, 0.03, 0.18 and 0.24 in drilling, subsea, seismic, oil and supply, respectively. The reduction was highly expected due to elimination of sub-sector specific risk.

*Table 6 –Single-Index correlation matrix*

| | SDRL | FOE | SONG | SEVDR | SUBC | AKER | AKSO | TGS | PGS | SPU | STL | DNO | DETNOR | PEN | PRS | SIOFF | SOFF | FAR | DESSC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SDRL** | 1.00 | 0.08 | 0.04 | 0.22 | 0.20 | 0.45 | 0.18 | 0.37 | 0.32 | 0.14 | 0.40 | 0.20 | 0.10 | 0.27 | 0.13 | 0.21 | 0.14 | 0.15 | 0.19 |
| **FOE** | | 1.00 | **0.01** | 0.05 | 0.05 | 0.10 | 0.04 | 0.08 | 0.07 | 0.03 | 0.09 | 0.05 | 0.02 | 0.06 | 0.03 | 0.05 | 0.03 | 0.03 | 0.04 |
| **SONG** | | | 1.00 | 0.02 | 0.02 | 0.05 | **0.02** | 0.04 | 0.03 | 0.01 | 0.04 | **0.02** | 0.01 | 0.03 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 |
| **SEVDR** | | | | 1.00 | 0.12 | 0.26 | 0.10 | 0.22 | 0.18 | 0.08 | 0.23 | 0.12 | 0.06 | 0.16 | 0.08 | 0.12 | 0.08 | 0.09 | 0.11 |
| **SUBC** | | | | | 1.00 | 0.24 | 0.09 | 0.20 | **0.17** | 0.07 | 0.22 | **0.11** | **0.05** | 0.14 | 0.07 | **0.11** | 0.08 | 0.08 | 0.10 |
| **AKER** | | | | | | 1.00 | 0.21 | 0.45 | 0.39 | 0.17 | 0.49 | 0.24 | 0.12 | 0.32 | 0.16 | 0.26 | 0.17 | 0.18 | 0.23 |
| **AKSO** | | | | | | | 1.00 | 0.17 | 0.15 | 0.07 | 0.19 | 0.09 | 0.05 | 0.13 | 0.06 | 0.10 | 0.07 | 0.07 | 0.09 |
| **TGS** | | | | | | | | 1.00 | 0.31 | 0.14 | 0.40 | **0.20** | **0.10** | 0.26 | 0.13 | **0.21** | 0.14 | 0.15 | 0.19 |
| **PGS** | | | | | | | | | 1.00 | **0.12** | 0.34 | 0.17 | 0.09 | 0.23 | **0.11** | 0.18 | 0.12 | **0.13** | **0.16** |
| **SPU** | | | | | | | | | | 1.00 | 0.15 | **0.07** | **0.04** | 0.10 | 0.05 | **0.08** | 0.05 | 0.05 | 0.07 |
| **STL** | | | | | | | | | | | 1.00 | 0.21 | 0.11 | 0.29 | 0.14 | 0.23 | 0.15 | 0.16 | 0.20 |
| **DNO** | | | | | | | | | | | | 1.00 | 0.05 | 0.14 | 0.07 | 0.11 | 0.08 | 0.08 | 0.10 |
| **DETNOR** | | | | | | | | | | | | | 1.00 | 0.07 | 0.04 | 0.06 | 0.04 | 0.04 | 0.05 |
| **PEN** | | | | | | | | | | | | | | 1.00 | 0.10 | 0.15 | 0.10 | 0.11 | 0.14 |
| **PRS** | | | | | | | | | | | | | | | 1.00 | **0.08** | 0.05 | 0.05 | 0.07 |
| **SIOFF** | | | | | | | | | | | | | | | | 1.00 | 0.08 | 0.08 | 0.11 |
| **SOFF** | | | | | | | | | | | | | | | | | 1.00 | 0.06 | 0.07 |
| **FAR** | | | | | | | | | | | | | | | | | | 1.00 | 0.08 |
| **DESSC** | | | | | | | | | | | | | | | | | | | 1.00 |

*Bold correlation-parameters are marked to stipulate the negative correlations appearing with the historic method.*

## 5.3 Black-Litterman

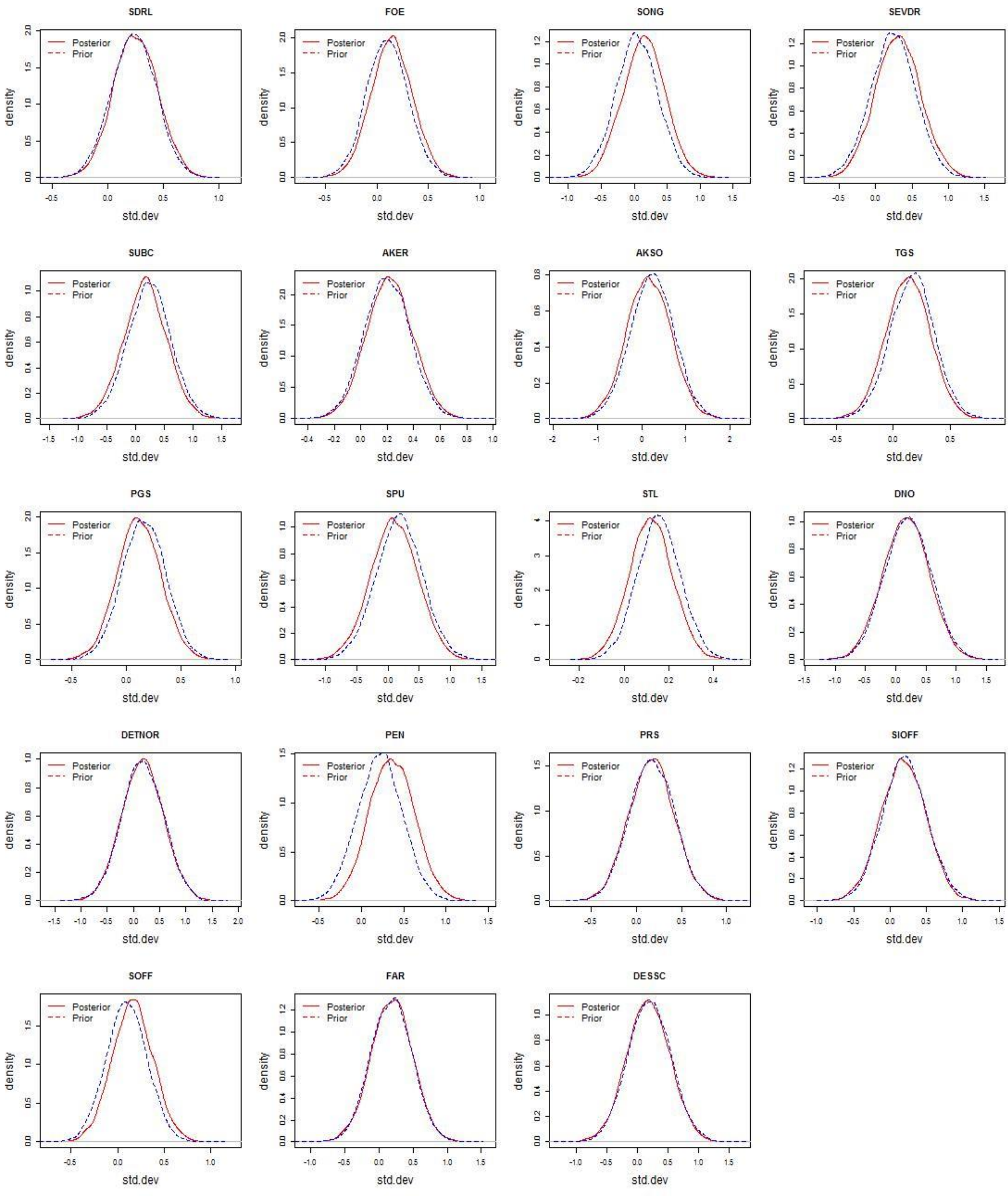
Firstly, applying the long restriction on Statoil will move allocation away from the prior market weights of the unconstrained optimization of the equilibrium returns, $\Pi$. And produce combined return vector not entirely affected by CAPM equilibrium and the view-vector, $Q$, but also by optimization technicalities. By doing this, we question the assumptions of BL, but we judge it as a necessity to produce portfolios incorporating our preferred bets.

The combined return vector, $\mu_{BL}$ is positive, unlike the rest of the frameworks (except EY), which is mainly due to the analyzed equities are interrelated through the oil price, yielding an overall positive correlation structure. In addition, our views are defined positive, which makes $\mu_{BL}$ non-negative. Moreover, the risk aversion coefficient, $\lambda$ has also influence on $\Pi$. $\lambda$ works as a scaling factor on $\Pi$, as we demand a higher return for a given risk level. Our estimated $\lambda$ is 4.87, which tilt the $\Pi$, relative to Litterman's model suggestion of 2.5. The relative weight of each asset in our sample will also tilt $\Pi$, as all hold the sample (market-) weights in equilibrium.

The views, $Q$, impact on $\mu_{BL}$ are vulnerable to especially $\tau$, which is a type of confidence in $Q$. We arrive at an estimate of 0.016, which means we put a relatively average confidence in our views as alternative methods of estimating $\tau$ suggests 0.025 or $1/N = 0.0125$. We emphasize that view variance, $\Omega$ is set proportional to $diag(\Sigma)$, where $\Sigma$ is the prior covariance matrix, which also scale $Q$'s impact on $\mu_{BL}$.

In figure 20, we observe the normal properties are intact and the views have not substantially changed the distributions as the posterior covariance matrix, $\Sigma_{BL}$ do not differ from $\Sigma$, although the difference between posterior, $\mu_{BL}$ and prior, $\Pi$ for some stocks is notable. We note the difference as $\mu_{BL}$- $\Pi$. Panoro has a positive difference from prior of 1.20%, mainly colored by the optimistic view. In Seismic, TGS differs with -0.31%, PGS with -0.38% and SPU with -0.67%. In the subsea segment, Aker Solutions differs with -0.63%. However, Solstad Offshore with 0.54%, Songa Offshore with 0.90%, Aker with 0.16% and Fred Olsen Energy with, 0.34% are viewed to perform to some extend better than the prior. Consequently, $Q$ influence $\mu_{BL}$ positively. For full list, see *Appendix 8*.

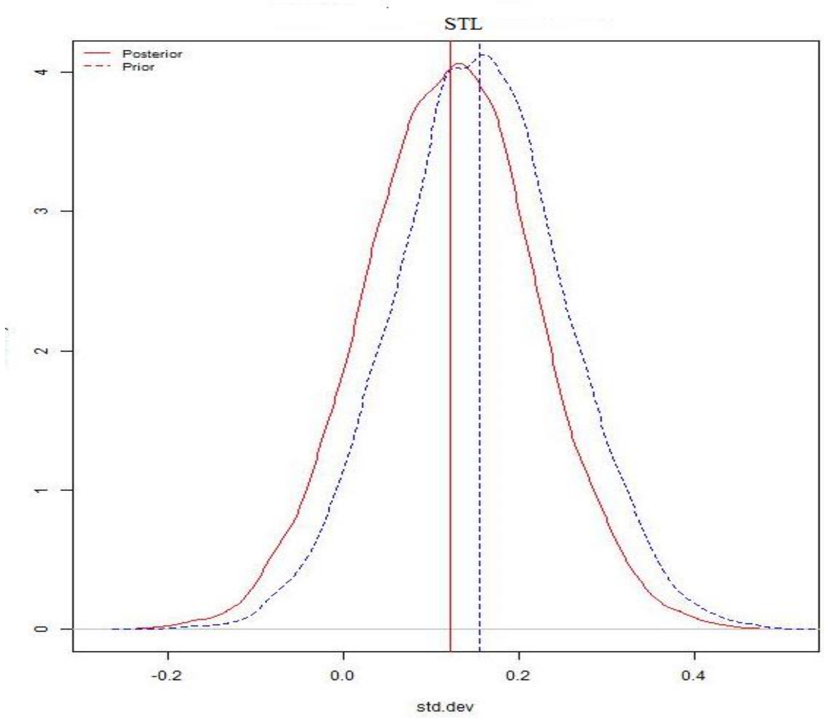
*Figure 20 – Probability density function of BL prior and posterior*




*Red line; Prior distribution $N(\Pi, \Sigma)$ ; constructed on the parameters of equilibrium returns and the historical variance matrix. Blue line; Posterior distribution $N(\mu_{BL}, \Sigma_{BL})$ ; constructed on the parameters of combined return vector and the view blended variance. The distributions are modeled with yearly data, leveraging from $Sd_T = Sd_t\sqrt{T}$ and $Er_T = T\ Er_t$.*

We analyze Statoil to give an example. In figure 21, we see the mean is moved with -0.29% from prior to posterior. The reason for this is $Q$, the views, impose a monthly expected return of 0.47%, while the prior, $\Pi$ impose an expected return of 1.3%. This is caused by a low implied cost of equity, $Q$ steaming from a sell recommendation, which move the posterior, $\mu_{BL}$ downwards from the prior. The low variance of Statoil, makes the $Q$ estimate precise, which lower $\mu_{BL}$ more than if the variance was high, because it makes it more certain that the $\mu_{BL}$ lies closer $Q$, according to Bayesian statistics. The large $\Pi$ is mainly due to the large Statoil weight (90%) in our sample and the low $\Sigma$ tilting equilibrium return. The reasoning is that CAPM optimal portfolios demand the equilibrium return of Statoil to be the optimal returns backed out from the reverse and unconstrained mean-variance optimization process. $\lambda$ also tilts $\Pi$, but are not extraordinary for Statoil and $\Sigma_{BL}$ are more or less equal to $\Sigma$.

*Figure 21 – Probability density function of Statoil - prior and posterior*




*Red line; Prior distribution $N(\Pi, \Sigma)$ ; constructed on the parameters of equilibrium returns and the historical variance matrix. Blue line; Posterior distribution $N(\mu_{BL}, \Sigma_{BL})$ ; constructed on the parameters of combined return vector and the view blended variance. The distribution are modeled with yearly data, leveraging from $Sd_T = Sd_t\sqrt{T}$ and $Er_T = T\ Er_t$.*

## 5.4 Portfolio Allocation

Portfolio weights and returns are presented in Table 8 and Figure *22*. Table 7 contains key-parameters of the equities.

### 5.4.1 Long Only - Markowitz

The long only restriction gives boundaries for exploiting high correlation structures with correspondingly negative returns across the analyzed equities. Thus, the allocation is more centered on assets generating the highest risk-adjusted return and foster less diversification. Moreover, the inherent CAPM diversification in the BL framework makes allocation more widespread than the other models. Thus, nine equities get allocation in the BL framework compared to three, six and five in Historic, SIC and EY, respectively. Wider allocation reduces the magnitude of firm-specific risk, which should foster more stability in portfolio returns according to MV-theory and favor BL.

There is some pattern of allocation across the models. BL puts most of the wealth in oil and drilling, while Historic and SIC favors seismic and subsea whereas EY favors drilling and supply. We will examine allocations to the sub-sectors in the following.

*Oil allocation*

EY and BL methods allocate to the sector, although not to the same assets. Statoil get a large allocation in BL of 27.39%, despite the sell recommendation, as the market weight of Statoil tilts the equilibrium return, $\Pi$. Conversely, the buy recommendation on Panoro results in an allocation weight of 22.7%, which is due to high Sharpe ratio of 0.21. EY allocates to DNO International and Det Norske Oljeselskap for the reason of low and negative correlation structure to the other assets in the portfolio. This is offset against the less-contribution of risk-adjusted return of DNO International and Det Norske Oljeselskap compared other equities having larger Sharpe's.

*Seismic allocation*

Historic and SIC allocate to seismic. 50% and 65% of the wealth are allocated in TGS for Historic and SIC, respectively. The reason is the high Sharpe at 0.23 and 0.18 for Historic and SIC. From EY and BL standpoint, there is no allocation to seismic due to unattractive Sharpes.

*Subsea allocation*

Aker is the most popular investment across the methods. Although our recommendation is buy, both Historic and SIC allocate more than BL. We claim this is in lack of more attractive risk-return profile of the equities, as the historic return profile has negative expected return on 13 of 19 stocks and small Sharpe for many of the other assets. From SIC perspective, Subsea 7 has a higher Sharpe at 0.13 compared to Aker and Aker Solutions at 0.08 and 0.10, respectively. Due to the large exposure, in TGS, the correlation structure is of importance. As Akers correlation is relatively low, a proportion is invested in Aker even though for low Sharpe compared in the sector. Further, BL have 16.45% allocation to Aker, which is in line with the positive view return, $Q$.

*Drilling allocation*

Each of the four equities is given a sell recommendation. Contradictory, we find BL allocate 24% of total wealth to the segment, distributed to all four equities. Seadrill and Sevan Drilling qualify to an allocation of 4.11% and 5.74% with a Sharpe of 0.19 and 0.15. Fred Olsen Energy and Songa Offshore get portfolio weights of 7.25% and 7.10%, with Sharpe's of 0.10 and 0.07. The reason for this is mainly due to low correlation against the other assets, where especially Songa Offshore is near zero-correlated to the other assets. In addition, the view return, $Q$ is relatively high in light of the sell recommendation. In the EY framework, Sevan Drilling has a Sharpe of 0.70 with a resulting weight of 39.13%, which in our opinion needs to be interpreted as artificial high, and therefore with precautions.

*Supply allocation*

PRS get 11.15% allocation in SIC and 0.98% in BL, both with a Sharpe of 0.10. In SIC, the allocation is mainly due to top-tier Sharpe ratio, whereas in BL, we observe a low or negative correlation. EY gives a large portfolio weight to Farstad with a Sharpe ratio of 0.63. Same precautions as for Sevan Drilling should be taken. An expected monthly return of 10.22% results in a high Sharpe ratio and the allocation of 46.28%. Even with a neutral recommendation and Sharpe of 0.11, Solstad Offshore gets a relatively high allocation of 8.28% in the BL framework, which is the highest within BL in the supply segment. This is mainly driven by a relatively high view return, $Q$ for the neutral recommendation given on Solstad Offshore, as we see equities with buy recommendation having lower view return, $Q$. Combining this with a relatively high equilibrium return, $\Pi$, particularly because of low correlation structure, yield allocation.

### 5.4.2 Short - Markowitz

When we loosen the assumption of shorting, we should according to CAPM maintain a positive efficient frontier if we are in equilibrium state. As we find negative weights in the modeled tangency portfolios, we are deviating from equilibrium and alpha return is expected to revert to equilibrium state on individual stock basis (Roll and Levy, 2015). We analyze a composition of companies, having the same ambient drivers, thus we find opportunities of exploiting correlation structures. Yet, we arrive at broader portfolios, which triggers transaction- and lending cost. We also find negative expected returns for the Historic and SIC models allowing for expected arbitrage, which is a breach to equilibrium pricing.

18 of 19 stocks are being allocated to for all models, with a varying composition through the models. However, we see some general trends on aggregated sub-sector level. We see oil is beneficial as no of the models allocate less than 30% to oil. Moreover, we see all models except BL allocated with positive weights to seismic, all but EY allocates positive to subsea, only BL are positive to drilling and only EY are positive on supply. Lastly, the EY framework has the largest absolute allocations, which should foster instability.

*Oil allocation*

In the oil segment, Statoil is binding constrain of maximum allocation for Historic, SIC and EY, hence the allocation is 40%. The main rationale for high allocation to Statoil is low risk and high correlation structure to the rest of the assets, which makes it more attractive when correlation can be exploited to the full. Panoro is being short allocated within all models except BL, driven by negative Sharpe for Historic and SIC. Yet, for EY it is more likely to do with the positive extreme risk-adjusted returns Farstad and Sevan Drilling produce. Therefore, a need for equities too short to leverage from high Sharpe arises. Historic has a long position in Det Norske Oljeselskap. Considering the negative Sharpe, we find the correlations to other assets as extremely favorable.

*Seismic allocation*

We find TGS decisive for the BL model performance, as the other models are considerably long TGS with at least 30%. However, BL is short by 11.20%, which is compliant with the sell recommendation. A consensus conception on short preferences on PGS has to do with negative expected risk-adjusted return for the Historic and SIC, and near zero Sharpe in the two last models.

*Subsea allocation*

Historic reduces allocation with 23% compared to long only portfolio to the sub-sector, which is primarily due to reduction in Aker. We argue the reduction is due to inherent purpose of non-restricted optimization. With allowance for use of negative returns and correlation structures to offset risk and increase expected returns of equities are Aker relatively less favorable than in long only case. We find that SIC maintain high allocation to Aker due to a smoothened noise factor in the correlation structure.

*Drilling allocation*

EY allocate with a net exposure of 0.46%, apportioned on especially short Seadrill and long Sevan Drilling. Although we see the exposure fall on Sevan Drilling (with high Sharpe) from the restricted short case, the reasoning is similar to the above-mentioned Aker case for the Historic model. BL increase total drilling allocation with 14.48%. The increased allocation to BL is breaching with our view on the sector.

*Supply allocation*

In the supply segment, EY allocates approximate 107% long and 41% short. With a 100% investment in Farstad the model is even more vulnerable than in the long only portfolio. Farstad is shorted equity for BL and Historic, but not for SIC. The view returns, $Q$ in BL-framework corresponds with a negative allocation to supply. Although, Solstad Offshore have become a long exposure for BL, as the Sharpe is relatively high. SIC and Historic are exploiting negative return of Solstad Offshore to offset risk against other allocations.

*Table 7 –Key parameters of modeled equities*

| Company | Expected Excess return* | | | Standard Deviation** | | Sharpe Ratio | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Historic/ SIC | EY | BL | Historic/ SIC/ EY | BL*** | Historic | SIC | EY | BL |
| **Oil** | | | | | | | | | |
| Statoil (STL) | 0.27 | 0.43 | 0.94 | 0.05 | 0.05 | 0.05 | 0.02 | 0.08 | 0.18 |
| DNO International (DNO) | -1.59 | 0.85 | 1.38 | 0.20 | 0.20 | -0.08 | -0.06 | 0.04 | 0.07 |
| Det Norske Oljeselskap (DETNOR) | -0.92 | 0.71 | 1.38 | 0.21 | 0.21 | -0.04 | -0.04 | 0.03 | 0.06 |
| Panoro Energy (PEN) | -2.40 | 1.93 | 2.95 | 0.14 | 0.14 | -0.17 | -0.15 | 0.14 | 0.21 |
| **Weighted Average** | **0.20** | **0.45** | **0.96** | **0.06** | **0.06** | **0.05** | **0.01** | **0.08** | **0.17** |
| **Seismic** | | | | | | | | | |
| TGS-NOPEC Geophysical (TGS) | 2.38 | 0.39 | 1.01 | 0.10 | 0.10 | 0.23 | 0.18 | 0.04 | 0.10 |
| Petroleum Geo-services (PGS) | -1.45 | 0.94 | 0.91 | 0.11 | 0.11 | -0.14 | -0.11 | 0.09 | 0.09 |
| Spectrum (SPU) | 2.29 | 0.76 | 0.77 | 0.20 | 0.20 | 0.11 | 0.22 | 0.04 | 0.04 |
| **Weighted Average** | **1.29** | **0.57** | **0.97** | **0.11** | **0.11** | **0.12** | **0.10** | **0.05** | **0.09** |
| **Subsea** | | | | | | | | | |
| Subsea 7 (SUBC) | 2.04 | 0.49 | 1.35 | 0.20 | 0.20 | 0.10 | 0.13 | 0.02 | 0.07 |
| Aker ASA (AKER) | 1.63 | 1.04 | 1.75 | 0.09 | 0.09 | 0.18 | 0.08 | 0.11 | 0.19 |
| Aker Solutions (AKSO) | 1.84 | 0.63 | 1.32 | 0.26 | 0.27 | 0.07 | 0.10 | 0.02 | 0.05 |
| **Weighted Average** | **1.89** | **0.66** | **1.45** | **0.19** | **0.19** | **0.11** | **0.11** | **0.05** | **0.10** |
| **Drilling** | | | | | | | | | |
| Seadrill (SDRL) | -0.03 | 2.05 | 2.00 | 0.11 | 0.11 | 0.00 | 0.00 | 0.19 | 0.19 |
| Fred Olsen Energy (FOE) | -1.73 | 2.59 | 1.12 | 0.11 | 0.11 | -0.16 | -0.10 | 0.24 | 0.10 |
| Songa Offshore (SONG) | -2.79 | 0.53 | 1.17 | 0.17 | 0.17 | -0.16 | -0.21 | 0.03 | 0.07 |
| Sevan Drilling (SEVDR) | -2.66 | 11.60 | 2.51 | 0.17 | 0.17 | -0.16 | -0.25 | 0.70 | 0.15 |
| **Weighted Average** | **-0.28** | **2.13** | **1.91** | **0.11** | **0.11** | **-0.02** | **-0.02** | **0.20** | **0.18** |
| **Supply** | | | | | | | | | |
| Prosafe (PRS) | 1.04 | 2.19 | 1.34 | 0.13 | 0.13 | 0.08 | 0.10 | 0.17 | 0.10 |
| Siem Offshore (SIOFF) | -2.96 | 4.69 | 1.46 | 0.16 | 0.16 | -0.18 | -0.24 | 0.29 | 0.09 |
| Solstad Offshore (SOFF) | -0.64 | 3.44 | 1.28 | 0.12 | 0.12 | -0.05 | -0.06 | 0.29 | 0.11 |
| Farstad Shipping (FAR) | -0.52 | 10.22 | 1.50 | 0.16 | 0.16 | -0.03 | -0.03 | 0.63 | 0.09 |
| Deep Sea Supply (DESSC) | -1.81 | 1.60 | 1.39 | 0.19 | 0.19 | -0.10 | -0.14 | 0.08 | 0.07 |
| **Weighted Average** | **-0.11** | **3.28** | **1.37** | **0.14** | **0.14** | **0.00** | **0.00** | **0.23** | **0.10** |
| **Total Weighted Average** | **0.36** | **0.63** | **1.07** | **0.08** | **0.08** | **0.05** | **0.02** | **0.09** | **0.16** |
| **OSELENX** | **0.33** | | | **0.05** | | **0.06** | | | |
| **OSEBX** | **1.18** | | | **0.05** | | **0.23** | | | |

**Percentage expected return over risk-free rate on a monthly basis. **Monthly Standard Deviation***Estimated with excess return, as may give rise to small differences when there are many negative observations. We assume the problem is minimal due to a low risk-free rate.*

*Table 8 –Mean-Variance optimized portfolio weights*

| | Only Long | | | | Short | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Company** | **Historic** | **SIC** | **EY** | **BL** | **Historic** | **SIC** | **EY** | **BL** | **Rec.*** |
| **Oil** | | | | | | | | | |
| Statoil (STL) | | | | 27.39 | 40.00 | 40.00 | 40.00 | 37.78 | Sell |
| DNO International (DNO) | | | 0.64 | | 3.56 | -1.59 | 5.38 | -1.84 | Neutral |
| Det Norske Oljeselskap (DETNOR) | | | 9.95 | | 15.66 | 0.82 | 0.62 | -1.41 | Buy |
| Panoro Energy (PEN) | | | | 22.70 | -15.23 | -8.15 | -13.09 | 26.24 | Buy |
| **Sum** | | | **10.59** | **50.09** | **43.99** | **31.09** | **32.90** | **60.76** | |
| **Seismic** | | | | | | | | | |
| TGS-NOPEC Geophysical (TGS) | 64.45 | 47.06 | | | 57.91 | 29.43 | 37.61 | -11.22 | Sell |
| Petroleum Geo-services (PGS) | | | | | -23.54 | -9.10 | 5.70 | -8.08 | Sell |
| Spectrum (SPU) | | 2.35 | | | 1.94 | 4.37 | | | Sell |
| **Sum** | **64.45** | **49.41** | | | **36.31** | **24.70** | **43.31** | **-19.30** | |
| **Subsea** | | | | | | | | | |
| Subsea 7 (SUBC) | | 3.97 | | | -2.48 | 3.80 | -50.34 | 2.63 | Neutral |
| Aker ASA (AKER) | 35.32 | 33.44 | | 16.45 | 12.36 | 30.40 | 2.16 | 25.18 | Buy |
| Aker Solutions (AKSO) | 0.24 | 2.03 | | | 2.16 | 2.04 | 5.77 | -1.60 | Sell |
| **Sum** | **35.55** | **39.44** | | **16.45** | **12.04** | **36.24** | **-42.41** | **26.21** | |
| **Drilling** | | | | | | | | | |
| Seadrill (SDRL) | | | | 4.11 | -5.18 | -2.55 | -31.22 | 14.59 | Sell |
| Fred Olsen Energy (FOE) | | | | 7.25 | 3.89 | 8.76 | 0.66 | 5.61 | Sell |
| Songa Offshore (SONG) | | | | 7.10 | 1.37 | -0.63 | 4.87 | 7.05 | Sell |
| Sevan Drilling (SEVDR) | | | 39.13 | 5.74 | | | 26.16 | 11.44 | Sell |
| **Sum** | | | **39.13** | **24.20** | **0.08** | **5.57** | **0.46** | **38.69** | |
| **Supply** | | | | | | | | | |
| Prosafe (PRS) | | 11.15 | | 0.98 | 4.91 | 13.36 | -8.64 | 3.81 | Sell |
| Siem Offshore (SIOFF) | | | 3.99 | | -3.13 | -13.36 | 6.67 | -8.77 | Neutral |
| Solstad Offshore (SOFF) | | | | 8.28 | 29.48 | 5.74 | -18.28 | 14.09 | Neutral |
| Farstad Shipping (FAR) | | | 46.28 | | -9.89 | 0.26 | 99.94 | -12.33 | Neutral |
| Deep Sea Supply (DESSC) | | | | | -13.77 | -3.59 | -13.95 | -3.16 | Buy |
| **Sum** | | **11.15** | **50.28** | **9.26** | **7.59** | **2.40** | **65.74** | **-6.35** | |

*The weights are given in percentages. *Rec. is the recommendation for each of the assets.*

### *Sharpe ratio performance*

In figure 22, we evaluate the portfolios in ex ante environment with respect to Sharpe ratio criteria. Expected performance of BL is better than both the benchmarks in long case with a Sharpe of 0.25, but performers equal to OSEBX with allowance for shorting, which gives a Sharpe of 0.23. The peer-benchmark index OSLENX is expected to perform absolutely the poorest with a Sharpe of 0.09. This is mainly due to a low Sharpe of Statoil as Statoil accounts for 85% of the market capitalization of OSLENX benchmark. We also find the other portfolios are performing better than BL model, except for long Historic and SIC models. This is result is mainly due to the moderating abilities of the CAPM equilibrium returns, which removes noise attached to the estimates compared to historic calculated estimates and therefore lowers expected returns.

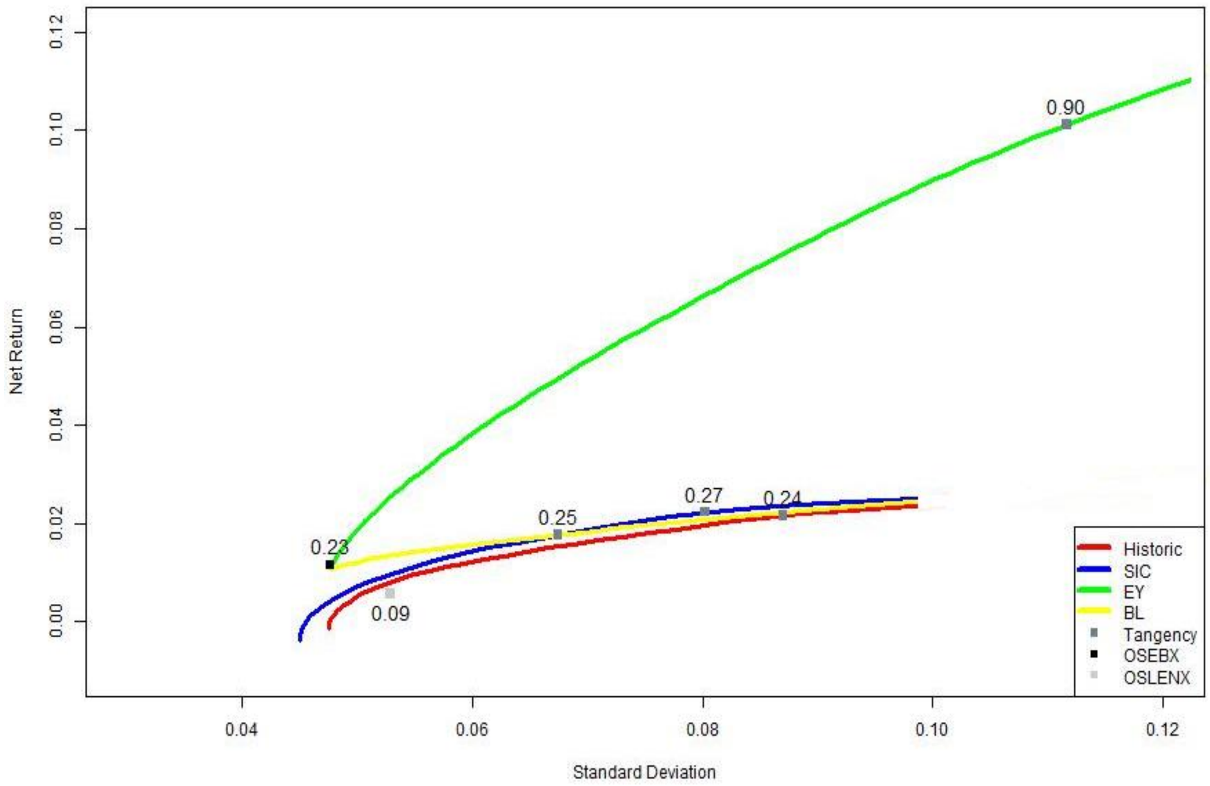
The Sharpe ratios indicate dominance of EY with Sharpe ratios of 0.90 and 1.14 in long and short case. High expected returns of Farstad and Sevan Drilling drives superior expected risk-adjusted portfolio return. The extreme return vector relates to high consensus earnings estimates[21] for 2016 in relation to the current stock price. We see the stock price have come down the last two years, whereas consensus estimates lag, making implied earnings yield increase correspondingly. The rational is that behavioral finance aspects influence irrational actions in investor's mind-set regarding these stocks, making valuations inconsequent and share prices to drop more than consensus estimates. Moreover, option-like pricing of the stocks can explain the economic rationale (Copeland and Antikarov, 2005). With market capitalization-to-enterprise value below 10%, the market expects the companies to either survive or end up in financial distress (Hotchkiss et al., 2008), which yields an extreme expected return if the companies survive.

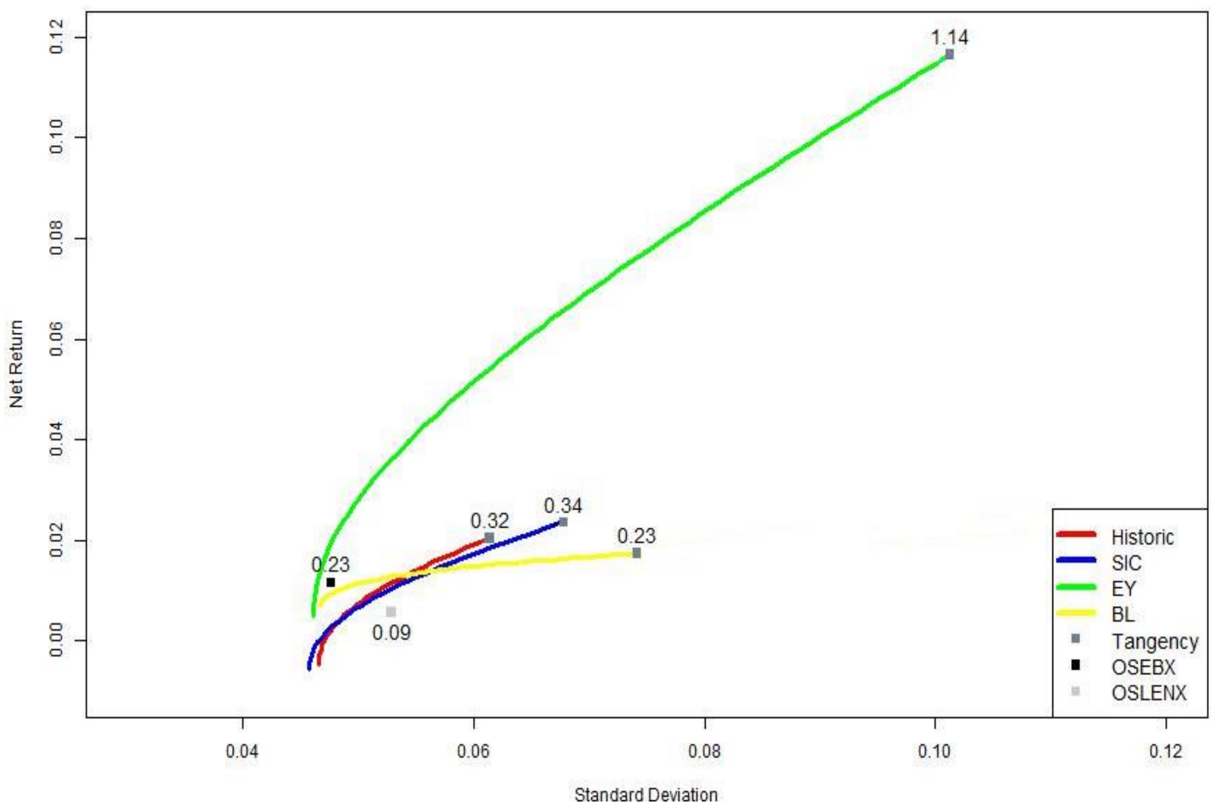
We find large differences in risk-adjusted returns. Short restricting the portfolios provides shrinkage of Sharpe ratio from the case where shorting are allowed. This finding is mainly due to reinforcement of the long allocations in the short strategy by going short the equities with low- /negative risk-adjusted return. This is especially evident for the Historic and SIC models which has negative returns for some equities. Negative returns foster expected risk-free return, which is meaningless in an equilibrium world. Since the analyzed equities have a high correlation the negative returns are even more decisive and tilt portfolio Sharpe ratios.

Even though the return vector dominate covariance input parameter in the optimization, we find that SIC with Sharpe of 0.27 and 0.34 in the long and short case are performing marginally better than Historic with 0.24 and 0.32 in long and short case. The portfolio allocations are nearly the same for both portfolios in under the same restrictions, yet the minor difference in expected Sharpe ratios are driven by reduced noise in the covariance matrix.

[21] Analysts are typically positively biased to pricing of stocks, i.e. earnings estimates.

*Figure 22 – Efficient frontiers- Upper: Long only – Lower: Short*




*Upper graph: illustration with restriction of shorting (Only Long). Lower graph: illustration when shorting is allowed. For all portfolios, the frontier starts at Minimum Variance portfolio. See Appendix 9 for the costs applied to short portfolio. For the short restricted portfolio, only transaction cost is applied with 0.02%*

*Information ratio performance*

Since our base is an efficient investor according to CAPM, we relate to Treynor-Black model thoughts of optimal active investing combined with a passive portfolio. We measure risk-adjusted level of stock picking by applying the IR with OSEBX as the tracking index.

In table 9, we find positive IR-ratios for all modeled portfolios, but only EY long and short are significant on 5% and 1% level[22] and therefore statistically robust. EY produce highly competitive active risk-adjusted returns, as the high unsystematic risk is offset by an extremely high alpha. Goodwin (2008)[23] view a monthly IR of 0.11 as above median performance, and IR above 0.19 and 0.32 within the $25^{th}$ and $5^{th}$ percentile. This places EY short and long in the top percentile. It places all the other portfolios above median, except Historic and SIC short strategy, which is expected to perform within the $25^{th}$ percentile. Therefore we establish a weak form persistence of outperformance on a risk-adjusted basis as we find all IR's above median threshold. The benchmark OSLENX obtains a negative IR of -0.20, which is within the $25^{\text{th}}$ percentile of poorest performers. This result is mainly driven by Statoil obtaining negative risk-adjusted $\alpha$ relative to OSEBX.

*Table 9 - Information Ratio.*

| | Long | | | | Short | | | | Benhmarks | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Measure** | **Historic** | **SIC** | **EY** | **BL** | **Historic** | **SIC** | **EY** | **BL** | **OSLENX** | **OSEBX** |
| **SR** | 0.244 | 0.271 | 0.901 | 0.250 | 0.324 | 0.344 | 1.139 | 0.232 | 0.094 | 0.234 |
| **IR** | 0.125 | 0.171 | 0.898 | 0.171 | 0.255 | 0.273 | 1.141 | 0.131 | -0.195 | |
| ***t(IR)*** | 0.323 | 0.441 | 2.320* | 0.441 | 0.659 | 0.705 | 2.947** | 0.339 | -0.503 | |
| ***α (%)*** | 0.72 | 0.89 | 9.09 | 0.86 | 1.23 | 1.41 | 10.99 | 0.78 | -0.626 | |
| ***β*** | 1.365 | 1.283 | 0.987 | 0.890 | 0.795 | 0.918 | 0.654 | 0.939 | 0.899 | |
| ***σε (P)*** | 0.058 | 0.052 | 0.101 | 0.050 | 0.048 | 0.052 | 0.096 | 0.059 | 0.032 | |

***Significant on 1 % level. *Significant on 5% level. OSEBX is the underlying benchmark and $\sigma_{\varepsilon p}$ is the unsystematic risk. To be consistent, we estimate ex-cost IR based on β approach as SIC and BL demand parametrically methods.*

We argue that expected performance based on ex ante figures is not reliable guidance for portfolio performance. Clark (2004) gives empirically support through his findings of in-sample performance is weak and misleading for true future performance. We will in the

[22] Significant values of IR current levels requires persistence over longer time than the data sample, as $t = IR_t\ \sqrt{T}$.

[23] We scale the Goodwin's yearly IR ratios to monthly equivalents by the factor; $\frac{1}{T/\sqrt{T}}$

following test our model performance under ex post environment, which recognizes true view- and modeling effort.

## 5.5 Out-of-Sample Testing

As we see in table 10, Sub-sector returns have evolved in a direction compliant with our sector views. Oil and subsea segments return 5% on average, seismic 3% and both supply and rig below 0%. Especially Panoro, Sevan Drilling and Farstad have large movements with 16%, -13% and 10%, respectively. This has large impact on portfolio performance for BL, which has a bet on Panoro, and for EY, which is betting on Farstad.

*Table 10 - Out-of-sample monthly return and std.dev (01.09.2015-29.11.2010)*

| | STL | DNO | DETNOR | PEN | TGS | PGS | SPU | SUBC | AKER | AKSO | SDRL | FOE | SONG | SEVDR | PRS | SIOFF | SOFF | FAR | DESSC | OSLENX | OSEBX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Return (%)** | 2.66 | -2.30 | 5.61 | 16.27 | 2.05 | 7.46 | -2.19 | 2.92 | 5.45 | 7.74 | 2.86 | -4.30 | 3.71 | -12.61 | 0.70 | -2.93 | -4.64 | 9.92 | -3.19 | 2.60 | 2.41 |
| **std dev.** | 0.10 | 0.14 | 0.14 | 0.21 | 0.11 | 0.16 | 0.08 | 0.13 | 0.89 | 0.16 | 1.30 | 0.20 | 0.20 | 0.14 | 0.15 | 0.13 | 0.23 | 0.23 | 0.16 | 0.09 | 0.06 |

*Sharpe ratio performance*

In table 11, we find low Sharpe ratios compared to the in-sample data set, which is due to increased variances as the oil price sensitivity have picked up. Moreover, the oil price has been highly volatile the last year. Ex-post portfolio return is on average higher than ex-ante emphasizing the large increase in risk when the net effect is negative for Sharpe ratios. OSEBX rose 2.41% a month, yielding a Sharpe of 0.22, which the modelled portfolios cannot compete with on a total risk level. Although it is clear distinction between EY and BL vs. Historic and SIC, affirming the poor forward-looking capabilities of the simple historic models. We see OSLENX yields the highest Sharpe, due to a Sharpe on Statoil of 0.26 and thus contradicting to both ex-ante performance and our fundamental valuation.

*Table 11 - Out-of-sample performance ratios (01.09.2015-29.11.2010)*

| | Long | | | | Short | | | | Benhmarks | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Measure** | **Historic** | **SIC** | **EY** | **BL** | **Historic** | **SIC** | **EY** | **BL** | **OSLENX** | **OSEBX** |
| **SR** | -0.044 | 0.002 | 0.047 | 0.002 | 0.018 | 0.025 | 0.134 | 0.106 | 0.257 | 0.222 |
| **IR** | 0.054 | 0.046 | -0.405 | 0.233 | -0.628 | -0.088 | 0.128 | 0.038 | 0.011 | - |
| ***t(IR)*** | 0.027 | 0.023 | -0.202 | 0.117 | -0.314 | -0.044 | 0.064 | 0.019 | 0.006 | - |
| ***α (%)*** | 0.032 | 0.030 | 0.000 | 0.042 | -0.030 | 0.012 | 0.053 | 0.029 | 0.014 | |
| ***β*** | 0.306 | 0.387 | 0.372 | 0.687 | 0.238 | 0.593 | 0.314 | 0.710 | 1.649 | |
| ***σ ε (P)2*** | 0.005 | 0.004 | 0.000 | -0.001 | 0.002 | 0.004 | 0.011 | -0.001 | 0.012 | |

*The ex-cost portfolio returns are calculated based on arithmetic log-returns on monthly basis and the standard deviations are based on daily returns and scaled according to $Sd_T = Sd_t\sqrt{T}$. We apply the numeric version of IR (excess risk and return), as beta- estimated unsystematic risk in such short time frame become negative, due to sensitive betas. The grey shading mark parameters not directly used in estimation.*

*Information ratio performance*

Long BL is performing the best of all portfolios with an IR of 0.23 and are within the 25th percentile according to Goodwin. Optimizing both the prior and posterior BL distributions, we find the views highly impactful on information ratio, as we lose 0.10 in IR when optimizing the prior. Although, looking at out-of-sample equity performance is Panoro highly contributing to IR with low relative market capitalization of OSEBX and high unsystematic return. If only the view return, $Q$ had been used, a greater fraction would be allocated to Panoro, as would increase performance. The reasoning for the actual allocation is the diversifying features of equilibrium return, $\Pi$, which reduce the expected return for Panoro, gives a lower allocation.

Short EY portfolio are performing second best with an IR of 0.13 and thus above the median percentile in Goodwins ranking. Mainly due to high performance of Farstad and the small market capitalization of Farstad in OSEBX, yielding a relative large impact on the portfolio performance. Therefore we find average of analyst estimates of short term earnings are therefore good predictor in a static P/E framework of ex post performance of Farstad. And since the overall portfolio contributes with positive unsystematic return, the EY portfolio arrives at positive IR. This is evident for stock picking skill in our Norwegian-listed, oil-related investment universe. On the flipside, the static P/E model may be the wrong equilibrium model, as cash flow models are most common on oil-related companies. In addition, the assumption of zero present value of growth opportunities may be wrong from the market participant's point of view. Both the latter imply Farstads performance is only luck and cannot be accredited to the model. This fact is backed by the poor performance of high allocation target, Sevan Drilling, which gives doubt to the model. Farstads performance can also be seen in a behavior or option-like pricing context (low enterprise value-to-market capitalization), as it is not implausible to see a stock gain high percentage recovery in a short period of time after declining more than 98% the past two years.

Short Historic and -SIC models perform poor with IR's of -0.42 and -0.09. Historic figures of returns contain a lot of noise, implying bad performance of average historic return vectors in optimization. We explain the finding with one expected part and one average error part in the return. Ex ante portfolios based on expected return and the average error part are outperformed by ex post portfolios, the true optimal allocation, only incorporating the expected part. As Historic and SIC contains both the expected part and the random part, they perform worst. This is also evidential for the long BL and short EY portfolios lies closer to the ex post portfolio, as our modelling and valuation effort gain information that reduce the error part of ex post returns.

### 5.6 Conclusion

In the out-of-sample testing period Long Black-Litterman model perform a monthly information ratio of 0.23, which is within the 25$^{th}$ historic best percentile according to Goodwin. Moreover, the information ratio is mostly driven by the views based upon the equity valuations. Especially Panoro has a high portfolio weight, small relative market capitalization and large out-of-sample Sharpe ratio are driving portfolio performance. The Implied Earning Yield model has a monthly information ratio of 0.13 and therefore above the Goodwin's median threshold of performance due to an extreme positive allocation to Farstad, in which is a high-performer in the out-of-sample period. Both the latter models beats the reference benchmark OSLENX on information ratio, therefore active management of a sub-portfolio in oil-related stocks on Oslo Stock Exchange generate excess return net of costs for an efficient and marginal investor. Our information ratio results are mainly driven by high relative weight in Statoil in the index. OSLENX gets outperformed with a monthly information ratio of 0.01, but the monthly Sharpe ratio of 0.27 is superior to all portfolios. The large Sharpe is mainly driven by the same reason as the low information ratio, the large fraction Statoil in the peer-index as well as in OSEBX. By constraining the portfolio optimization to actively deviate from peer benchmark OSLENX with restrictions on Statoil. We produce higher information ratio criteria than a passive peer index strategy, but it costs us reduced Sharpe ratio. We emphasize that the index is although more expensive to replicate in the market than we stipulate in our analysis.

### 5.7 Limitations

The most obvious limitation for our result is the length of the out-of-sample testing period. With three months, fundamental valuations may not materialize and the corresponding performance results can relate to noise and luck, and not persistency. For the Black-Litterman framework, the implied cost of equity backed out from discounted cash flow models is the basis for view vector, therefore the estimates are more of a long term character, which may imply the three month out-sample period is containing a lot of noise. In the next section, we extend our analysis to incorporate non-normal equity returns, as the normal distribution is a rigid assumption to make when we found some fat tails and asymmetry in the in-sample period of data.

# 6. Extensions

Copula Opinion Pooling ("COP") methodology is an appropriate framework incorporating non-normal properties of equity distributions (Meucci, 2006, 2008). The framework does also model crisis correlation, extreme event co-movements with copulas, which is not captured by simple parametric modeling. In sum, the output from the COP framework demands an optimization framework, which account for asymmetries and multivariate dependencies. Therefore, we introduce an optimizer with Conditional Value at Risk ("CVaR") objectives. Firstly, we discuss the applicable theory, and then we analyze the results. Lastly, we use Out-of-Sample testing to test performance in a forward-looking matter.

## 6.1 Executive Summary – CVaR preferences

An investor represented with CVaR preferences should according to the forthcoming findings hold the market portfolio, thus the modeling effort is unnecessary to generate the highest risk-adjusted return. Therefore, optimal bets are not present in oil-related stocks when the investor has CVaR preferences. The reasoning follows the cross-dependencies between the equities, modeled with Copulas, is less dominating than when correlation is the measure of dependencies. In combination with the potential to offset CVaR against other equities disappear in a portfolio where the equities is exogenously connected through the oil price makes OSEBX a better investment due to larger sample of stocks with offsetting extreme tail occurrences.

## 6.2 Theory

### 6.2.1 Mean-CVaR Optimization and Conditional Sharpe-Ratio

Conditional Value-at-Risk ("CVaR") is a conservative and coherent risk measure focusing on the tail loss of returns strictly exceeding the threshold of VaR[25]. A general definition of CVaR gives a lot of intuition*; "CVaR is the expected loss during an N-day period, conditional that the loss is greater than the $p^{th}$ percentile of the loss distribution".* In this thesis *N*=20 (a month of trading days) and *p* is 95%, then CVaR is the average expected loss of a month, assuming

[25] Value-at-Risk is defined as the largest loss likely over a holding period T with a given confidence level.

the loss is among the 5 % largest in the loss distribution. We can formally express it as according to Acerbi and Tasche (2002)

$$CVaR^{(p)}(X) = \frac{1}{p} \int_0^p \inf\{x|F(x) \geq p\}\, dp \quad (6.1)$$

where $\inf\{y|F(y) \geq p\}$ is the quantile function of $F(x) = P(X \leq x)$.

We optimize portfolios in a Mean-CVaR ("MC") framework using linear programming on the following minimization problem (Uryasev, 2000).

$$\min_{P} CVaR_p(P) \quad (6.2)$$

$$s.t. \; \sum_{n=1}^{N} w_n = 1, \; w^T\mu \geq r, \; Ax <=> b$$

Where $P$ is the total portfolio, $w$ is the relative weight in *N*$^{th}$ equity. The first constrain denoting the aggregated weights must sum to 1, second constrain says that portfolio return must be equal or larger than a threshold, $r$. The third constraint is a general constrain equivalent to the one in BL and can be selected as desired. We will apply equivalent constraints as in the MV framework. The minimization formulation has no closed-end solution, yet it can be interpreted by a more intuitive maximization problem. We maximize the Conditional Value at Risk ("CSR") for the set of assets. According to, Argawal and Naik (2004), CSR measures the left-tail risk-adjusted excess return of the return distributions and is a measure to evaluate performance of equity- and portfolio performance in a MC framework.

$$CSR_i = \frac{x_i - r_f}{CVaR_i} \quad (6.3)$$

### 6.2.2 Copula Opinion Pooling

The COP approach provides a posterior market distribution, which smoothly blends an arbitrarily distributed prior market distribution with arbitrarily chosen views. The method relies on a large number of Monte Carlo simulations, in which the user has to be willing to accept no closed end result. Muecci (2006) made the views dependent on "realizations of the market", not on estimated market equilibrium parameters as in the original formulation of BL.

*Prior Market Distribution*

The starting point for the COP is a multivariate market (*M*), which is an $D$ X $N$ matrix of log-returns and from *M*, we can define a probability density function (pdf) to represent the prior market. We will make use of Azzalini and Capitanio (2003) skewed multivariate t-distribution function

$$f_Y(Y) = 2t_d(y; v)T_1\left(\alpha^T\omega^{-1}(y-\xi)\left(\frac{v+d}{Q_y+v}\right)^{1/2}; v+d\right) \quad (6.4)$$

where $\xi$ is the expected return, $\alpha$ is a shape parameter regulating the slant of the distribution and $\omega = diag(w_{11}, \dots, \omega_{dd})^{1/2}$ of $N$ X $N$ dispersion matrix $\Omega$,

$$Q_y = (y - \xi)^T\Omega^{-1}(y - \xi),$$

$$t_d(y; v) = \frac{1}{|\Omega|^{1/2}}g_d(Q_y; v) = \frac{\Gamma(\frac{v+d}{2})}{|\Omega|^{1/2}(\pi d)^{d/2}\Gamma(\frac{v}{2})}\left(1+\frac{Q_y}{v}\right)^{-(v+d)/2}$$

is the density function of $N$-dimensional *t* variate with v degrees of freedom and where $T_1(x; v + d)$ state the scalar *t* distribution with $v + d$ degrees of freedom. Convenient features of the skewed T is when $\varphi \to \infty$, i.e. the distribution converges to a skewed normal distribution, when $\alpha = 0$ the distribution becomes a regular Student-T and when $\varphi$ decrease it is more plausible to have tail observations i.e. a leptokurtic shape.

The parameters are estimated by maximum-likelihood estimation and a rearrangement of (7.4) is necessary for estimation. We can represent the pdf as

$$M \sim SkT(\xi, \Omega, \alpha, \varphi) \quad (6.5)$$

Let $\xi_i = \beta^T x_i$, for $i = 1, \dots, D$, $x_i$ be a $K$ dimensional vector and $\beta$ is a $K$ X $D$ matrix of parameters. Furthermore, the model assume $X = (x_1, x_2, \dots, x_D)^T$ to be a $K$ X $D$ design matrix. Effectively, we can now write

$$\Omega^{-1} = A^T diag(e^{-2\rho})A = A^T DA, \qquad \eta = \omega^{-1}\alpha$$

where $A$ is an upper triangular $N$ X $N$ matrix with diagonals of 1 and $\rho \in \mathbb{R}^d$. The log-likelihood function for $\theta = (\beta, A, \rho, \eta, \log v)$ is then given by

$$\ell(\theta) = \sum_{i=1}^{n}\left[\log 2 + \frac{1}{2}\log|D| + \log g_d(Q_i; v) + \log T_1(t(L_i, Q_i, v); v+d)\right], \quad (6.6)$$

where,

$$u_i = y_i - \beta^T x_i, \qquad Q_i = u_i^T\,\Omega^{-1}u_i, \qquad L_i = \alpha^T\omega^{-1}u_i, \qquad t(L, Q, v) = L\left(\frac{v+d}{Q+v}\right)^{1/2}$$

We denote the prior cumulative distribution (cdf) function as $F_k(v) \equiv P_{Prior}\{V_k < v\}$, $k = 1, \ldots . K$.

*Views*

As in the BL framework, the *k*th view *Q*, are expressed in a linear matter and the practitioner can vary their views between relative and absolute views depending on opinion. The views are accompanied with a pick matrix (*P*), which dictates a theoretical upper limit of *K* views equal to *N* equities. The view-adjusted market can now be defined as an *N*-dimensional vector

$$V \equiv PM \tag{6.7}$$

A *K* X *N* matrix, where only the *k*th first columns of *V* are statements on market-implied views now represents *V*. The cdf of $k^{\text{th}}$ view is therefore; $\hat{F}_k(v) \equiv P_{views}\{V_k < v\}$, $k = 1, \ldots . K$. In general, any distribution can be fitted, although only uniform distributed will be considered in this thesis. The multivariate normal case as in the BL framework is rather good, because it is unlikely to have an investor defining a stochastic set of estimates. Therefore, a univariate representation is a favorable choice, as an investor is more likely to set a target return range on the equities.

*Posterior Market Distribution*

To solve the dichotomy of the prior and the view distribution, we firstly determine the posterior function of each view individually by using opinion-pooling techniques, and then we determine the joint posterior distribution of the views by drawing knowledge of the dependence structures from the market prior. Lastly, we calculate the joint posterior distribution of the market by including the view distribution in a suitable set of market co-ordinates. The posterior marginal pdf of the $k^{\text{th}}$ view is a weighted average of the prior market pdf and the subjective pdf of each view.

$$\tilde{F}_k(v) \equiv c_k\hat{F}_k + (1 - c_k)F_k \qquad k = 1, \ldots, K \tag{6.8}$$

Where $c_k \in (0,1)$ is the confidence level of the views. An interpretation can be given in relation to the BL framework as the inverse uncertainty in the view estimate. The joint distribution of each view is determined from Sklar's Theorem (7.10) and (7.11), where the posterior joint distribution can be written in terms of the marginal posterior distribution and dependency structures in market returns, called copula. Copulas model complex non-linear relationship between the equities, which simple correlations cannot capture. Consider a random vector$(X_1, \ldots, X_k)$. The copula $C$ is the joint cumulative distribution of $(U_1, \ldots, U_k)$, which has uniformly distributed marginals, $U_j \in (0,1)$. We can then write it as $C(u_1, \dots, u_k) = P(U_1 \leq u_1, \dots, U_k \leq u_k)$. In this thesis, we make use of t-distributed copulas because this allows for joint fat tails and higher probability of joint extreme events than normal copula. The t-copula can be written

$$C_{\rho,v}(u,v) = \int_{-\infty}^{t_v^{-1}(u)} \int_{-\infty}^{t_v^{-1}} \frac{1}{2\pi(1-\rho^2)^{0.5}} \left\{1 + \frac{X^2 - 2\rho xy + y^2}{v(1-\rho^2)}\right\}^{-(v+2)/2} ds\, dt \qquad (6.9)$$

where $\rho$ and v are parameters of the copula and $t_v^{-1}$ is the inverse standard univariate t-distribution with $v$ degress of freedom, expectation 0 and variance,$\frac{v}{v-2}$. The copula of the posterior distribution is inherited from the prior.

$$C \equiv \begin{pmatrix} C_1 \\ \vdots \\ C_K \end{pmatrix} = \begin{pmatrix} F_1(V_1) \\ \vdots \\ F_K(V_K) \end{pmatrix} \qquad (6.10)$$

Therefore can we express the posterior joint distribution of the views by means of

$$\tilde{V} \equiv \begin{pmatrix} \tilde{V}_1 \\ \vdots \\ \tilde{V}_K \end{pmatrix} = \begin{pmatrix} \widetilde{F_1}^{-1}(C_1) \\ \vdots \\ \widetilde{F_K}^{-1}(C_K) \end{pmatrix} \qquad (6.11)$$

where $\widetilde{F_k}^{-1}$ is the quantile function relative to the cdf, $\widetilde{F_K}$ .The method leverage from a linear interpolator function to transform $C$ back to the posterior empirical distribution of $V_K, \tilde{V}_K$. Finally, we can determine the posterior market distribution ($\widetilde{M}$), where $K$ first entries of $\tilde{V}$are the posterior distribution in (7.11) and the rest are equal to the prior.

$$\widetilde{M} = P^{-1}\tilde{V} \qquad (6.12)$$

## 6.3 Results

### 6.3.1 Distributional modeling – Copula Opinion Pooling

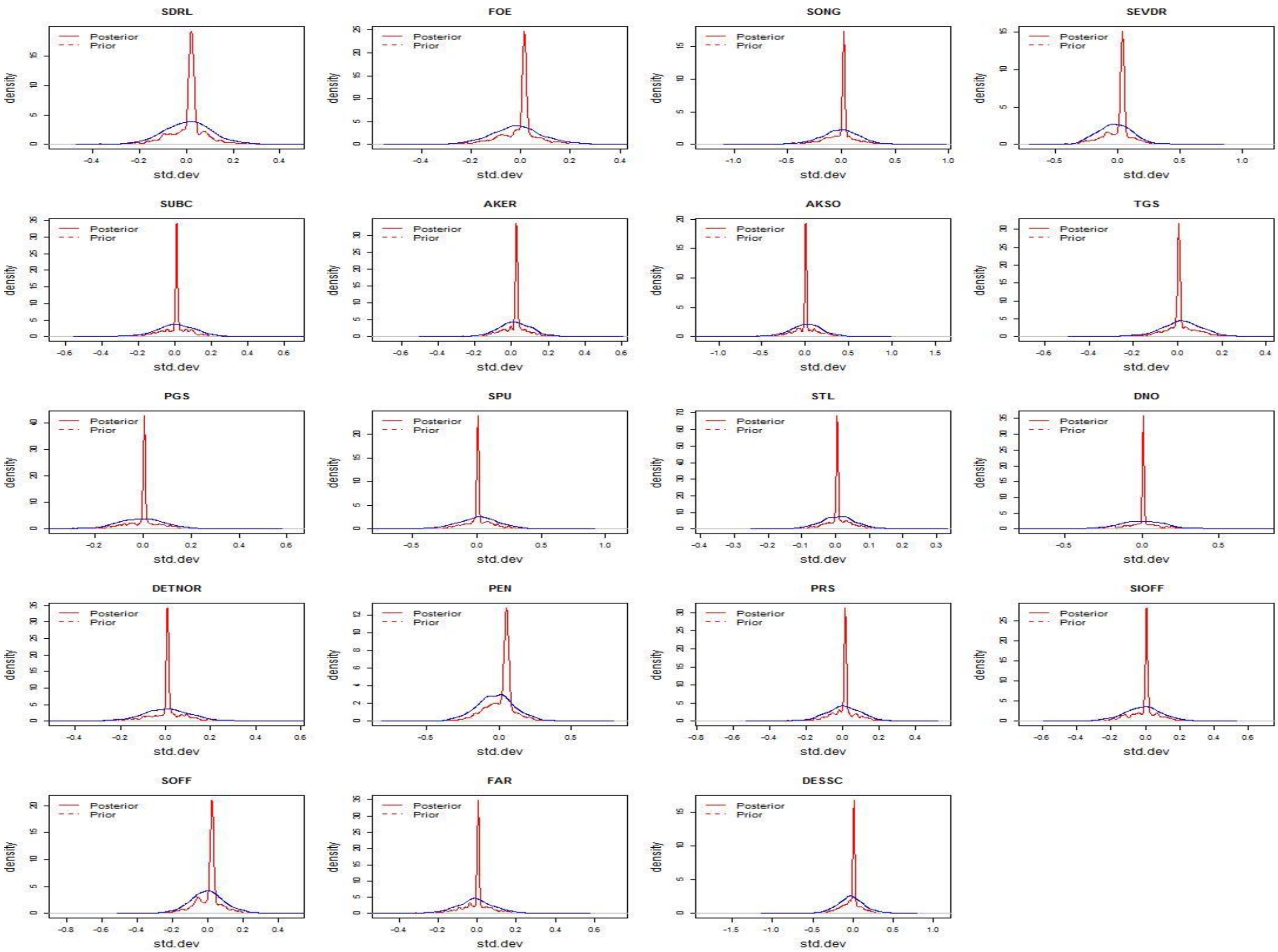
*Views*

We model the views, $V$ based on a univariate model distribution, where we allow the target price to range plus-minus 20% to account for variability in the estimates. We further set the confidence, $c_k$based on a study done by CXO Advisory Group (2012) on the hit-ratio of equity market experts[26]. According to the study, the median-quartile hit ratio is between 44% and 52%. We settle with a $c_k$ of 44%, in the low end of the median-quartile, because we recognize the skill set and the long-run experience of the experts analyzed in the study.

*From Prior to Posterior*

The modeling of copula, $C$ of the flexible skew-t distribution, preserves the tail-risk properties inherent in the prior market distributions $M$, to the posterior market distributions, $\widetilde{M}$. Although, imposing the univariate view structure $V$, will make the posterior different from the prior with changes mainly around the mean, $\xi$ of the equities as we can see in figure 23.

*Figure 23 – Probability density function of COP prior and posterior*

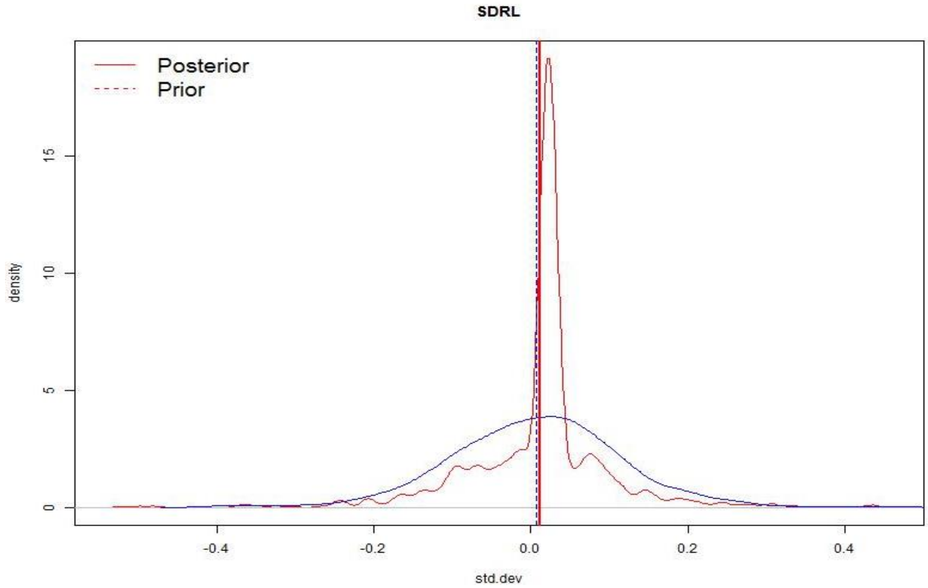



*Red line; Prior distributions ($M$); constructed on the parameters of the Skew-T distribution. Blue line; Posterior distributions ($\widetilde{M}$); modeled on the prior T-Skewed distributions blended with the univariate view distributions. The distributions are modeled with monthly data,*

[26] The study is based on 6,582 forecast in the U.S equity market from 68 equity experts in the period from late 1998 to 2012.

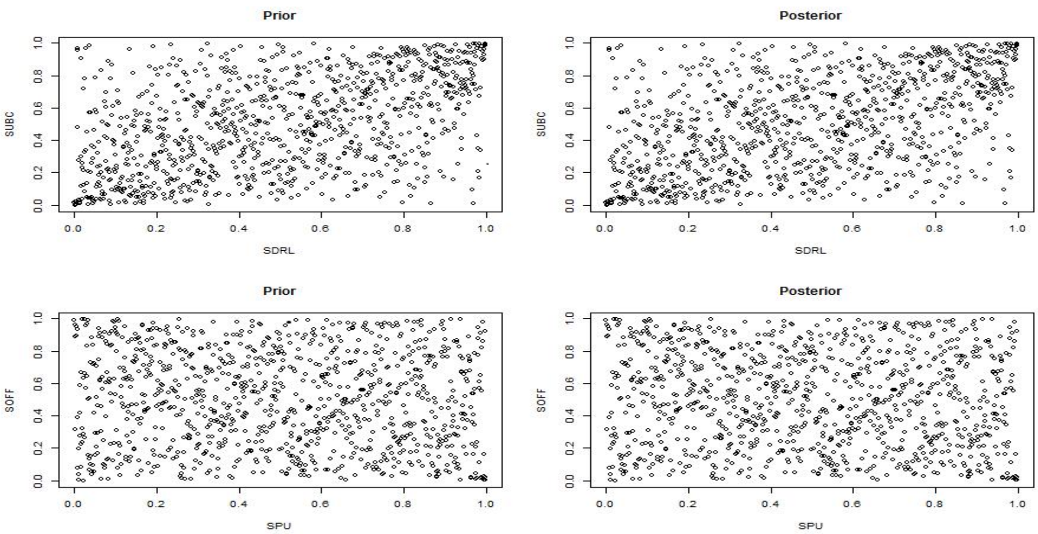
We analyze Seadrill to exemplify the process. We see know that view cdf, $\hat{F}_k$ impose change to the posterior cdf, $\tilde{F}_k$ by observing the changed around the mean from $M$ to $\widetilde{M}$ in figure 24. The univariate structure of $\hat{F}_k$ increase the probability that the expected return is around mean of distributions. In sum, $\widetilde{M}$ has taken a leptokurtic shape and the minor left-skewed profile is still intact due to the implementation of $C$ to $\widetilde{M}$ .

*Figure 24 –COP Probability density function of COP prior and posterior –Seadrill*




We examine $C$ of $M$ and $\widetilde{M}$ to assure correct application of the framework. According to figure 25, Seadrill has the same structure of dependencies against Subsea 7 in $M$ and $\widetilde{M}$ . The same holds for Spectrum and Solstad Offshore. The modeling of $C$ holds for all equity inter-relations.

*Figure 25 –COP prior and posterior copulas*



The correlation structure has changed substantial from the Historic and BL matrices after we fitted the t-copulas to the posterior distribution. It is smoothed out and negative correlations are almost gone. This costs us 5.57 degrees of freedom, however since we are able to leverage from the copula patterns in the posterior distribution we are willing to carry the cost of degrees of freedom. The reduction in correlations is mainly due to normal distribution exaggerate the impact of extreme events and thus increase absolute correlation. We find the reduction in negative correlation is evidential for our hypothesis of the common directional risk factor in the oil price, as extreme positive movements are driving correlations positively. See Appendix 12 for the posterior correlation matrix.

### 6.3.2 CVaR Portfolio Allocations

We have to model CVaR values of SIC, EY and BL parametrically[27], since we do not have either historic data or know the true distributions of the models. In sum, this implies CVaR optimal portfolio weights are equal to weights from the MV framework (Xiong, 2010). We use historic data to calculate Historic CVaR and bootstrapped COP-realizations to calculate the CVaR of the COP model. See equity CSR's and portfolio allocations in table 12 and 13. Consistently for all portfolios and benchmarks, we use a CVaR confidence-level of 95%.

*Historic - MV-preferences versus MC-preferences*

Considering changes from the MV framework of the Historic model, TGS' get reduced weight to allocate a fraction to Spectrum. Aker gets increased allocation when shorting is considered, and vice versa, which is due to possibility to exploit dependencies across the equities. Also Fred Olsen Energy gets increased allocations in the short case. The changes are mainly due to the objective of the MC optimizer, as MC favors positively skewed and thin-tailed assets, while the MV framework ignores the information from skewness and kurtosis.

*Oil - low tail risk increase attractiveness in COP*

We observe COP allocate by far the most towards oil with over 55% and 71% in long and short portfolios, respectively, which is primarily due to low tail risk of Statoil, Det Norske Oljeselskap and Panoro compared to other assets. This is in line with the fact that smoothened COP correlations on general basis drive allocation depending more on each equity's CSRs,

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[27] RiskMetrics (1996) introduced a method of calculating CVaR based mean and standard deviation. Yielding$-\mu + \sigma\frac{n(z)}{1-p}$, where $n(z)$the value of the standard normal density function is evaluated in $z$ and $p$ is the percentile.

although we emphasize the lower tails are the objective, thus giving limited interpretation of the dependencies. Statoil binds the 40% constrain, which means increased allocations would increase portfolio CSR. Moreover, the increased allocation to Statoil further violates our sell recommendation on the stock.

*Seismic - TGS has favorable interdependency structure with other assets*

COP has high allocation to seismic compared to BL, but not compared to the rest of the models. In the long only case, the interest in TGS vanish due to lack of possibilities to offset some of the dependency driven CVaR risks TGS produce with other equities on portfolio level. Consequently, the allocation to TGS violets our sell recommendation and we find the allocation in the short strategy a breach to our view on the stock.

*Drilling - less favorable judged by tail risk*

In comparison with the BL framework, COP are more in line with the sell recommendation on the drilling sector with net allocation of 0% and 8.50%, long and short, respectively. We see all drilling equities less favorable judged by tail risk. This has mainly to do with high sensitivity to oil price, as exploring drilling services are cut back early under E&P spending. Moreover, we note the returns for Songa Offshore and Fred Olsen Energy are negative, thus negative CSR. This is due to the posterior mean properties of $\widetilde{M}$ is made on negative prior expected return, $\xi$ and negative recommendation on stocks materializes into low $V$on the stocks.

*Supply - exploiting high dependency structures*

COP has the highest short allocation to supply of all the models and a zero-allocation in the long only case driven by negative expected returns of $\widetilde{M}$ on Siem Offshore, Farstad and Deep Sea Supply. Solstad Offshore is attractive under short strategy, as it is possible to exploit dependency structures. Although the CSR is only 0.01, allocation is 32.80%, 18.7% higher than in the BL framework. This reinforces the statement of dependencies in the returns within supply. As we see in figure 26, there are substantial positive co-dependencies between the return structure of Solstad Offshore and the other supply companies especially in the lower tail, which is the objective of the optimizer to minimize. This is mainly due to Supply is a homogeny and low entry barrier sub-sector driven by a generic rate level.

*Figure 26 – COP- Solstad Offshore vs. supply – posterior copulas*

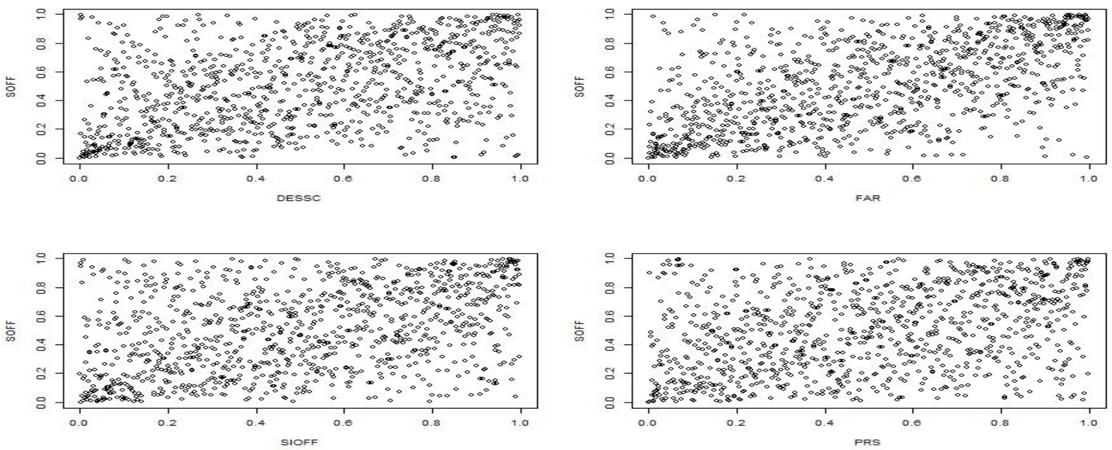



*Table 12 –Conditional Sharpe ratio of Modeled Equities*

| | Conditional Sharpe Ratio | | | | | |
|---|---|---|---|---|---|---|
| **Company** | **Historic** | **SIC** | **EY** | **BL** | **COP** | **Weight(%)** |
| **Oil** | | | | | | |
| Statoil (STL) | 0.02 | 0.01 | 0.04 | 0.09 | 0.07 | 75.66 |
| DNO International (DNO) | -0.03 | -0.03 | 0.02 | 0.03 | 0.00 | 1.92 |
| Det Norske Oljeselskap (DETNOR) | -0.02 | -0.02 | 0.02 | 0.03 | 0.03 | 1.86 |
| Panoro Energy (PEN) | -0.07 | -0.07 | 0.08 | 0.11 | 0.06 | 0.03 |
| **Weighted Average** | **0.02** | **0.01** | **0.04** | **0.09** | **0.06** | **79.47** |
| **Seismic** | | | | | | |
| TGS-NOPEC Geophysical (TGS) | 0.13 | 0.10 | 0.02 | 0.05 | 0.05 | 3.09 |
| Petroleum Geo-services (PGS) | -0.05 | -0.05 | 0.05 | 0.04 | -0.01 | 1.35 |
| Spectrum (SPU) | 0.09 | 0.11 | 0.02 | 0.02 | 0.03 | 0.31 |
| **Weighted Average** | **0.07** | **0.06** | **0.03** | **0.05** | **0.03** | **4.75** |
| **Subsea** | | | | | | |
| Subsea 7 (SUBC) | 0.08 | 0.07 | 0.01 | 0.03 | 0.02 | 4.43 |
| Aker ASA (AKER) | 0.09 | 0.04 | 0.06 | 0.10 | 0.09 | 2.21 |
| Aker Solutions (AKSO) | 0.03 | 0.05 | 0.01 | 0.02 | -0.01 | 1.67 |
| **Weighted Average** | **0.07** | **0.06** | **0.02** | **0.05** | **0.04** | **8.31** |
| **Drilling** | | | | | | |
| Seadrill (SDRL) | 0.00 | 0.00 | 0.10 | 0.10 | 0.05 | 5.29 |
| Fred Olsen Energy (FOE) | -0.05 | -0.05 | 0.14 | 0.05 | -0.02 | 0.50 |
| Songa Offshore (SONG) | -0.06 | -0.10 | 0.02 | 0.03 | -0.01 | 0.17 |
| Sevan Drilling (SEVDR) | -0.05 | -0.11 | 0.52 | 0.08 | 0.02 | 0.05 |
| **Weighted Average** | **-0.01** | **-0.01** | **0.11** | **0.10** | **0.04** | **6.01** |
| **Supply** | | | | | | |
| Prosafe (PRS) | 0.04 | 0.05 | 0.09 | 0.05 | 0.03 | 1.04 |
| Siem Offshore (SIOFF) | -0.06 | -0.10 | 0.16 | 0.05 | -0.02 | 0.30 |
| Solstad Offshore (SOFF) | -0.02 | -0.03 | 0.16 | 0.06 | 0.01 | 0.19 |
| Farstad Shipping (FAR) | -0.02 | -0.01 | 0.44 | 0.05 | -0.02 | 0.13 |
| Deep Sea Supply (DESSC) | -0.05 | -0.07 | 0.04 | 0.04 | -0.05 | 0.11 |
| **Weighted Average** | **0.01** | **0.01** | **0.13** | **0.05** | **0.01** | **1.77** |
| **Total Weighted Average** | **0.03** | **0.01** | **0.05** | **0.08** | **0.06** | **100** |
| **OSLENX** | **0.03** | | | | | |
| **OSEBX*** | **0.12** | | | | | |

**CVaR of OSEBX and OSLENX are estimated non-parametric. The CSR's are consistently built on CVaR at 95th percentile and yields the expected excess return per % of the investment we on average loose in the 5% worst monthly losses.*

*Table 13 –Mean-CVaR optimized portfolio weights*

| | Only Long | | | | | Short | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Company** | **Historic** | **SIC** | **EY** | **BL** | **COP** | **Historic** | **SIC** | **EY** | **BL** | **COP** | **Rec.*** |
| **Oil** | | | | | | | | | | | |
| Statoil (STL) | | | - | 27.39 | 35.20 | 40.00 | 40.00 | 40.00 | 37.78 | 40.00 | Sell |
| DNO International (DNO) | | | 0.64 | | - | 1.29 | -1.59 | 5.38 | -1.84 | 2.54 | Neutral |
| Det Norske Oljeselskap (DETNOR) | 0.70 | | 9.95 | | - | 14.36 | 0.82 | 0.62 | -1.41 | 18.10 | Buy |
| Panoro Energy (PEN) | | | | 22.70 | 20.06 | -12.89 | -8.15 | -13.09 | 26.24 | 11.06 | Buy |
| **Sum** | **0.70** | | **10.59** | **50.09** | **55.26** | **42.76** | **31.09** | **32.90** | **60.76** | **71.70** | |
| **Seismic** | | | | | | | | | | | |
| TGS-NOPEC Geophysical (TGS) | 67.46 | 47.06 | | | - | 53.93 | 29.43 | 37.61 | -11.22 | 21.58 | Sell |
| Petroleum Geo-services (PGS) | | | | | - | -25.63 | -9.10 | 5.70 | -8.08 | -4.98 | Sell |
| Spectrum (SPU) | 0.58 | 2.35 | | | 9.38 | 4.23 | 4.37 | | | 8.58 | Sell |
| **Sum** | **68.04** | **49.41** | | | **9.38** | **32.53** | **24.70** | **43.31** | **-19.30** | **25.17** | |
| **Subsea** | | | | | | | | | | | |
| Subsea 7 (SUBC) | | 3.97 | | | | -4.14 | 3.80 | -50.34 | 2.63 | -2.69 | Neutral |
| Aker ASA (AKER) | 26.65 | 33.44 | | 16.45 | 35.36 | 25.05 | 30.40 | 2.16 | 25.18 | 23.19 | Buy |
| Aker Solutions (AKSO) | 4.60 | 2.03 | | | | 1.60 | 2.04 | 5.77 | -1.60 | -9.80 | Sell |
| **Sum** | **31.26** | **39.44** | | **16.45** | **35.36** | **22.51** | **36.24** | **-42.41** | **26.21** | **10.70** | |
| **Drilling** | | | | | | | | | | | |
| Seadrill (SDRL) | | | | 4.11 | | -4.38 | -2.55 | -31.22 | 14.59 | 8.72 | Sell |
| Fred Olsen Energy (FOE) | | | | 7.25 | | 9.13 | 8.76 | 0.66 | 5.61 | 0.66 | Sell |
| Songa Offshore (SONG) | | | | 7.10 | | 0.49 | -0.63 | 4.87 | 7.05 | -0.88 | Sell |
| Sevan Drilling (SEVDR) | | | 39.13 | 5.74 | | - | | 26.16 | 11.44 | - | Sell |
| **Sum** | | | **39.13** | **24.20** | | **5.24** | **5.57** | **0.46** | **38.69** | **8.50** | |
| **Supply** | | | | | | | | | | | |
| Prosafe (PRS) | | 11.15 | | 0.98 | | 5.11 | 13.36 | -8.64 | 3.81 | -3.71 | Sell |
| Siem Offshore (SIOFF) | | | 3.99 | | | -3.33 | -13.36 | 6.67 | -8.77 | -16.23 | Neutral |
| Solstad Offshore (SOFF) | | | | 8.28 | | 13.85 | 5.74 | -18.28 | 14.09 | 32.80 | Neutral |
| Farstad Shipping (FAR) | | | 46.28 | | | -5.35 | 0.26 | 99.94 | -12.33 | -13.78 | Neutral |
| Deep Sea Supply (DESSC) | | | | | | -13.32 | -3.59 | -13.95 | -3.16 | -15.15 | Buy |
| **Sum** | | **11.15** | **50.28** | **9.26** | | **-3.04** | **2.40** | **65.74** | **-6.35** | **-16.08** | |

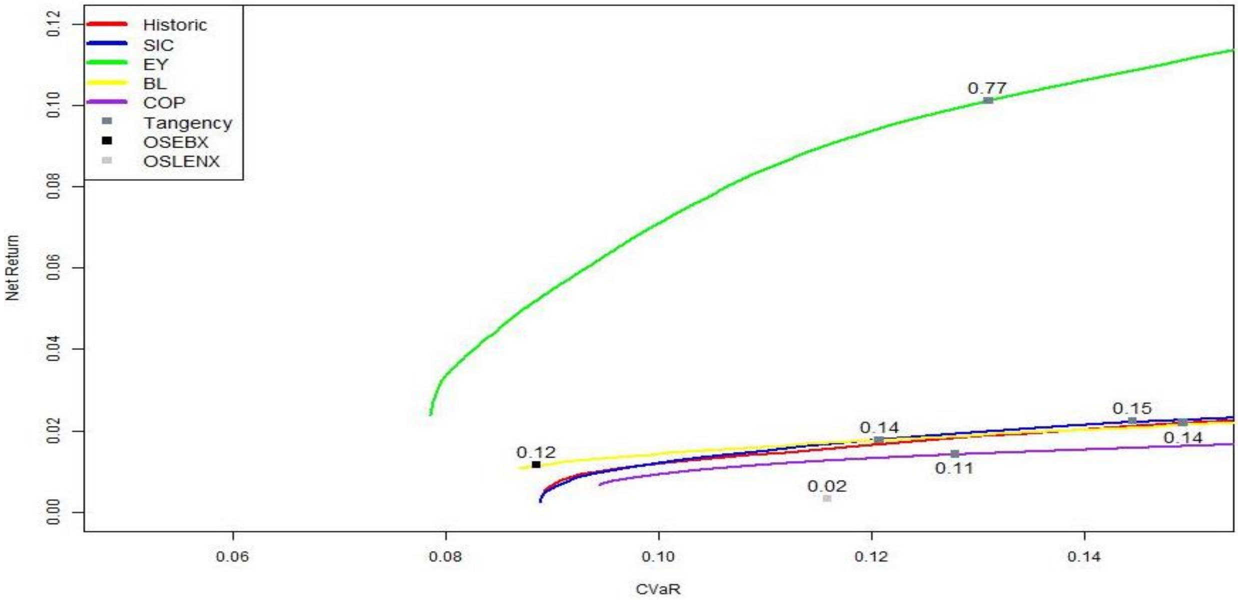
**Rec. is our recommendation given for each of the assets. The weights are given in percentages and grey columns mark that portfolio weights are equal to MV-case.*

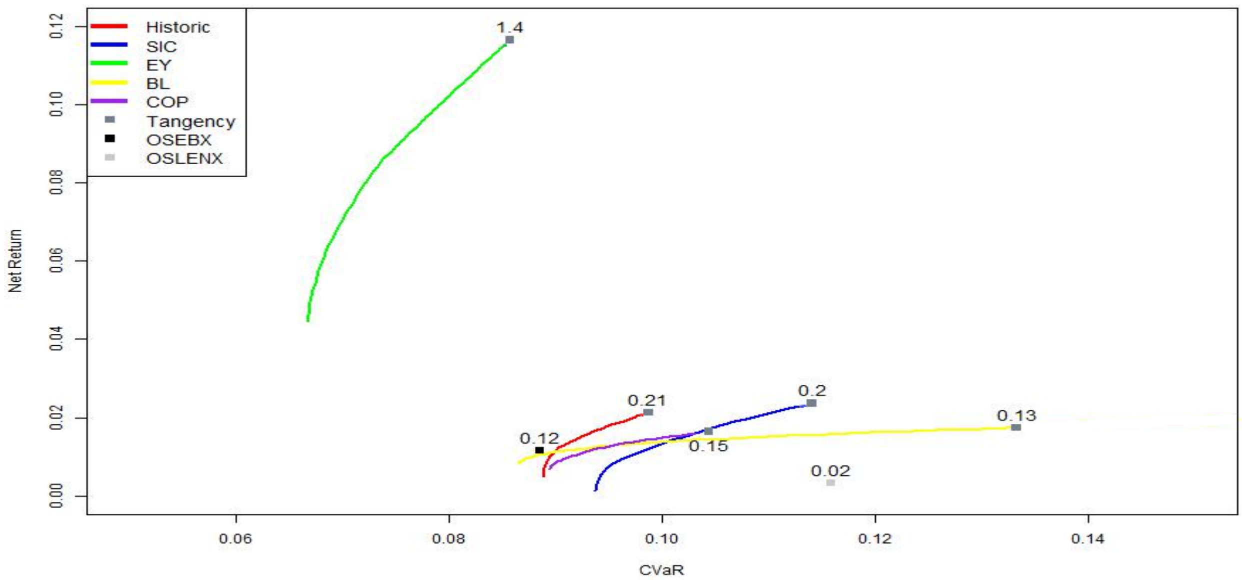
### 6.3.3 CVaR Portfolio Performance

*In-sample performance*

As we see in figure 27, long COP performs the worst with a CSR of 0.11, marginally worse than OSEBX. However, this is a natural consequence of the modeling features of COP, as it incorporates fat tails and extreme dependencies between the equities. Historic follows with 0.14, which reinforces the non-parametric of COP. BL is also performing at 0.14 and SIC are performing marginally better with 0.15. Similarly, as in the MV framework, EY performs best. This holds also for the short case, where BL is performing worst, followed by COP, SIC and Historic. The active index OSLENX is performing the worst of all, mainly due to high CVaR risk. We emphasize this is not driven by the mean, as Statoil return is high and the relative proportion of Statoil in the index is high, but the remaining 10% of equities are increasing CVaR substantial. This finding has parity with the CVaRs found on analyzed equities. The argument from MV- framework of negative return impacting Historic and SIC Short portfolio performance positive holds up here as well, as the copulas are not turning the inter-relations upside down. Ex ante evaluation is not necessarily the most appropriate environment to test the portfolio performance, thus we will evaluate in ex-post environment where our valuation- and modeling effort is incorporated.

*Figure 27 –Mean-CVaR efficient frontiers - Upper: Long only – Lower: Short*




*Upper graph: illustration with restriction of shorting (Only Long). Lower graph: illustration of no restrictions on shorting. For all portfolios, the frontier starts at Minimum CVaR portfolio. See Appendix 9 for the costs applied to short portfolio. For the short restricted portfolio only transaction cost is applied with 0.02%*

*Out-of-sample performance*

Equivalent to the MV-framework, the benchmarks are performing best on absolute risk-adjusted measures out-of-sample. The ranking order has changed from MV-framework, as OSEBX are superior to OSLENX, with 0.02. This is mainly due to CVaR only capture the downside risk in a distribution compared to standard deviation which incorporate both up- and downside risk. Thus, risk factors in MV-framework are being underestimated due to overriding small upside risk compared to downside risk in a two-sided distribution measure as standard deviation. We therefore find larger down side risk in peer index, OSLENX than the market index, OSEBX, which is a plausible finding due to offsetting copula of sectors. To exemplify, E&P and shipping has an offsetting relationship, due to inverse sensitivity to oil price.

*Table 14 – In and Out-of-sample testing (01.09.2015-29.11.2010), CSR*

| | Long | | | | | Short | | | | | Benhmarks | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Measure** | **Historic** | **SIC** | **EY** | **BL** | **COP** | **Historic** | **SIC** | **EY** | **BL** | **COP** | **OSLENX** | **OSEBX** |
| **In-Sample** | 0.147 | 0.155 | 0.772 | 0.147 | 0.112 | 0.215 | 0.207 | 1.358 | 0.131 | 0.158 | 0.028 | 0.131 |
| **Out-of-Samle** | 0.019 | 0.021 | -0.023 | 0.019 | 0.049 | -0.024 | 0.002 | 0.047 | 0.002 | -0.001 | 0.151 | 0.173 |

*The ex-cost portfolio and benchmark returns are calculated on arithmetic log-returns on monthly basis and CVaRs are estimated based on on daily returns and scaled using* $CVaR_T = CVaR_t\sqrt{T}$. *Refer to Appendix 11 for monthly out-of-sample equity returns and CVaRs.*

CVaR for all stocks have increased substantially from the in-sample-period and Statoil is the least impacted stock, which is decisive for OSLENX performance, thus beat the portfolios with large margin. Of all the portfolios, COP is performing overall best in the short-restricted case with a CSR of 0.049, but other portfolios are better than COP short strategy portfolio yielding a negative risk-adjusted return of -0.001. We note that EY yield performs second best with 0.047 and Short Historic and SIC, in addition to Long EY are performing poor. The latter are emphasizing the findings from MV-framework.

Since none of the portfolios CSR's can compete with the full-diversified index-portfolio OSEBX, we settle with that the most favourable investment is done in OSEBX according to tail-risk considerations.

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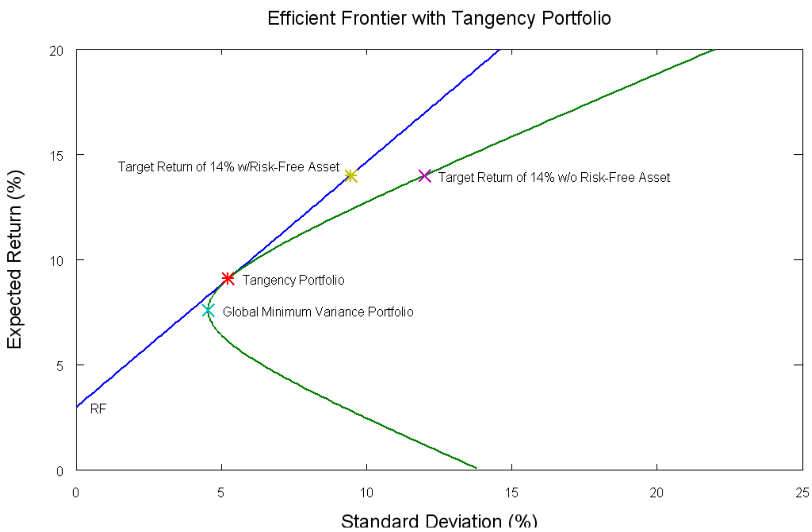
# 8. Appendix

## **Appendix 1:** *Historic Correlation Matrix*

| Historic | SDRL | FOE | SONG | SEVDR | SUBC | AKER | AKSO | TGS | PGS | SPU | STL | DNO | DETNOR | PEN | PRS | SIOFF | SOFF | FAR | DESSC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SDRL** | 1.00 | 0.35 | 0.17 | 0.44 | 0.35 | 0.53 | 0.17 | **0.50** | 0.35 | 0.22 | 0.55 | 0.20 | 0.13 | 0.51 | 0.33 | 0.37 | 0.34 | 0.42 | 0.38 |
| **FOE** | | 1.00 | -0.09 | 0.32 | 0.13 | 0.17 | 0.05 | 0.10 | 0.06 | 0.11 | 0.26 | 0.03 | 0.09 | 0.21 | 0.27 | 0.12 | 0.27 | 0.31 | 0.08 |
| **SONG** | | | 1.00 | 0.05 | 0.10 | 0.13 | -0.12 | 0.14 | 0.00 | 0.04 | 0.05 | -0.02 | 0.00 | 0.08 | 0.01 | 0.00 | 0.00 | 0.10 | 0.05 |
| **SEVDR** | | | | 1.00 | 0.11 | 0.45 | 0.13 | 0.15 | **0.50** | -0.03 | 0.39 | 0.35 | 0.33 | 0.30 | 0.17 | **0.54** | 0.31 | 0.21 | 0.18 |
| **SUBC** | | | | | 1.00 | 0.18 | 0.16 | **0.73** | -0.07 | **0.68** | 0.22 | -0.43 | **-0.60** | 0.10 | **0.72** | -0.31 | **0.50** | **0.79** | **0.59** |
| **AKER** | | | | | | 1.00 | 0.27 | 0.44 | 0.49 | 0.11 | **0.59** | 0.36 | 0.37 | 0.43 | 0.18 | 0.38 | 0.22 | 0.15 | 0.28 |
| **AKSO** | | | | | | | 1.00 | 0.23 | 0.20 | 0.18 | 0.14 | 0.25 | 0.01 | 0.27 | 0.20 | 0.09 | 0.14 | 0.06 | 0.22 |
| **TGS** | | | | | | | | 1.00 | 0.23 | 0.58 | 0.34 | -0.18 | -0.37 | 0.26 | **0.56** | -0.15 | 0.39 | **0.57** | **0.53** |
| **PGS** | | | | | | | | | 1.00 | -0.14 | 0.42 | **0.59** | 0.41 | 0.24 | -0.01 | 0.56 | 0.03 | -0.16 | -0.06 |
| **SPU** | | | | | | | | | | 1.00 | 0.19 | -0.39 | **-0.50** | 0.09 | **0.57** | -0.33 | 0.31 | **0.61** | 0.34 |
| **STL** | | | | | | | | | | | 1.00 | 0.29 | 0.32 | 0.42 | 0.30 | 0.39 | 0.17 | 0.24 | 0.21 |
| **DNO** | | | | | | | | | | | 1.00 | 0.29 | 0.32 | 0.42 | -0.30 | **0.61** | -0.28 | -0.47 | -0.30 |
| **DETNOR** | | | | | | | | | | | | | 1.00 | 0.21 | -0.41 | **0.67** | -0.40 | **-0.52** | -0.36 |
| **PEN** | | | | | | | | | | | | | | 1.00 | 0.22 | 0.34 | 0.19 | 0.21 | 0.15 |
| **PRS** | | | | | | | | | | | | | | | 1.00 | -0.23 | 0.61 | 0.73 | 0.48 |
| **SIOFF** | | | | | | | | | | | | | | | | 1.00 | -0.06 | -0.22 | -0.12 |
| **SOFF** | | | | | | | | | | | | | | | | | 1.00 | 0.70 | 0.59 |
| **FAR** | | | | | | | | | | | | | | | | | | 1.00 | 0.64 |
| **DESSC** | | | | | | | | | | | | | | | | | | | 1.00 |

*Extreme values are bold*

## **Appendix 2:** *Efficient Frontier, MPT Assumptions and Further Insight*




MPT was founded on the assumption that investors are price takers with rational behavior and make investments based on homogenous expectations based on the same information regarding risky assets' expected return and variance, which follows the normal distribution. Correlations and variances are known, there are no taxes or transaction costs and all securities are indefinitely diversifiable. Further, can an investor lend and borrow money freely (Markowitz, 1952). The efficient set of portfolios is then the portfolios, which either maximize expected return for given level of risk or minimize risk for a given level of return, in the investment opportunity set of attainable portfolio (Wei J., 2003). Secondly, the efficient frontier is then being combined with the investor's utility function to find investors optimal portfolio dependent on the degree of risk aversion. It fosters the Tangency portfolio, which combined with the Capital Market Line yield a superior risk-return trade off as seen in the illustration above. The slope of Capital Market Line is called the Sharp ratio.

**Appendix 3:** *Proof of BL-Formula*

Below follows derivation of BL formula from Christodoulakis, G.A. (2002) Applying Bayes rule to extract the conditional probability distribution of equilibrium returns given the expected returns can be represented

$$\Pr(\mu|\Pi) = \frac{\Pr(\Pi|\mu)\Pr(\mu)}{\Pr(\mu)}$$

We will further assume prior beliefs in Pr($\mu$) can be expressed with the vector K x 1 $\mu$ multiplied with K x N matrix P.

$$P\,\mu = Q + \varepsilon,$$

Where $Q$ and $\varepsilon$ are equivalent with (3.19), therefore know that

$$P\,\mu \sim N(Q, \Omega)$$

The conditional expected returns given by $\Pi|\mu$ are expected to be

$$\Pi|\mu \sim N(\mu, \Sigma)$$

From the sketched distributions can we now create pdf

$$pdf(P\mu) = \frac{1}{\sqrt{2\alpha^k|\Omega|}}\exp(-\frac{1}{2}(P\mu - Q)^T\Omega^{-1}(P\mu - Q))$$

$$pdf(\Pi|\mu) = \frac{1}{\sqrt{2\alpha^k|\tau\Sigma|}}\exp(-\frac{1}{2}(\Pi - \mu)^T(\tau\Sigma)^{-1}(\Pi - \mu))$$

Substituting the posterior probability density function using Bayes theorem will give us

$$\exp\left(-\frac{1}{2}(\Pi - \mu)^T(\tau\Sigma)^{-1}(\Pi - \mu) - \frac{1}{2}(P\mu - Q)^T\Omega^{-1}(P\mu - Q)\right)$$

Which can be written as

$$\exp\left(-\frac{1}{2}(\mu^T H\mu - 2C^T\mu + A)\right)$$

$$= \exp\left(-\frac{1}{2}(\mu^T H^T H H^{-1}\mu - 2C^T H^{-1} H\mu + A)\right)$$

$$= \exp\left(-\frac{1}{2}[(H\mu - C)^T H^{-1}(H\mu - C) - C^T H^{-1} C + A)\right)$$

$$= \exp\left(-\frac{1}{2}(A - C^T H^{-1} C)\right) x \exp\left(-\frac{1}{2}(H\mu - C)^T H^{-1}(H\mu - C)\right)$$

where,

$$H = (\tau\Sigma)^{-1} P^T \Omega^{-1} P$$

$$C = (\tau\Sigma)^{-1}\Pi + P^T\Omega^{-1} Q$$

$$A = \Pi^T (\tau\Sigma)^{-1}\Pi + Q^T\Omega^{-1} Q$$

Thus, The term $\exp\left(-\frac{1}{2}(A - C^T H^{-1} C)\right)$ and the denominator pdf $(\Pi)$ which is not modelled will be absorbed into an integrating constant for the posterior pdf. Hence the results follow,

$$\mu_{BL} = H^{-1}C = \Pi + \Sigma P^T\left((P\Sigma P^T) + \Omega\right)^{-1}(Q - P^T\Pi) \quad (3.1)$$

$$\sigma_{BL} = H^{-1} = \Sigma + (\tau\Sigma)^{-1} P^T \Omega^{-1} P, \quad (3.2)$$

that can easily be shown to be an alternate formula of the following. See Walters J. (2014)

$$\mu_{BL} = [(\tau\Sigma)^{-1} + P^T \Omega^{-1} P]^{-1} [(\tau\Sigma)^{-1}\Pi + P^T\Omega^{-1} Q] \quad (3.3)$$

$$\Sigma_{BL} = [(\tau\Sigma)^{-1} + P^T \Omega^{-1} P]^{-1} \quad (3.4)$$

**Appendix 4:** *Oil Demand Growth*

| **Oil Demand Growth (Million bpd)** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Americas | 0.5 | -0.2 | -0.3 | 0.4 | 0.1 | 0.4 | 0.1 | 0.1 | 0.1 | -0.1 | 0 |
| Europe | 0 | -0.4 | -0.5 | -0.1 | -0.2 | 0.2 | 0 | -0.1 | -0.1 | -0.1 | -0.1 |
| Asia Oceania | 0.2 | 0 | 0.4 | -0.2 | -0.2 | 0 | -0.1 | 0 | 0 | -0.1 | 0 |
| **Total OECD** | **0.6** | **-0.5** | **-0.5** | **0.1** | **-0.3** | **0.6** | **0** | **0** | **0** | **-0.2** | **-0.2** |
| | | | | | | | | | | | |
| FSU | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 | 0 | -0.1 | 0 | 0.1 | 0.1 | 0.1 |
| Europe | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| china | 0.9 | 0.5 | 0.5 | 0.2 | 0.3 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Other Asia | 0.6 | 0.2 | 0.4 | 0.3 | 0.2 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Latin America | 0.4 | 0.1 | 0.2 | 0.2 | 0.2 | 0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Middle East | 0.2 | 0.1 | 0.3 | 0.2 | 0.2 | 0.1 | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 |
| Africa | 0.1 | 0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 |
| **Total Non-OECD** | **2.3** | **1.2** | **1.7** | **1.2** | **1.2** | **1.1** | **1.2** | **1.3** | **1.2** | **1.3** | **1.3** |
| | | | | | | | | | | | |
| **World** | **2.9** | **0.6** | **1.2** | **1.2** | **0.8** | **1.8** | **1.2** | **1.2** | **1.2** | **1.1** | **1.1** |

## Appendix 5: *Oil Supply Growth*

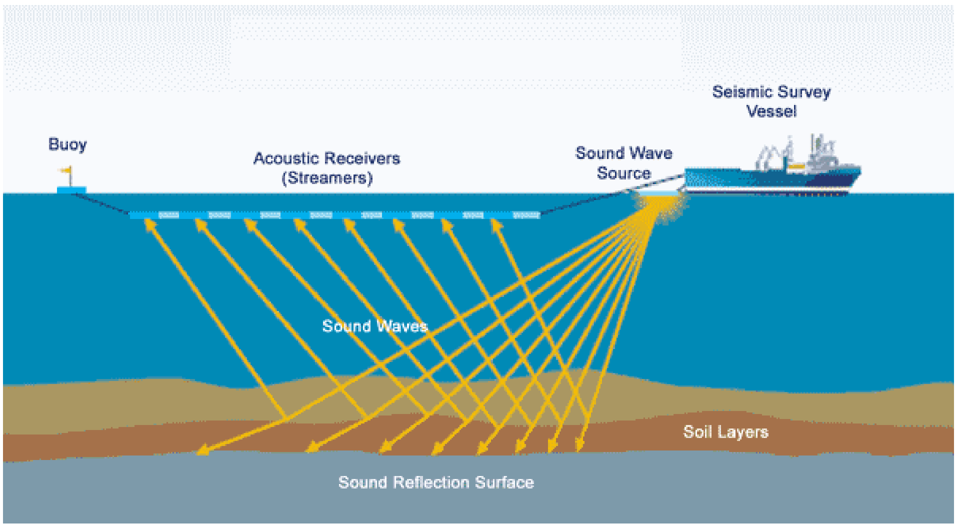
| Non-OPEC Supply Growtl | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Russia | 240 | 150 | 130 | 150 | 110 | 110 | -90 | -340 | -40 | -100 | -80 |
| Africa | -50 | 90 | -330 | 60 | 50 | -40 | -50 | 190 | -50 | -60 | -120 |
| Norway | -260 | -100 | -130 | -70 | 50 | 30 | -70 | -80 | -10 | -40 | -20 |
| China | 210 | 0 | 70 | 10 | 40 | 100 | -110 | -30 | 0 | 30 | 80 |
| Brazil | 110 | 60 | -40 | -40 | 230 | 220 | 100 | 200 | 160 | 110 | 70 |
| Canada | 130 | 180 | 220 | 240 | 270 | 100 | 140 | -60 | 130 | 150 | 250 |
| USA | 330 | 370 | 140 | 1 140 | 1 720 | 790 | -190 | 500 | 310 | 290 | 300 |
| Other FSU | 40 | -130 | -40 | 70 | -50 | -20 | -110 | 0 | 30 | 150 | 10 |
| Mexico | -20 | -20 | -20 | -30 | -80 | -210 | -70 | 80 | 0 | 60 | 120 |
| UK | -120 | -240 | -180 | -90 | -20 | 60 | -40 | -60 | 10 | -10 | 0 |
| Global biofuels | 300 | -30 | -10 | 150 | 180 | 120 | 40 | -30 | 40 | 20 | 30 |
| Other | 160 | -150 | -130 | -250 | -90 | -20 | -60 | 120 | 120 | -40 | -160 |
| **Total Non-OPEC** | **1 070** | **180** | **580** | **1 340** | **2 410** | **1 240** | **-510** | **490** | **700** | **560** | **480** |

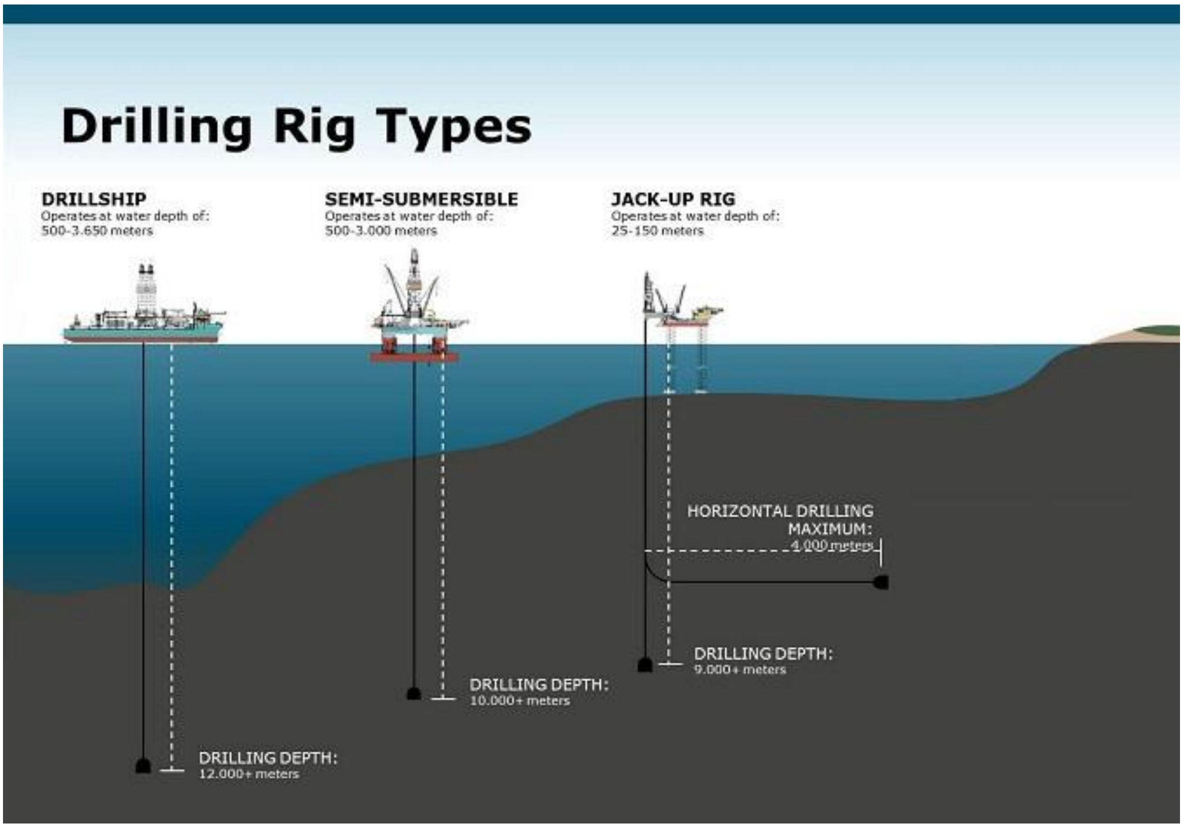
| OPEC Capacity Growth | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Saudi Arabia | -5 | 1 180 | 425 | -203 | 120 | -40 | 80 | 70 | -30 | -50 | -20 |
| Iran | -40 | -80 | -620 | -318 | 540 | 0 | 0 | 0 | 0 | 0 | 0 |
| Iraq | -70 | 310 | 280 | 126 | 400 | 240 | 200 | 120 | 110 | 190 | 210 |
| UAE | 40 | 190 | 150 | 64 | 30 | 40 | 40 | 50 | 70 | 50 | 60 |
| Kuwait | 15 | 240 | 195 | 52 | -20 | -40 | 20 | 0 | -10 | -30 | -40 |
| Watar | 0 | 0 | 0 | -9 | -10 | -30 | 0 | 10 | 10 | 10 | 0 |
| Angola | 0 | -90 | 120 | 0 | -110 | 30 | 0 | 40 | 20 | 0 | 0 |
| Nigeria | 260 | 100 | -80 | -145 | -330 | -60 | -10 | -10 | -10 | 0 | 0 |
| Libyia | 0 | -1 090 | 930 | -477 | -570 | -350 | 150 | 100 | 60 | 60 | 110 |
| Algeria | -30 | -30 | -10 | -20 | -10 | -30 | -40 | -40 | -40 | -40 | -30 |
| Equador | 0 | 30 | 0 | 0 | 40 | 0 | 0 | 10 | 10 | 0 | 0 |
| Venezuela | -140 | -30 | 0 | 11 | -40 | -70 | -40 | -50 | 50 | 60 | 50 |
| **Total Crude Oil** | **30** | **730** | **1 390** | **-919** | **50** | **-310** | **400** | **300** | **240** | **250** | **340** |
| NGLs | 460 | 360 | 360 | 50 | 134 | 190 | 237 | 55 | 13 | 19 | 21 |
| **Total OPEC** | **490** | **1 090** | **1 750** | **-869** | **184** | **-120** | **637** | **355** | **253** | **269** | **361** |
| | | | | | | | | | | | |
| **Total World** | **1 560** | **1 270** | **2 330** | **471** | **2 594** | **1 120** | **127** | **845** | **953** | **829** | **841** |

## Appendix 6: *Physical Oil Market Equilibrium*

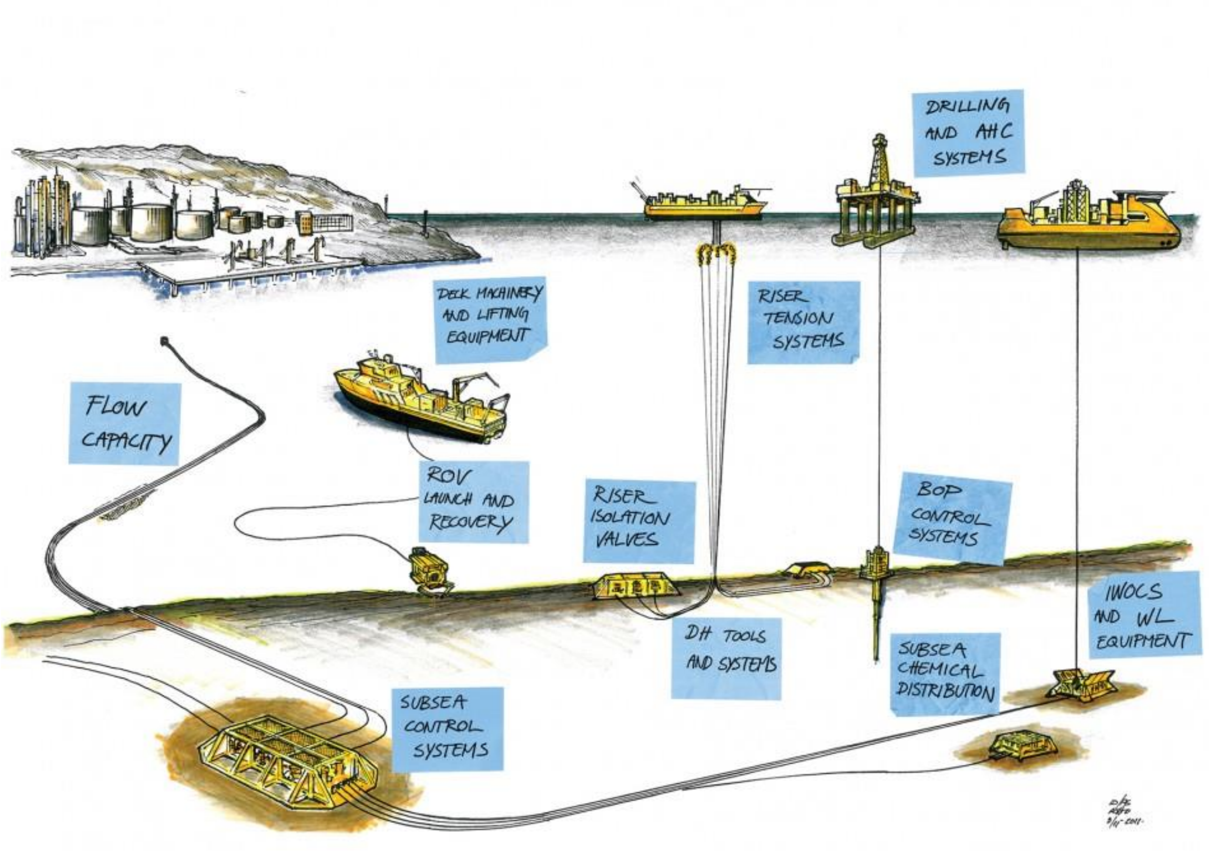
| Oil Market Balance | 1Q15 | 2Q15 | 3Q15 | 4Q15 | 1Q16 | 2Q16 | 3Q16 | 4Q16 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OECD Demand | 46.5 | 45.3 | 46.7 | 46.7 | 46.6 | 45.5 | 46.4 | 46.9 | 46.1 | 45.7 | 46.3 | 46.3 |
| Non-OECD Demand | 47.1 | 48.6 | 48.5 | 48.7 | 48.3 | 49.6 | 49.8 | 49.8 | 45.8 | 47.1 | 48.2 | 49.4 |
| **Total Demand** | **93.6** | **93.9** | **95.2** | **95.4** | **94.9** | **95.1** | **96.2** | **96.7** | **91.9** | **92.8** | **94.5** | **95.7** |
| | | | | | | | | | | | | |
| Non-OPEC Supply | 58.1 | 58.3 | 58.5 | 58.3 | 57.8 | 57.6 | 57.7 | 57.9 | 54.6 | 57 | 58.3 | 57.8 |
| OPEC Crude | 30.5 | 31.5 | 31.7 | 31.7 | 31.7 | 31.7 | 31.7 | 31.7 | 30.5 | 30.2 | 31.4 | 31.7 |
| OPEC NGL`s | 6.5 | 6.5 | 6.6 | 6.7 | 6.7 | 6.8 | 6.9 | 6.9 | 6.3 | 6.4 | 6.6 | 6.8 |
| **Total Supply** | **95.1** | **96.3** | **96.8** | **96.7** | **96.2** | **96.1** | **96.3** | **96.5** | **91.4** | **93.6** | **96.3** | **96.3** |
| | | | | | | | | | | | | |
| **Deficit (-)/Surplus (+)** | **1.5** | **2.4** | **1.6** | **1.3** | **1.3** | **1** | **0.1** | **-0.2** | **-0.5** | **0.8** | **1.8** | **0.6** |
| | | | | | | | | | | | | |
| Iran Added Barrels | 0 | 0 | 0 | 0 | 0.5 | 0.7 | 1.0 | 1.0 | 0 | 0 | 0 | 0.8 |
| | | | | | | | | | | | | |
| **Deficit (-)/Surplus (+)** | **1.5** | **2.4** | **1.65** | **1.3** | **1.8** | **1.7** | **1.1** | **0.8** | **-0.5** | **0.8** | **1.8** | **1.4** |

## Appendix 7: *Detailed Oil Service Market Overview*






*Subsea Infrastructure*



## **Appendix 8:** *BL Return Residuals*

| | STL | DNO | DETNOR | PEN | TGS | PGS | SPU | SUBC | AKER | AKSO | SDRL | FOE | SONG | SEVDR | PRS | SIOFF | SOFF | FAR | DESSC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Posterior - Prior(%) | -0.288 | -0.239 | -0.010 | 1.193 | -0.307 | -0.378 | -0.666 | -0.588 | 0.155 | -0.628 | 0.147 | 0.347 | 0.902 | 0.554 | -0.045 | -0.148 | 0.539 | 0.057 | -0.171 |

## **Appendix 9:** *Transaction Costs*

| | Historic | SIC | EY | BL | COP |
|---|---|---|---|---|---|
| MV | 0.41 | 0.23 | 0.73 | 0.28 | - |
| CVaR | 0.38 | 0.23 | 0.75 | 0.46 | 0.37 |

*The costs are given in percentages.*

## **Appendix 10***: COP Posterior Correlation Matrix.*

| | SDRL | FOE | SONG | SEVDR | SUBC | AKER | AKSO | TGS | PGS | SPU | STL | DNO | DETNOR | PEN | PRS | SIOFF | SOFF | FAR | DESSC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDRL | 1.00 | 0.28 | 0.23 | 0.47 | 0.48 | 0.50 | 0.27 | 0.56 | 0.39 | 0.20 | 0.46 | 0.25 | 0.17 | 0.41 | 0.23 | 0.47 | 0.27 | 0.46 | 0.44 |
| FOE | | 1.00 | -0.03 | 0.30 | 0.18 | 0.14 | 0.06 | 0.11 | 0.04 | 0.16 | 0.15 | 0.13 | 0.12 | 0.19 | 0.17 | 0.16 | 0.22 | 0.32 | 0.12 |
| SONG | | | 1.00 | 0.06 | 0.16 | 0.29 | 0.05 | 0.27 | 0.01 | 0.02 | 0.14 | 0.03 | 0.13 | 0.14 | 0.01 | 0.02 | -0.04 | 0.15 | 0.11 |
| SEVDR | | | | 1.00 | 0.41 | 0.44 | 0.23 | 0.35 | 0.48 | 0.14 | 0.37 | 0.36 | 0.17 | 0.27 | 0.29 | 0.54 | 0.37 | 0.48 | 0.35 |
| SUBC | | | | | 1.00 | 0.51 | 0.34 | 0.60 | 0.53 | 0.24 | 0.49 | 0.22 | 0.12 | 0.26 | 0.43 | 0.42 | 0.22 | 0.42 | 0.38 |
| AKER | | | | | | 1.00 | 0.37 | 0.65 | 0.46 | 0.20 | 0.53 | 0.30 | 0.29 | 0.41 | 0.33 | 0.37 | 0.31 | 0.43 | 0.47 |
| AKSO | | | | | | | 1.00 | 0.35 | 0.37 | 0.28 | 0.24 | 0.36 | 0.02 | 0.16 | 0.30 | 0.17 | 0.21 | 0.15 | 0.26 |
| TGS | | | | | | | | 1.00 | 0.54 | 0.31 | 0.42 | 0.16 | 0.07 | 0.31 | 0.32 | 0.29 | 0.14 | 0.32 | 0.45 |
| PGS | | | | | | | | | 1.00 | 0.24 | 0.47 | 0.39 | 0.03 | 0.16 | 0.40 | 0.41 | 0.23 | 0.29 | 0.23 |
| SPU | | | | | | | | | | 1.00 | 0.27 | 0.11 | 0.15 | 0.06 | 0.16 | 0.18 | -0.10 | 0.17 | 0.00 |
| STL | | | | | | | | | | | 1.00 | 0.31 | 0.36 | 0.28 | 0.41 | 0.43 | 0.30 | 0.42 | 0.28 |
| DNO | | | | | | | | | | | | 1.00 | 0.12 | 0.20 | 0.23 | 0.27 | 0.13 | 0.21 | 0.08 |
| DETNOR | | | | | | | | | | | | | 1.00 | 0.12 | 0.13 | 0.18 | -0.11 | 0.16 | 0.00 |
| PEN | | | | | | | | | | | | | | 1.00 | 0.28 | 0.30 | 0.26 | 0.35 | 0.22 |
| PRS | | | | | | | | | | | | | | | 1.00 | 0.23 | 0.38 | 0.38 | 0.14 |
| SIOFF | | | | | | | | | | | | | | | | 1.00 | 0.37 | 0.46 | 0.34 |
| SOFF | | | | | | | | | | | | | | | | | 1.00 | 0.47 | 0.40 |
| FAR | | | | | | | | | | | | | | | | | | 1.00 | 0.40 |
| DESSC | | | | | | | | | | | | | | | | | | | 1.00 |

## **Appendix 11:** *Out of Sample Mean and CVaR properties*

| | STL | DNO | DETNOR | PEN | TGS | PGS | SPU | SUBC | AKER | AKSO | SDRL | FOE | SONG | SEVDR | PRS | SIOFF | SOFF | FAR | DESSC | OSLENX | OSEBX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Return (%) | 2.66 | -2.30 | 5.61 | 16.27 | 2.05 | 7.46 | -2.19 | 2.92 | 5.45 | 7.74 | 2.86 | -4.30 | 3.71 | -12.61 | 0.70 | -2.93 | -4.64 | 9.92 | -3.19 | 2.60 | 2.41 |
| CVaR | 0.17 | 0.24 | 0.24 | 0.30 | 0.19 | 0.26 | 0.17 | 0.21 | 1.86 | 0.26 | 0.31 | 0.46 | 0.34 | 0.37 | 0.30 | 0.21 | 0.54 | 0.39 | 0.31 | 0.12 | 0.11 |