Real options: A way to improve valuation accuracy in industry life cycle transitions

- A case study of Maersk Drilling

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Executive Summary

This thesis draws upon real option valuation (ROV), to overcome the shortcomings of the discounted cash flow model (DCF) when valuing companies facing an industry life cycle (ILC) transition. This thesis criticises the DCF-model's ability to capture the upside value in environments with high volatility. With the aim to solve this issue, this thesis argues that ROV is the best way to capture the upside value in high volatility environments. To test this hypothesis, this thesis applies the combination of the DCF-model and ROV to a case study of Maersk Drilling. Maersk Drilling is identified as a company operating in an industry, which is transitioning from its maturity to decline. This transition has been identified by looking at selected industry characteristics; Industry drivers, market saturation, competitive situation, technical development and lastly, by looking at five financial principles that characterise companies that have transitioned from its maturity to decline.

This thesis defines the ILC transition from maturity to decline as a relatively short period in which the industry experiences characteristics of both the mature and the decline phase at the same time. As a result, this period is more volatile and uncertain than the middle of the phase. After the ILC-transition has been identified, an in-depth look at the DCF-model reveals that volatility will always affect the valuation negatively. The model cannot capture the upside potential of volatility. As a result, it undervalues companies in volatile environments. An in-depth look at ROV, reveals that the upside value of volatility can be captured by considering the managerial flexibility.

Finally, the theories are put to use, and this thesis conducts a valuation of Maersk Drilling based on the DCF-model as well as with the addition of ROV. A comprehensive forecasted budget is estimated and the DCF-model values Maersk Drilling at a share price of USD51.04 (DKK345.10). The ROV is then applied on a business unit level. The chosen business unit is the one with the highest uncertainty, as this theoretically should be the one where managerial flexibility is most valuable. The thesis identifies an abandonment option which, through a five-step framework, is valued at USD 229m. This results in a 10.80% value increase compared to the initial valuation and a fair share price of USD56.56 (DKK382.43). The increased valuation implies that the DCF-model on a stand-alone basis undervalues companies in ILC-transitions.

Table of contents

1. Introduction

1.1 Background

Valuations are very important to the world of finance. Value is the driver of all investments and valuations are the only tool that investors can use to quantify the value and thereby determine whether an investment is fair or not.

Furthermore, companies are judged by their ability to create value for their shareholders. In this regard, valuation models have become tools to measure attractiveness for investors. Investors do not just look at the short-term operational analysis, they rely on models like the DCF-model to value companies' ability to create long-term cash flows for its shareholders. On top of the value creation for the shareholders, theory argues that valuation models, such as DCF, measure companies' ability to create value for its stakeholders as well. The logic being, that a company can only create long term value for its shareholders if it also creates value for its stakeholders. As a result of the increased focus on valuations and their implications for shareholders, it has become a competitive driver for companies, leading to optimisation in the pursuit of high valuations.

The benchmark for valuation models has long been the DCF-model, and with good reason. The DCF-model can capture both short-term performance and long-term growth. However, the DCF-model is not without flaws. This thesis sets out to identify the weaknesses of the model and strengthen these by supplementing the DCF-model with the necessary tools from real option valuation. The DCF-model builds on several assumptions about the future cash flows that has to be made by the analyst. This leaves the quality of the valuation in the hands of the person who is conducting it and thus poses a risk to the accuracy.

The DCF-model assumes a fixed path for the company's cash flows, but this is only realistic if the environment is stable. If the company is operating in uncertainty, this fixed path might end up being far from the truth. In practice, the management will try to navigate in the business environment and exploit the opportunities that arise. If for instance, the market turns out to be more favourable than anticipated, the company might increase investments, and vice versa, if the market turns out to be worse, the company might divest. By supplementing the DCF-model with real option valuation when valuing parts of the business with high uncertainty, the accuracy of the valuation can be increased. Real option valuation takes managerial flexibility into account and the model allows the management to act accordingly if the business environment changes.

The only way the DCF-model can incorporate similar changes is by running several scenarios in separate models and weighting their result based on their probability of materialising. Thus, requiring a significant calculational burden for the analyst. On the contrary, if you know the possible scenarios to create multiple DCF-models, then you can also create even more accurate real option valuations.

1.2 Problem outline

The research gap that this thesis aims to specify and mitigate, is the shortcomings of the DCF-model when valuing companies in industries that are transitioning from one phase to another.

Shortcomings of the DCF-model are nothing new, and the model has been critiqued by many academics and practitioners since its invention. When industries are transitioning from one phase to another, the shortcomings of the DCF-model are even more profound because of the increased uncertainty. For many years the period of transition was rarely the focal point of critique. Research has generally been weak when it comes to looking at transitioning industries. Not in the middle of the phases such as growth or maturity, but rather when an industry transitions from one to another. The challenge is that the pace of the transition is uncertain and volatility increases as the industry experiences characteristics from both of the phases it is in between at the same time. However, within the last decade, more attention has been paid to this. The far majority have focused on the shortcomings when valuing companies transitioning from the start-up phase to the growth phase or from the growth-phase to the maturity-phase. Somehow, the literature has to a large degree overlooked the transition from maturity-phase to decline.

The DCF-model fails to accurately estimate the intrinsic value of companies that are operating in uncertainty, as it does not consider the management's ability to act accordingly. Furthermore, the model assumes that the company will operate on a going concern basis. This will likely overvalue companies that are in decline, as the industry is assumed to never die, or that the company successfully switches to another industry.

As alternatives or supplements to the DCF-model, there are plenty of other valuation models which can be used in a combination or on its own. Whether a combination or a stand-alone model is outperforming the others is up for debate and depends on which type of company is being analysed. In other words, there are no "one size fits all" but rather a tailored suit for various parts of the industry lifecycle. However, how to tailor the suit is the real question.

The aim of this thesis is then to identify the weaknesses of the DCF-model in the transition from maturity to decline and strengthen these. This will be done with the use of a supplementary valuation model that is more suited for volatile and uncertain industries. This thesis argues that teal option valuation is such a model. Note that this thesis then, is not aiming to create a new valuation model, or invent new combinations of existing methods, rather it is trying to identify how existing models and methods can be used to uncover value in uncertainty to reach a more accurate valuation.

1.3 Problem statement

Based on the research gap identified above, the thesis aims to shed light on the shortcomings of the DCF-model when valuing companies in ILC-transitions. The thesis will follow a two-steps approach. Firstly, by identifying an industry that is facing an ILC-transition and analyse *how, when* and *to what degree* this transition will affect the industry and companies within. Secondly, by supplementing the traditional DCF-model with real option valuation to capture the value of managerial flexibility.

The research question for this thesis is:

> *"How can real option valuation overcome the shortcomings of the DCF-model to increase the valuation accuracy of companies in industry life cycle transitions?"*

To ensure that the research question is answered exhaustively, several sub-questions will be answered:

- What is the ILC and what are the characteristics of companies in the various phases and transitions? *(Summary in chapter 2.1.3)*
- How does the traditional DCF-model capture value and is it applicable for companies in ILC transitions? *(Summary in chapter 2.2.4)*
- How does ROV capture value and is it applicable for companies in ILC transitions? *(Summary in chapter 2.3.4)*
- How can ROV strengthen the DCF-model when conducting valuations in ILC transitions? (*Summary in chapter 2.4)*
- Where on the ILC-cycle is the offshore drilling industry? *(Summary in chapter 4.5 & 4.6.1)*
- What would a DCF-model value Maersk Drilling at? *(Summary in chapter 7.4)*

- How would the DCF-valuation change with the addition of ROV? *(Summary in chapter 8.6)*

1.4 Delimitation

Due to the Covid-19 and OPEC+'s price/supply war, the analysis of this thesis has been conducted with a cut-off date of the 31st of January 2020. Information that has come forth after this, have been excluded in the analysis, to ensure comparability in data. It is not possible for us to assess with any certainty the implications of COVID-19 and OPEC+'s failed renegotiation on Maersk Drilling or the industry, both generally in terms of how long the current crisis may last and more specifically in terms of its impact on Maersk Drilling's business. Maersk Drilling is likely to face significant supply issues if its supply chain includes companies in regions where the authorities have implemented, or may implement, measures to contain and/or prevent the spread of COVID-19. Similarly, demand for products may be significantly impacted. Maersk Drilling has recently modified its short-term projections to try and show a possible outcome; it has not publicly considered the potential impact on balance sheet items. Furthermore, this thesis will be limited to only look at real option valuation as a supplement to the DCF-model, as the space restriction of the thesis does not allow the application of multiple theories.

1.5 Methodology

This thesis utilises the deductive approach in which existing literature is used to identify potential research gaps. The aim is then to bridge these gaps by using existing theory in a different way or a different context such as the chosen case. The research gap that this thesis aims to exploit, is the shortcomings of the DCF-model when valuing companies within transitioning industries, that are characterised as highly uncertain. This exploitation is done through a case study of Maersk Drilling and the offshore drilling industry.

The analysis of this dissertation is based on the strategic concept of managerial flexibility. In addition, financial theory is applied in an untraditional way in the attempt to quantify the value of the managerial flexibility. During this process, the thesis will utilise a positivistic approach where the analysis will be conducted in the most objective way possible to facilitate research replication and thus increase reliability. In line with the positivistic approach, this thesis will take its outset in observable, measurable and quantifiable facts, where the

use of undocumented facts and qualitative data is minimised. This allows an objective outsider to reach the same results as this thesis if a similar analysis is conducted.
Reliability is an important characteristic of research quality, but it is not sufficient to ensure high-quality research. Validity is also an important characteristic of research quality. Validity refers to the appropriateness of measures used, and more specifically if the collected data truly represent the phenomenon being examined (Saunders et al., 2016). To ensure validity this thesis mainly utilises secondary and public data in the form of annual reports, industry reports, market reports, energy databases, company press releases and similar. Furthermore, to validate the utilised research data, non-biased sources have been triangulated. In addition, the annual reports for Maersk Drilling and its peers have all been audited, and thereby assumed to be as credible as possible.

To investigate the aforementioned research gap, a *case study* was chosen as the primary research design. The choice of research design was based on the fact, that case studies can generate valuable theoretic insights from an in-depth study of a phenomenon in its real-life context (Saunders et al., 2016). As valuation research is context-depending, we find the use of a case study highly appropriate.
Despite the case study being one of the most utilised research designs, the generalisability of the method is still highly debatable. The criticism of the case study is primarily based on the problem of induction, where no amount of data is ever sufficient to serve as ultimate proof for a general statement. Consequently, the findings of a case study will rarely be generalisable, and therefore the research design might not be contributing to the scientific development (Holm, 2016).
Despite the arguments presented above, Flyvbjerg (2015) argues, that the generalisability of the case study increases when the case is carefully selected. By doing this, the take-aways from a single case study can thus be applied to many cases. Figuratively speaking, by choosing companies that operate within uncertain business environments similar to Maersk Drilling's. It can thus be shown, to some extent, that the findings of this dissertation also apply to the other resembling firms and industries. As a result, by following the arguments of Flyvbjerg (2015), this paper will conclusively attempt to propose some level of generalisability of the presented findings.

As previously stated, this thesis will use Maersk Drilling as a case study. The reason for choosing Maersk Drilling is that the company is operating in an uncertain business environment due to the challenges that the offshore oil & gas drilling industry is facing. The industry as a whole is expected to shrink in the future, as the world transitions to greener energy sources. As a result, the industry will transition from being a mature industry to a declining industry. However, despite a declining trend in the industry, the future of some segments are more uncertain than others, as a result of higher asset specificity. Maersk Drilling is operating both in segments with relatively high and low asset specificity. Furthermore, the company has strong liquidity and a low degree of leverage which benefits the managerial flexibility. As a result, it makes sense to apply real option valuation methodology to the uncertain segments/business units to accurately estimate the intrinsic value of the company.

As explained in the background this thesis aims to bridge the research gap identified by applying a combination of valuation models. Here the DCF-model will build the fundamental valuation, and ROV will value the strategic element of managerial flexibility. In an old and established company like Maersk Drilling, it is expected that a significant amount of the value is captured in the DCF. As a result, this thesis makes sure to conduct an in-depth analysis and create a solid budget and forecast to ensure that the conditions for the subsequent ROV are optimal. As the ROV is the analysis that assumedly bridges the research gap, a significant amount of weight has been put on this part.

The overall structure of the dissertation is as follow:

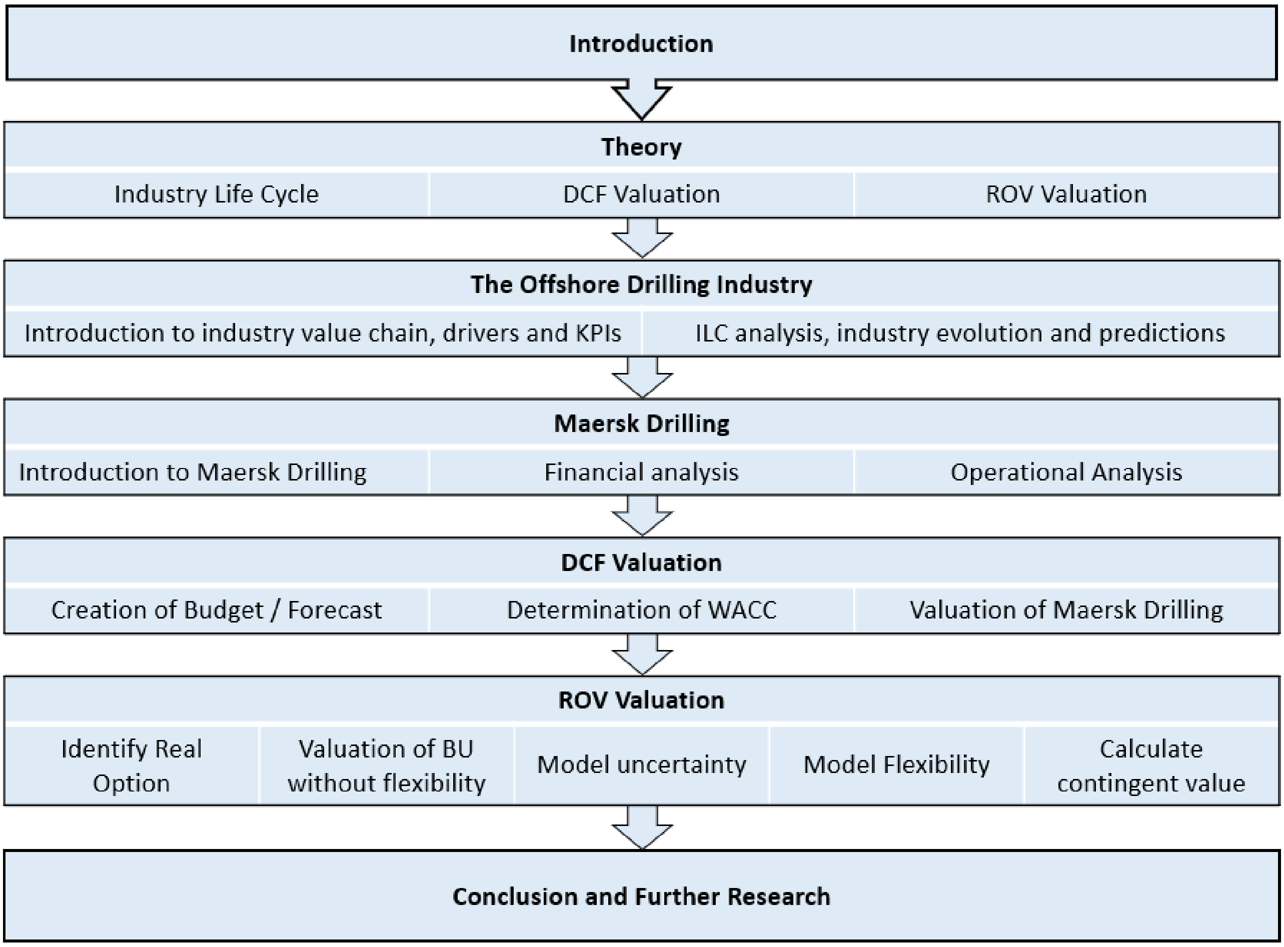

Figure 1: Thesis structure (Authors' creation)

2. Theory

This part of the thesis will revolve around the theories that will be used in the analysis. This includes the industry life cycle, the DCF-model, the ROV-model and Monte Carlo simulation.

2.1 Industry Life Cycle

The industry life cycle theory describes the life of an industry from its origins to its vanishing. The theory is relatively young compared to other industry-related theories. The idea of an industry life cycle has been around for a long time, but it was formalised by an empirical study conducted by Gort and Keppler in 1982 when the two identified five phases of a *product* life cycle (Klepper & Gort, 1982).

2.1.1 Industry life cycle phases

As can be seen on the graph below, the ILC-theory divides an industry's life into four phases, rather than five, as for the product life cycle (Klepper & Gort, 1982).

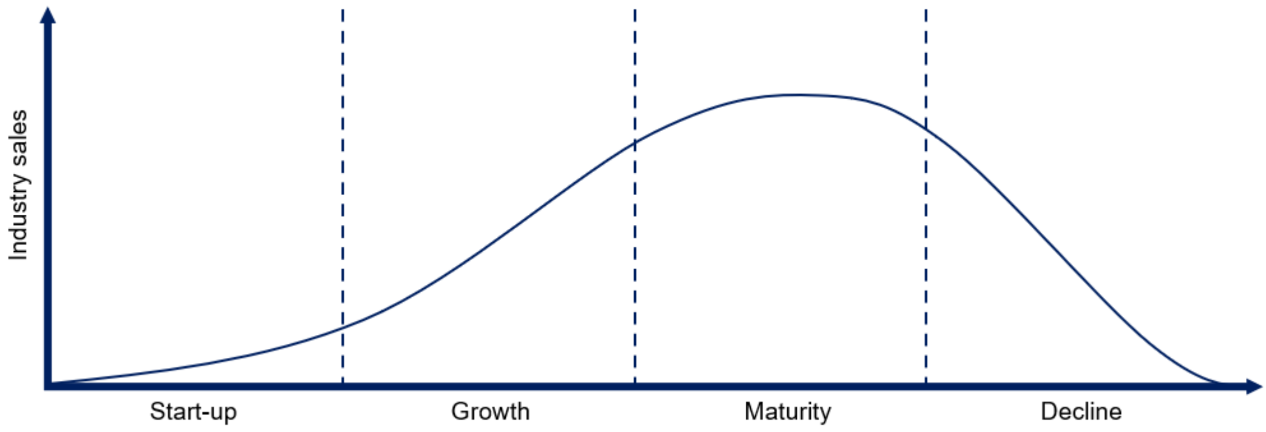

Figure 2: Illustration of the ILC (Authors' creation)

Each phase is characterised by certain features such as profitability, revenue growth, competition and more.

Start-up Phase:

The start-up phase, sometimes referred to as the introduction phase, is as the name indicates the birth of the industry. In this phase, a new product or service is being developed and some degree of marketing is happening. As the information about the product and service is typically fairly low, the revenue is as well. As this is very early in the life cycle the products are often being developed throughout the phase and improvements happens almost continuously. The industry tends to be highly fragmented and the profit is usually negative as costs are allocated to research and development while the revenue is low (Klepper, Industry Life Cycles, 1997).

Growth Phase:

In the growth phase, the product or service has progressed significantly in its development, and consumers have noticed the value. An increased focus on marketing spreads information about the product to more potential customers, as a result, revenue is growing rapidly. Usually, a few players in the industry manage to play an important role and conquer a significant market share. Profits are still not the top priority and are typically negative or low as companies still spend money on research & development, expansion and marketing. In the later part of the growth stage, the focus on business processes and general efficiency increases, in order to set up the industry for future profitability. At this point, established companies from related industries might try to enter through M&A activities (Peltoniemi, 2011).

Maturity Phase:

As the growth phase ends with established companies trying to enter the industry, the maturity phase starts with a shakeout period. During this period the growth slows down. The companies that successfully managed to improve business processes in the previous phase, now have an advantage. Often M&A activity will lead to economies of scale and smaller companies will not be able to compete anymore. In this phase, the barriers to entry become higher as the industry leaders have built economies of scale and also gained significant experience and knowledge (Klepper, 1996). Once the smaller companies have been forced out of the industry, profitability increases for the remaining players (Esteve-Pérez, Pieri, & Rodriguez, 2018).

Decline Phase:

The final phase of the industry life cycle is the decline phase. In this phase, the industry is no longer able to create revenue growth. As the competitors can no longer compete for growth, they will start competing more fiercely for the existing market share. This forces the weaker players out of the industry or to be acquired by stronger players as they search for potential synergies (Martin & Eisenhardt, 2004).

2.1.2 Industry life cycle transitions

Companies experience the most turbulent periods during the ILC-transitions as this is the time where their priorities change. As a result, it is crucial for companies to change their priorities at the right time to put itself in a competitive market position when entering the new ILC-phase (Peltoniemi, 2011).

Newly established firms rarely survive the first transition from a start-up to a growth firm. The first challenge when examining a young firm in the start-up-phase of the ILC curve is figuring out which firms will live on to the growth phase. For the companies that do survive the start-up-phase, the challenge is now to estimate the rate of growth. Not only is it difficult to predict the growth rate for the industry, but as companies are growing and established companies from other industries enter in the early growth phase, some of these will outperform the smaller firms (Klepper, 1996). As a result, it is very difficult to estimate the growth rate on a company basis shortly after the transition. The companies that were outperforming the others will inevitably enter the mature phase, where the management's focus changes in the direction of cost reductions, capital structure and inorganic expansions through M&A (Damodaran, 2009). The last transition is the transition from maturity to decline, which is the transition this thesis will focus on. The phase is by many overlooked, as managers typically deny the decline. Instead, they present turnaround solutions or plans to reinvent the industry, rather than discuss the fact that the industry is in decline. This mindset starts from the late growth stage, where companies wish to maintain growth, rather than enter the mature phase. Mature companies likewise do not want to enter the declining phase. A negative paradox that this mindset leads to, is the pursuit of new growth, that often leads to unprofitable investments, increased debt, and as a result; value destruction (Damodaran, 2009). The transition from maturity to decline is particularly interesting because the industry is changing from a steady phase to a phase where revenue starts to decline and industry players start fighting for market shares to maintain profits. As a result, it is a significant challenge for the industry players to decide when to start changing their strategy (i.e. when to acquire or merge with competitors, when and if to start a price war etc. (Peltoniemi, 2011). Companies that enter the transition with weak liquidity, high leverage, high production costs or the likes will be challenged, and eventually forced out of the industry. The reason being, that companies need to prepare themselves for this transition. If a company just keeps going about its business as it did during the maturity phase, it will not have the ability to compete with its competitors who expected this change and prepared for it (Martin & Eisenhardt, 2004). Changing strategy in the late mature phase to prepare for the transition is a difficult decision to make. Companies that do so, are naturally limiting themselves by reducing their spending, borrowing and retaining their earnings. This decreases the short-term profitability more than their competitors who go about business as usual. The question is therefore whether to maximise profits during the maturity phase followed by a sharper decline or to limit profitability in the late maturity phase and soften the decline. This thesis takes inspiration in Damodaran (2009) and identifies companies in a declining phase as so:

1. All value comes from existing assets, and some of these assets might be worth more liquidated. The existing assets that generate all the value, might even be worth more in the hands of others – as a result, should be divested.

2. Little or no value can be gained from growth, and investments in growth are likely to give a negative return.
3. Companies in the decline phase, are facing far more severe consequences of being highly leveraged compared to other phases, as they cannot count on growth or improving margins to help pay their debt obligations. As a result, decline and distress are often closely linked.

2.1.3 Summary of the ILC phases, the transitions and their effects on companies

The ILC is a theory that describes the life cycle of all industries, by dividing it into four phases. The ILC phases (start-up, growth, mature, decline), all have different implications for the companies operating within these. Each phase requires companies to adjust their priorities and strategies to be competitive. In the start-up phase, the industry tends to be highly fragmented and the profit is usually negative as costs are allocated to research and development and innovation is the main focus. In the growth phase focus changes in the direction of marketing and spreading information about the product to more potential customers. Usually, a few players in the industry manage to play an important role and conquer a significant market share. In the mature phase companies that successfully managed to improve business processes in the previous phase, now have an advantage. Often M&A activity will lead to economies of scale and smaller companies will not be able to compete anymore. In the decline phase, the industry is no longer able to create revenue growth. As the competitors can no longer compete for growth, they will start competing more fiercely for the existing market share.

Transitioning from one phase to another poses a significant challenge, as companies in this period are affected by the characteristics of two phases at the same time. As a result, timing is important when adjusting the strategy to be successful in the coming phase. The focal point of this thesis is the transition from the mature phase to the decline phase. This transition has to a large degree been overseen because the general optimistic mindset of managements, leads us to believe that the phase is avoidable. However, it is concluded that new growth cannot always be found and the decline phase is a certainty for some. In this transition, companies will phase characteristics such as stagnating or declining revenue and margins. A growing share of the value created will be generated by existing assets and investments in growth will not create the same value as it did previously.

2.2 Discounted Cash Flow analysis

As for all valuation models, the Discounted Cash Flow-model (DCF) is trying to capture the value created by a selected company or asset. In essence, the value created by a company is driven by its ability to generate a positive return on invested capital and its ability to grow. The DCF-model quantifies the intrinsic value of an asset, by discounting the future cash flow to today's value. This will return the fair price, solely based on the cash flows generated. It is essential to know this when acquiring assets, to avoid paying more than the fair price for the future cash flows that the buyer will take over (Damodaran, 2006).

The DCF-model is heavily reliant on an accurate discount rate. While discounting future values to present value can be traced back to 1907 (Fischer, 1907), it was not commonly used as a valuation model until 1962 when Gordon popularised it (Gordon, 1962).

Since then, the DCF-model has become one of the most used valuation models for both practitioners and academics. The main argument that speaks in favour of the DCF-model is that the method solely relies on cash flows and not accounting-based results. This means that the valuation cannot be manipulated by creative accounting schemes.

2.2.1 Fundamental of the DCF-model

There are several methods to conduct a DCF analysis. This thesis will use a common variant, which discounts the free cash flow to the firm (FCFF) (Penman, 2012) (Imam, Barker, & Clubb, 2008). The FCFF denotes the cash flow that belongs to the whole company, i.e. both the creditors and the equity owners. The formula for FCFF can read as:

$$FCFF = NOPAT + non\ cash\ operating\ expenses + change\ in\ net\ opreating\ assets$$

In the formula above, NOPAT represents the Net Operating Profit After Tax. To go from NOPAT to the free cash flow, non-cash operating expenses such as depreciation and amortisation is added as well as the change in net operating assets.

Once the FCFF has been calculated and forecasted for the number of periods where it is deemed accurate, it is discounted back to today's value. As this paper uses FCFF, which belongs to both the creditors and equity holders, the cash flow has to be discounted with the weighted average cost of capital (Koller et. al, 2015). However, as mentioned just above, the FCFF is only forecasted for a number of periods, after which the forecasted FCFF is deemed inaccurate. To value the cashflows generated after this period, the DCF-model assumes that the company enters a steady-state with a constant growth rate of the FCFF on a going concern basis. In other words, the model assumes that the company will operate forever, at a certain growth rate. The complete formula for the DCF-model can be read as (Koller et. Al., 2015, p. 795):

$$DCF = \left(\frac{FCFF_1}{1+WACC} + \frac{FCFF_2}{1+WACC^2} + \cdots + \frac{FCFF_n}{1+WACC^n}\right) + \left(\frac{FCFF_n * (1+g)}{WACC-g} * \frac{1}{1+WACC^n}\right)$$

The first half of the formula represents the discounted value of the forecasted FCFF. The second half of the formula is Gordon's Growth Model (Gordon, 1962). It represents the company in its steady-state with a constant growth (or decline) rate on a going concern basis. Here "g" is the constant growth rate. The perpetuity is necessary because the alternative is to forecast each periods' FCFF to eternity, as a result of the going concern assumption.

To the common reader, it might sound controversial to believe that it is possible to accurately predict the future FCFF and more so, a perpetual stream of cash flows with a specified growth rate. However, most sophisticated valuation models require forecasting as part of the analysis. As a result, this thesis argues that the methodology of forecasting cash flows in the DCF-model should not raise any concerns.

2.2.2 Uncertainty in the DCF-model

A point of critique about the DCF-model is its ability to value uncertainty. Some valuation models have dedicated features to accurately evaluate and put a value on uncertainty. However, the DCF-model only captures the uncertainty in the weighted average cost of capital (WACC) (Bierman, 2009). The WACC is a widely used concept, but that does not mean that it is without flaws. The WACC, as seen below, consists of several components, which are all posing a risk of imprecision (Koller et. al., 2015).

$$WACC = \left(\frac{Net\ Debt}{EV} * r_D * (1-tax)\right) + \left(\frac{Equity}{EV} * r_E\right) + \left(\frac{Preferred\ Stock}{EV} * r_{PS}\right)$$

The DCF-model uses the WACC, as the rate at which the future cash flows are discounted. The WACC represents the required return from all sources of financing. The concept is fairly simple and easy to understand. However, this does not mean that estimating an accurate WACC is simple. The WACC can include many sources of financing, which can easily be incorporated in the formula, as long as the required return can be estimated. The return requirements for debt is in theory not very complicated to calculate, but the return requirements on equity can carry a lot of computational risks and be hard to compute accurately, as several components go into this computation (Bierman, 2009). Regardless of the level of complexity when calculating the return requirements it is important to rely on solid data, to avoid ‘fudge factors’, which is a biased adjustment on the rates, based on the analyst’s intuition.

The cost of debt is computationally lighter than the cost of equity. Often the cost of debt can be observed from a company’s debt obligations. As the debt obligations are typically more senior than other financial obligations, the yield to maturity can be used, as this represents the interest if the bond is held until maturity (Homer & Leibowitz, 2013). Another more computationally heavy method is to compute the cost of debt as the risk-free rate with an added premium. Note here that premium will be lower than for equity, as debt is more senior than equity in case of bankruptcy (Newton, 2003). It must also be noted that the effective cost of debt is reduced, as the company benefits from a tax shield on its debt obligations based on its marginal corporate tax. The WACC formula assumes that the company can make full use of the tax shield, which also makes the computation lighter.

The cost of equity represents the return that the shareholders require given the risk they take. This return is calculated using the Capital Asset Pricing Model (CAPM) developed in 1964 by Sharpe (Sharpe, 1964). The formula can be read as:

$$r_E = risk\ free\ rate + \beta * market\ risk\ premium$$

The output of the CAPM plays a significant role in the WACC formula. As a result, it is important that the calculations of all components are accurate. In the formula, β represents the market risk that shareholders are taking. It is a historical measure of how much the equity’s value fluctuates relative to the market. The β does not include firm-specific risk, but only the market risk. This is because classic portfolio theory argues that firm-specific risk can be diversified (Bodie, Kane, & Marcus, 2014). The more sensitive the company is to market movements the higher the β-value will be, which indicates higher market risk. The lowest risk possible is if β is zero, as this means the company moves completely independently from the market. A negative β means that the company moves in the opposite way of the market. The risk-free rate and the market risk premium are unrelated to the firm, as they represent what alternatives the investor has. The risk-free rate can be observed by looking at government bonds. The market risk premium can be calculated by looking at historic

returns from relevant stock indices and deducting the risk-free rate from this return (Pratt, Grabowski, & Brealey, 2014).
Based on the components just discussed, β accounts for the risk that an investor takes when investing in the firm's equity. In other words, the β defines the risk in the CAPM-formula. The CAPM-formula's ability to capture risk can be criticised though. If the firm has a high β and investor will require a high return according to the CAPM. Tracing the effect of a high β back to the WACC formula, this will increase. As a result, the higher discount rate will result in a lower valuation (Pratt, Grabowski, & Brealey, 2014). However, a high β does imply a larger risk, but also a larger potential reward. As a result, the DCF-model can be seen as risk-averse as it fails to capture this element (Chong & Philips, 2012). As this thesis is focusing on valuations in ILC transitions, the risk is further increased as described earlier. The result of this is that the valuation will suffer under an increasing β.

2.2.3 Flexibility in the DCF-model

Uncertainty is not the only area, critique can be pointed towards. Often uncertainty requires management to act, which creates an element of optionality or flexibility. The DCF-model builds on a forecasted FCFF that is predetermined for each period when the valuation takes place. In other words, if unexpected events occur and the FCFF changes, the DCF valuation will no longer be accurate. Events could affect the future FCFF both positively and negatively, but the DCF-model would not be able to incorporate either scenario in its valuation. In practice, the management will act and modify the firm's strategy if the FCFF changes unexpectedly. This managerial flexibility is not captured in the DCF valuation. This thesis argues that in order to capture the most accurate value, the valuation method must treat the future FCFF as a probability, rather than a certainty as the DCF-model does.
To compensate for the lack of uncertainty, the DCF-model can be modified with the use of sensitivity and scenario analysis. However, as this thesis argues that value can be captured from the management's ability to choose between different plans, based on how the future develops, the DCF-model is not adequate even combined with a sensitivity and scenario analysis (Trigeorgis, 1996).

2.2.4 Summary of the DCF-model and its applicability in ILC-transitions

The DCF-model is the benchmark of valuation models. It is a valuation model that is very accurate if the underlying assumptions are fair. The model discounts the future cash flows with a rate that represent the return requirements of the investors and creditors. This thesis argues that the DCF-model is most accurate when used in the middle of the ILC phases, as the operating environments in these, all else being equal, are more stable than in the transitions. In the transitions, industries and companies within, are experiencing more uncertainty and higher volatility due to the market changes. This causes the underlying assumptions to be less accurate and more importantly, it causes the risk measurement in the DCF-model, beta, to increase. As a result of this, the valuation will decrease as the DCF-model cannot capture the upside of increased volatility. This chapter concludes that the DCF-model should be supplemented by a model which can accurately value both the upside and the downside of increased volatility, especially in ILC-transitions.

2.3 Real Option Valuation

Essentially real options are just an extension of financial options. Where a financial option is a contractual option that gives the buyer the right but not the obligation to buy or sell an underlying asset at a predetermined price, the real option represents the same way of thinking but applied to real assets without a contract (Peters, 2016). With this in mind, understanding financial options is the most logic way to introduce the concept of real options. A financial option is a type of derivative, which means that its value is derived from an underlying asset or security. The buyer of an option, can either bet on an increase or a decrease in the value of the underlying asset. If the buyer believes that the value of the underlying asset will increase, a *call option* is relevant. Vice versa, if the buyer believes that the underlying asset will decrease in value, a *put option* is relevant (Bodie, Kane, & Marcus, 2014).

A *call option* gives its holder the right to buy the underlying asset at a predetermined price in the future. The predetermined price is referred to as the exercise- or strike price. The holder of the option or the "right", will only exercise the option so forth the value of the underlying asset is higher than the exercise price. If that is not the case, the holder will simply let the option lapse and the contract will no longer be valid. If the value of the underlying asset is higher than the exercise price, the holder will use his right to acquire the asset at the exercise price. The holder of the option will then profit from the difference between the exercise price and the market price of the underlying asset. If the option is exercised the net profit equals, the market price of the underlying asset minus the exercise price and the price paid for the option, called the option premium (Bodie, Kane, & Marcus, 2014).

A *put option* is essentially the same thing as a call option, but instead of betting on an increase in the value of the underlying asset, you are now betting on a decrease. The put option gives its holder the right to sell the underlying asset at a predetermined price. This means that the holder of a put option will exercise the option, only if the value of the underlying asset is lower than the exercise price. If the put option is exercised, the net profit is equal to the exercise price minus the market value and the option premium (Bodie, Kane, & Marcus, 2014).

If it is rational to exercise the option, i.e. if the difference between the market value of the asset and the exercise price is in favour of the holder, the option is said to be "in the money". If the option holder rationally chooses not to exercise the option as this would cause a loss, the option is said to be "out of the money". Lastly, should the exercise price be equal to the market value of the asset, the option is said to be "at the money" (Jordan, Hillier, Westerfield , Clacher, & Ross, 2017).

Financial options have become a standard financial derivative and can be traded over the counter (OTC) for almost any underlying asset. The contractual agreements of an option can vary depending on the buyer's risk preferences. The most common option is noted as a *European style* option. A European style option means that the option can only be exercised at the maturity date. In other words, the holder of the option can only choose to exercise the option at a specific point in time, that is predetermined when the contract is agreed upon. Another style of option is an *American Option* which allows the holder of the option to exercise the option any time before the maturity date. Naturally, this type of option demands a higher premium as it limits the option holder's risk (Bodie, Kane, & Marcus, 2014).

Table 1: Financial option vs Real option (Authors' analysis)

Variable	**Financial option**	**Real option**
Underlying asset price, S	Stock price	Intrinsic valuation
Exercise price, K	Exercise price as per contract	Investment cost/sales price of realising the option
Volatility, σ	The volatility of the stock price	Uncertainty in the development of intrinsic value and exercise price
Maturity, T	Time to maturity as per contract	The period where the option can be exercised / completion time

Real options theory is a way of applying financial principles to real assets. Real options are used to describe the option a company has to choose between different plans, as the future evolves (McGrath, 1999). The table above shows the similarities between real options and financial options. In the table, it can be seen which real variables are equivalent to which financial variables. Even though the table above might depict financial and real option as being very similar, there are significant differences. Firstly, real options are rarely put in place by a contract, and the option can lapse before the initial estimated expiration date if circumstances change. As a result of this, the real options can be pre-empted and are mostly non-tradeable (Trigeorgis, 1996). The fact that changes to the future can pre-empt the real option, implies that the management must be aware of the real options and act accordingly to make sure to capture value from them. As a result, the value of the real options can be affected by internal organisational decisions and competitors acting unexpectedly. This makes real option significantly different from financial options. Real options are typically most similar to American style options, as there are no contractual terms stating the exact exercise date. However, the maturity date is not set in stone and can quickly change. As a result of these differences, one cannot simply apply regular option valuation techniques such as the Black-Scholes to compute the value of a real option (Black & Scholes, 1973).
Despite these important differences between financial and real options, this thesis argues that ROV is a valuable model for capturing the value of managerial flexibility in uncertainty. In *table 2* below, an overview of the most common real options are presented, as well as their equivalent financial option.

Table 2: Types of options (Authors' analysis)

Type of option	**Description**	**Equivalent financial option**
Abandonment	The option to leave or divest an asset if circumstances turn out unfavourable.	Put
Expansion	The option to expand an asset or operations if circumstances turn out favourable.	Call
Switch	The option to switch priorities and upscale an asset or operation while downscaling another.	Put and Call
Defer	The option to postpone decision making based on future information. Only exercising the option if circumstances are favourable.	Call

2.3.1 Fundamentals of ROV

As explained above, real options have some significant differences from financial options, which means that the financial valuation models have to be modified to accurately value real options. It is also mentioned that real options are most likely to take shape as an American option. For this reason, it is discouraged to use the Black Scholes formula. In the literature, one can find several ways of valuing a real option. This thesis argues that using a binomial approach will give the most accurate option valuation, as this is the preferred way of valuing American style options. The binomial valuation method was developed in 1979 (Cox, Ross, & Rubenstein, 1979) as a more intuitive tool to value options compared to the Black-Scholes, which was designed to value European financial options. The binomial approach has many benefits for the reader and the analyst. It is easy to comprehend and apply to a wide range of options, both financial and real. It maps the different scenarios of how the option can play out in a simple manner. Furthermore, the binomial approach does not force fit the option into the model.

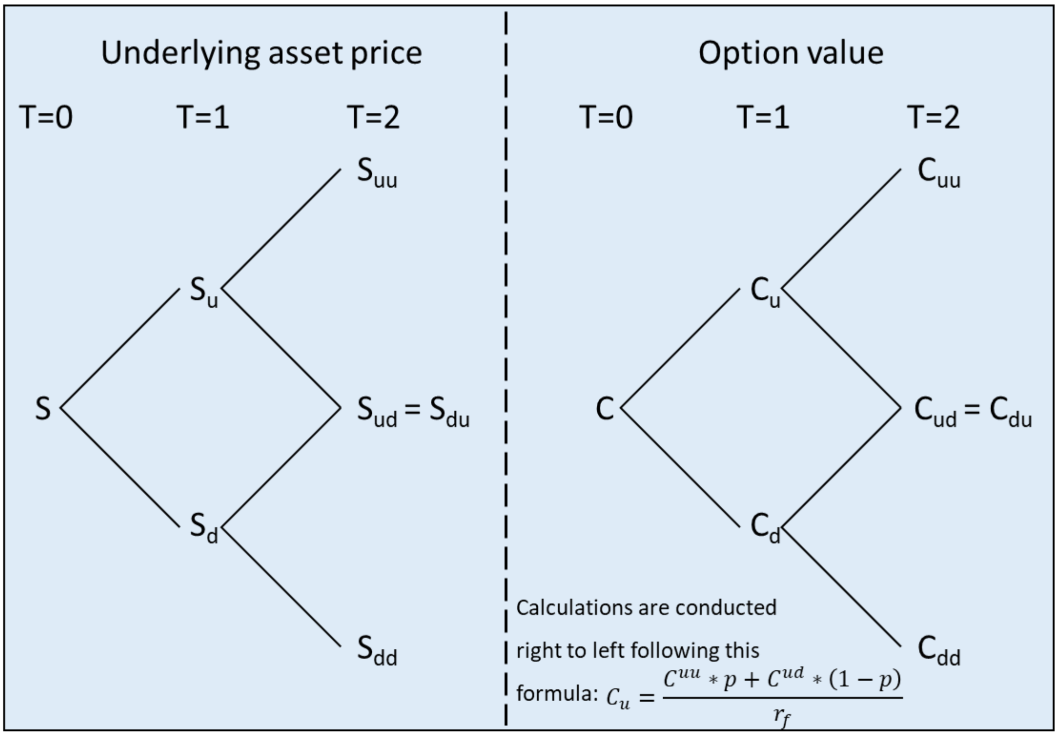

Figure 3: Binomial Valuation Method (Authors' creation)

Figure 3 above shows how the price development in the underlying asset (LHS) materialises in the option value (RHS). Each node on the left-hand side corresponds with the equivalent node on the right-hand side. The change in value from one node to the next is defined by the up- and down-factor: $up = e^{\sigma\sqrt{\frac{T}{N}}}$ and $down = \frac{1}{up}$

As it can be deducted from the up and down formulas, the volatility in the underlying asset value, σ, can result in both an upside and a downside. The likelihood of a node to move up or down is defined by the risk-neutral probabilities, where the probability of an up movement equals $P = \frac{\left((1+r_f)-d\right)}{u-d}$ and a down movement is then equal to $1 - P$.

One of the benefits of using risk-neutral probabilities is that the approach is basically calculating the certainty equivalent (CEQ) cash flows, which allows the analyst to discount with the same risk-free rate in all periods. This is because when using CEQ cash flows, the analyst has already accounted for risk, and therefore only needs to take account of the time value (Allen, Brealey, & Myers, 2016).

2.3.2 Uncertainty in the ROV approach

As mentioned above, the ROV-method uses the volatility in relevant variables to estimate a single value for the total volatility to develop up- & down-factors.

This means that through a “random walk” the model can estimate different outcomes and their likelihood of happening (Kac, 1947). This can seem simplified at first glance, but actually, this method solves one of the problems that this thesis has criticised the DCF-model of. The DCF-model can only account for uncertainty as a negative measure, as a higher beta equals a higher discount rate. Whereas, the ROV maps out various possible scenarios including high-case scenarios where the volatility has caused continuous up-movements, and conversely low-case scenarios where the volatility has caused continuous down-movements. In this sense, the model is much better at handling uncertainty than the DCF-model (Koller et. al, 2015). Empirical research shows that firm volatility seems to increase returns, which is contradicting to the traditional DCF-thinking. However, this is of course in an operating environment where the management can navigate in the uncertainty to exploit the market movements. To navigate the environment, the management can use strategic tools to adjust to a changing market. Furthermore, research has shown that the ROV-model’s assumption of constant volatility throughout the life of the option is fair (Copeland & Antikarov, 2001).

The ROV-method manages to separate risk and uncertainty, where the DCF-model combines the two. The way that ROV separates the two, is to measure risk as the volatility in the price of the underlying asset and uncertainty as to whether the real option is exercisable. This is one of the most important aspects of the ROV-method compared to the DCF-model. The ROV-approach to volatility is not without issues, however. Generally, the ROV can use two methods of calculating the volatility. One approach is to use historical figures, another is to use a subjective approach. Whether to use one or the other is determined by the prediction of the future. If it is fair to assume that the past is a good indicator of the future, a historical approach might be used, but if there has been no pattern to the volatility and the future is expected to be different, a subjective approach might be more appropriate (Cools & Nuyens, 2014). The historical approach looks at the key variables behind a firm's free cash flow and measures the past volatility and the correlations between these. Through Monte Carlo simulation the volatility is compounded into one measure. This approach is very similar to estimating beta in the DCF-model's, and while this does give reason for estimation concerns, the issues are less significant than the ones in the DCF-model (Cools & Nuyens, 2014).

2.3.3 Flexibility in the ROV approach

As touched upon above, the advantage of ROV is its ability to capture flexibility. More specifically the ROV-model can capture the management's ability to navigate in a changing environment and act accordingly. Managerial flexibility is the essence of option value creation (Koller et al., 2015). Naturally, the model cannot capture all scenarios, as it can only model what we know, and what we know that we do not know. In other words, the model cannot capture *unknown unknowns* (Penman, 2012). The dynamic approach that this model has, allows for the management to either exercise the option or not. This way ROV can maximise the upside, while limiting the downside, by always choosing the best option as long as no unknown unknowns materialise (Koller et al., 2015). This element of flexibility sounds essential for any valuation, yet the DCF-model cannot take it into account (Pivorienė, 2017). However, it is important to note that it is indeed a possibility to encounter unknown unknowns. The further into the future the model predicts, the higher the uncertainty is. This increases the value of the option, but it also increases the risk that unknown unknowns materialises. As a result, it is important to take this into account when modelling the forecast horizon.

2.3.4 Summary of the ROV and its applicability in ILC transitions

ROV is a valuation model that can capture value from managerial flexibility. The model does not value a company as a whole, but rather the options the management can choose between. It does this through a binomial approach in which the value of the underlying asset goes either up or down for each period into the future. The size of the up and down moves are dictated by the volatility of the variables that drive the value of the underlying asset. Because this model factors in, both up and down moves, the management can utilise the upside, while limiting the downside by exercising the real options that are available to them. The model is applicable both in the middle of the phase as well as in the ILC-transitions. One requirement for an accurate estimate is that the volatility can be measured accurately. As discussed earlier, transitions are rare and complex, why the historical volatility might not be accurate, and forecasting is necessary. This could potentially lead to less accurate valuations.

2.4 ROV as a supplement to the DCF-model

Above, this thesis discussed the strengths, weaknesses and differences between ROV and the DCF-model. This chapter will discuss how ROV can supplement the DCF-model.

This thesis argues that the DCF-model is still to be considered the benchmark of valuation models. For this reason, ROV should, and could not, be used to value a company as a stand-alone model but should be used in combination with the DCF-model. The DCF-model is great to value companies in predictable environments, as accurate forecasts can be made. However, the DCF-model is not ideal under high volatility and uncertainty, as companies experience in ILC-transitions. More specifically the DCF-model lacks the ability to capture the upside potential of volatility through managerial flexibility. The ROV can be applied to capture just this value. As a result, the ROV supplements the DCF-model in high volatility scenarios that are affected by uncertainty. It should be noted, that this is only the case if there is a real option present and the management can exercise this (Koller et. al, 2015). It must also be noted that ROV as a stand-alone model can, in theory, be used to value commodities and assets where the price is observable in the market. However, in most cases, the underlying asset is not traded OTC and thus, the underlying value has to be estimated with a model such as the DCF-model.

2.5 Monte Carlo Simulation

As previously stated, Copeland and Antikarov (2001) use Monte Carlo simulations to model the volatility of the real option.

Monte Carlo simulation is an analytical method in which real-life systems are imitated. The simulations randomly generate values for uncertain variables repeatedly to simulate a real-life model. The uncertain variables are defined as variables, which has a known or estimated range of value, but an uncertain value for any specific time, event etc. (i.e. demand, day rates, revenue, production costs etc.). Based on the characteristics of the uncertain variable, a corresponding probability distribution is assigned. An assigned computer-based simulator such as @Crystalball or @Risk, will then run a number of predetermined simulations and randomly generate value for each uncertain variable (Mun, 2005).

The simulations allow the analyst to identify the possible outcomes and their likelihood, and thereby quantify and asses the risk taken when committing to a given action (Cools & Nuyens, 2014).

Monte Carlo simulation is particularly relevant for option and real option valuations based on binomial methods, as the simulations can provide the analyst with potential outcomes at each binomial step. Volatility increases the complexity of real options valuation and makes it near impossible to calculate an accurate value using closed-form solutions, if there are various types of uncertainties and correlating variables. An advantage of the Monte Carlo simulation is its applicability in situations where different paths give different results.

3. The offshore oil & gas industry

This part of the thesis will focus on the offshore oil & gas industry and the drivers within to give context to the analysis. The offshore oil & gas industry supplies the world with fossil energy sources. The industry plays a vital role in global energy demand and has done so for many decades. Through approvals from various countries' governments, private or national companies are granted access to explore and produce oil across the world (Maersk Drilling, 2019).

3.1 The offshore oil & gas value chain

To comprehend the otherwise complex value chain, it is typically divided into three segments: Upstream, Midstream and Downstream.

Upstream refers to the exploration, development and production of reserves from offshore reservoirs. *Midstream* refers to the transportation and storage of the reserves (*Figure 4)*. *Downstream* refers to the refining, marketing and distribution of the reserves.

Figure 4: Illustration of the oil & gas value chain (Maersk Drilling Annual Report 2019)

Different companies take on different parts of the value chain and some take on more parts than others. Some companies handle the whole value chain themselves. These are so-called "Fully integrated" and are categorised as "Supermajors". Examples of such companies are ExxonMobil, British Petroleum, Eni, Shell, Total and Chevron. In addition to the supermajors, some countries have their own national oil & gas companies that are also fully integrated, referred to as National Oil Companies (NOC). Examples are Saudi Aramco and ADNOC (Maersk Drilling, 2019).

Other oil & gas companies only handle selected parts of the value chain and typically focuses on either Upstream, Midstream or Downstream. This type of companies are categorised as "Independents" and examples of such companies are Aker BP, Premier Oil and Tullow.

3.2 Offshore Reservoir life cycle

As this paper is a case study of Maersk Drilling, the focus will be on the upstream part of the value chain. This means that the reservoir life cycle is key to understanding Maersk Drilling's part of the value chain. The upstream part of the value chain spans from exploration to development, to production and maintenance to the last phase where the plugging and abandonment of wells take place (*Figure 5)*.

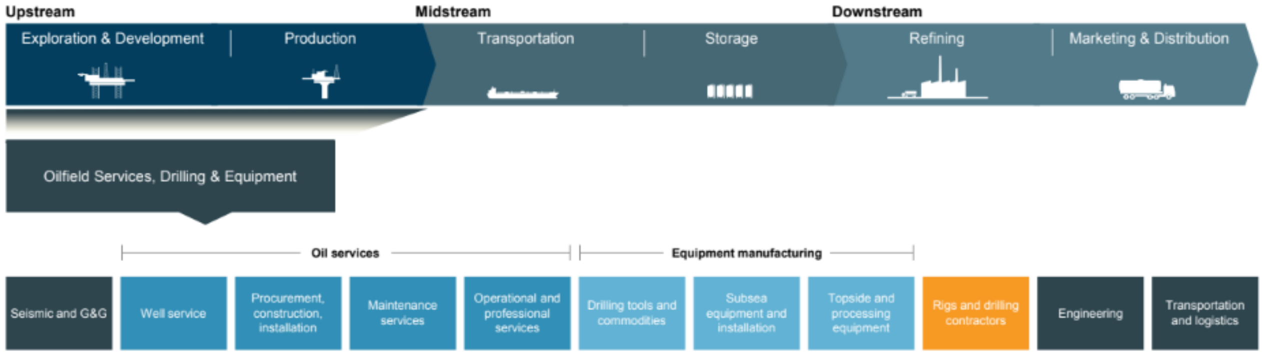

Figure 5: Detailed Illustration of the upstream part of the oil & gas value chain (Maersk Drilling Annual report 2019)

Exploration

The first step of the value chain is the seismic analysis. In this process, the seabed is being analysed by sending seismic waves through the seabed and into the underground to detect potential oil and gas reserves. If the seismic analysis shows sufficient evidence of an oil and gas reservoir, the actual exploration will start. A drilling company such as Maersk Drilling will drill an exploration well, also known as “Wildcat”, to confirm the seismic analysis and determined to what degree the oil and gas can be extracted. If it turns out there is no or a very little amount of oil and gas, the well is called a dry well. But if there is a significant amount of oil and gas the well will be set up for development. During this phase, drillers can also do appraisal drilling, which essentially is a number of exploration wells scattered near the initial well to see how far the reservoir extends (Maersk Drilling, 2019).

Development

Once the reservoir has been discovered and deemed economical, the development of the field begins. During the development of the field, the drilling contractor drills development wells that allow for the oil and gas to be extracted from the reservoir. This phase is more comprehensive than the exploration phase, as the wells are more complex. Furthermore, production and processing equipment needs to be installed to the wells and the flow line is to be connected to transport extracted oil and gas (Maersk Drilling, 2019).

Production and maintenance

Once all the equipment and flow lines have been installed on the well, the production can start. This is the phase where the oil and gas are extracted from the reservoir and either brought on to a tanker or directly to shore via pipelines.

During the production period, oil companies can choose to drill more wells in between functional wells to extract oil and gas even quicker. This type of well is called an infill well. Furthermore, injection wells are often drilled to enhance oil and gas recovery from a reservoir by pushing the oil and gas to other producing wells.

A reservoir can contain so large amounts of oil and gas that production can take decades. Due to the very long lifetime of such a reservoir, a significant degree of maintenance of wells and equipment is required to live up to the safety and environmental regulations. This maintenance is typically done by third-party contractors (Maersk Drilling, 2019).

Plugging and Abandonment

The last phase of the upstream part of the value chain is the decommissioning of the wells drilled. In this phase, the drilling contractor places a cement plug in the well to stop spillage of any oil and gas remains.

In case the exploration well is dry, the well will be plugged and decommissioned before reaching the development phase (Maersk Drilling, 2019).

3.3 Offshore drilling rigs

In the offshore drilling industry, three different rig types are used for different wells, depending on water depth and operating environment. The three types of rigs are Jackups, Semi-submersibles and Drillships (Maersk Drilling, 2019) Often the latter two are referred to as floaters, as they floating on the ocean surface rather than being attached to the seabed as a Jackup. This allows semisubmersibles and drillships to drill wells on much deeper water depths than jackups, but also means less stability when the operating environment gets challenging.

As illustrated in *figure 6* the best drillships can operate on water depths up to 12,000 feet, semisubmersibles up to 10,000 feet and jackups up to 492 feet.

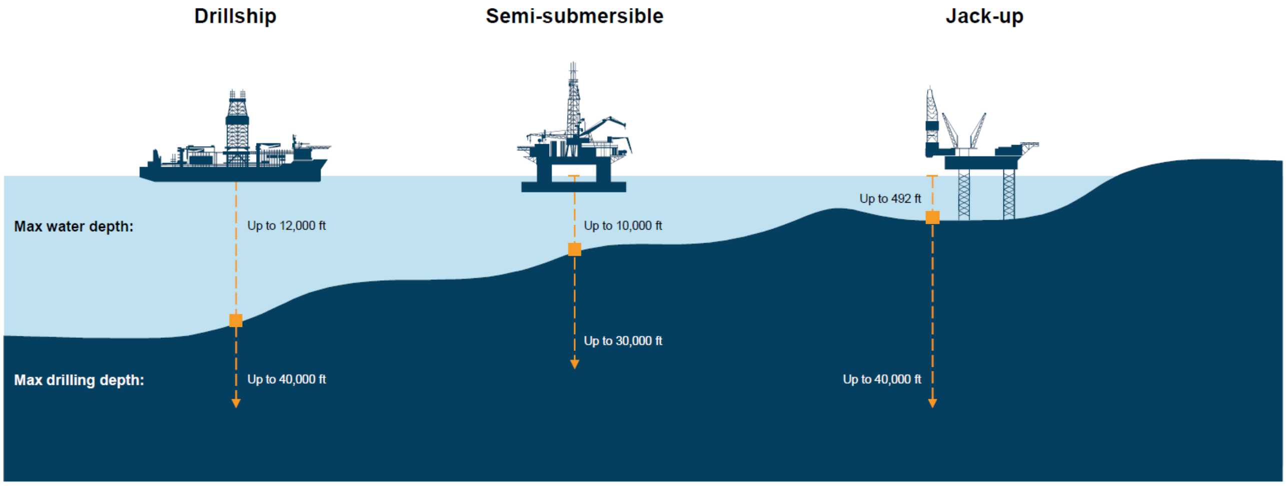

Figure 6: Illustration of the different rig types and associated water depths (Maersk Drilling Capital Market Day presentation 2019)

Jackup rigs

Jackups are made for shallow water as they stand on the seabed. The platform is mounted to a self-elevating system that ensures that the platform always has the correct distance from the ocean surface and seabed. This type of rig is typically the cheapest in terms of both day rates and construction costs. The use of jackups varies from the Middle East, North

America, North-West Europe to South East Asia (Maersk Drilling, 2019) (Rystad Energy, 2020).

Semisubmersibles

Semisubmersibles are floating rigs that can operate on deeper water depths than jackups. Semisubmersibles can adjust its weight with a ballasting system depending on the drilling intensity and operating environment. The more the pontoons are filled the more submerged the rig is. This means that the rig is less exposed to storms and waves.

Modern semisubmersibles are typically equipped with a dynamic positioning system, which essentially is a number of thrusters underneath the rig that can be controlled with the aid of a satellite navigation system to ensure that the rig stays still over the well being drilled. However, if the well is being drilled at lower water depths than 5,000 feet, the rig can be moored to the seabed by 6 to 12 anchors to keep its position. This is often preferred as the costs are lower when mooring the rig (IHS Markit, 2019).

Some semisubmersibles are built to operate in harsh- and ultra-harsh environments. By combining an advanced positioning and ballasting system they can resist hard winds and waves.

Due to the versatile nature of semisubmersibles, this rig type is used globally in all sorts of environments and across a significant range of water depths (Maersk Drilling, 2019) (Rystad Energy, 2020).

Drillships

A drillship looks similar to conventional ships and does have a normal propulsion system (in addition to a dynamic positioning system). However, a drillship, like a semisubmersible, has a so-called *moon pool* in the middle of the rig, where the drilling is conducted from. The drillship is characterised by a high degree of mobility which makes the rig ideal for exploration drilling as this often required the rig to move from location to location. However, the conventional design also means that drillships are less resistant to harsh environments. As a result, drillships are only used in benign environments (Maersk Drilling, 2019).

3.4 Offshore operating environments

In the offshore oil and gas drilling industry the operating environment strongly affects operations and technical requirements demanded by both customers and governments. The operational environment is mainly defined by wind, waves and temperatures. Across the industry, the common terminology for the operating environments is *benign environments* and *harsh environments.* Certain areas are affected by extreme weather conditions and are by some oil & gas companies characterised as *ultra-harsh environments* (Maersk Drilling, 2019).

Benign Environment

Benign operating environments are characterised by relatively still water, calm wind conditions and mild temperatures. The majority of offshore drilling work takes place in environments such as this. Benign environments are the easiest to operate in and all types of rigs can work here. Furthermore, the technical requirements are also the lowest. As a result of this, day rates are also lower than in harsh environments (Maersk Drilling, 2019).

Harsh Environment

Harsh operating environments are characterised by hard waves, strong winds and low temperatures. Harsh environment areas can be found scattered around the globe, but are mainly found in the North Sea and across the Canadian coast. Drillships cannot operate in these conditions as it requires a stable rig to resist winds and waves. Furthermore, rigs often need to get a governmental certificate to work in these areas. For instance, in the UK, the government will issue a UK oil & gas certificate on a rig basis. Because of the more challenging environment, the day rates are also higher than in the benign environment (Maersk Drilling, 2019).

Ultra-harsh Environment

The ultra-harsh operating environment is characterised by extreme waves and winds combined with freezing temperatures. This environment is only associated with the Norwegian Continental Shelf (NCS). To operate on the NCS, drilling contractors, such as Maersk Drilling, need an Acknowledgement of Compliance (AoC) from the Norwegian government. Obtaining and AoC is a difficult task that requires not only advanced technology installed on the rig but also highly skilled personnel. This environment is known for the highest day rates, but also the highest operating expenditures (Maersk Drilling, 2019).

3.5 Key performance indicators in the oil drilling industry

Day rates

One of the main drivers behind the revenue generation in the oil drilling industry is the day rate. The day rate is the daily leasing fee oil companies pay the drilling company when contracted. The day rate is dependent on the oil price, how complex the wellbore is, which rig is being used, what environment the well is to be drilled in and more (Maersk Drilling, 2019). The day rate fluctuates significantly and the industry has seen rates fall about two-thirds of its value in just a couple of months.

When the oil price is high, the increased demand for drilling pushes the day rate up and vice versa when the oil prices are low. But besides the supply/demand changes and external impacts, the technical specifications of a rig also affects the day rate. The high spec rigs can typically earn a higher rate than those with lower specifications. What sets the day rates apart though, are when certain wells require certain specifications, which only very few rigs have (IHS Markit, 2019). For instance, when drilling in Norway, rigs must have a governmental approval from the government called an Acknowledgement of Compliance (AoC). It is very difficult to obtain such a certificate, and as a result, the drilling companies with such licence have more pricing power (Petroleum Safety Authority Norway, 2019).

Utilisation rates

Utilisation rates are measuring how utilised a rig or a type of rig is. Essentially looking at how much time a rig is left without work waiting for a contract against how much time it is utilised (IHS Markit, 2020).

The industry generally looks at the utilisation rates in three ways. Utilisation can be defined as *contracted, under contract* or *working.* When measuring utilisation by *contracted* rigs, the definition of a rig being utilised is that is has a future contract signed or is currently under contract. When measuring utilisation by rigs *under contract* rigs are only defined as utilised if they are currently under a contract, while the last measure, *working,* only counts utilisation if the rig is operating (IHS Markit, 2020).

This thesis will look at all three measures, however, *under contract* will mainly be the definition referred to.

Operational expenditure

In the offshore oil drilling industry, the operational expenditure (opex) is particularly high (Maersk Drilling, 2019). The consumption of fuel and drilling fluids is high, the frequency and price of replacing equipment are high and the salary level is also high. Generally, jackups are less expensive to operate than floaters (Maersk Drilling, 2019). The daily operational cost of a jackup is in the range of USD45,000 to USD140,000 depending on its specifications. For floating rigs, this number grows to USD110,000 to USD150,000 (Maersk Drilling, 2019).

4 Estimating the industry maturity

This chapter will attempt to identify where in the industry life cycle, the offshore oil drilling industry is currently at. This will be done by referring to the Industry Life Cycle Curve (ILC) covered in chapter 2.1.

As clarified earlier, the different phases have different characteristics. This paper will try to identify the characteristics of the offshore oil drilling industry to place it and thereby also Maersk Drilling on the ILC-curve.

The identification of phases will be supported with both qualitative as well as quantitative data. Both qualitative and quantitative analysis is necessary when analysing the pace of the transition as the industry and the external environment affecting the industry is rather complex. The global transition to green energy has already become a reality, as a result, the oil & gas industry will likely experience an accelerated transition to the declining phase in the industry life cycle. Not only is the global demand for green energy accelerating this transition, but also political decisions can be a cause for concern for oil & gas companies when it comes to speeding up the transition. To understand the potential accelerated transition a qualitative approach to the political environment is needed. Elements from traditional analysis tools such as PESTEL (Grant, 2016) will be incorporated when deemed relevant. However, for the general trend of transitioning from fossils to renewables, data analysis can be used in the forecasting.

To place the offshore oil drilling industry on the ILC-curve this thesis will look at four aspects: Industry drivers, market saturation, shake-out and dominant design. These four aspects are inspired by Mirva Peltoniemi's recommendations (Peltoniemi, 2011). This part of the thesis will look at the development over the last 20 years and evaluate expert reports and energy databases to understand how the future demand for offshore oil & gas drilling could look.

4.1 Industry drivers

The oil drilling industry is very cyclical and reliant on a lot of external drivers. These drivers are political, economic, social, technological, environmental and legislative. In *figure 7* below, is a non-exhaustive illustration of the PESTEL-drivers behind the industry.

Figure 7: PESTEL-drivers (Authors' creation)

The most relevant drivers of the above vary from region to region, for instance, some regions have many legal requirements and others have almost none. However, despite variations from region to region, the industry as a whole is driven by the same drivers globally (Wood Mackenzie, 2020).

As explained in the value chain, the demand for offshore drilling is a direct product of the demand for energy. As the demand for energy grows – assuming the energy demand grows more than oil and gas decreases in the energy mix – the demand for oil and gas grows. An almost direct indicator of energy demand growth is GDP growth. The energy consumption is closely linked to the world economy and therefore, the GDP is an accurate measure for the energy demand (Sharma, Smeets, & Tryggestad, 2019). However, over the last 20 years, oil and gas have represented almost the same portion of the energy mix while renew-ables have grown significantly (Chapter 5.1 & 5.2). Furthermore, it is expected that oil and gas' share of the energy mix will decrease in the near future, indicating an industry between its maturity and decline (International Energy Agency, 2020).

The political scheme is also an important driver for the industry. Across the globe different political opinions on oil production shape the industry. Some governments use subsidies to incentivise oil companies to keep exploring and producing oil and gas, and thereby generate money for the government who take a cut of the reservoir value. This is typically a phenomenon in less developed countries, but we do see outliers such as Norway (Norwegian Petroleum, 2019). In contrary to the governments of less developed countries, more developed countries are increasingly giving subsidies to renewable energy companies, to accelerate the green transition. This indicates that the industry is transiting towards a decline.

4.2 Market saturation

This chapter will discuss the current market situation and compare it with the total market potential. A fully saturated market will be defined as a market in which there is a 100% utilisation of drilling rigs. In other words, a market where all drilling rigs are under contract and none are idle or stacked while looking for customers.

Below is an illustration of the utilisation figures for jackups on the left-hand side and floaters on the right-hand side. The utilisation figures show contracted rigs, meaning how many rigs that have current or future contractual obligations with an exploration and production (E&P) company.

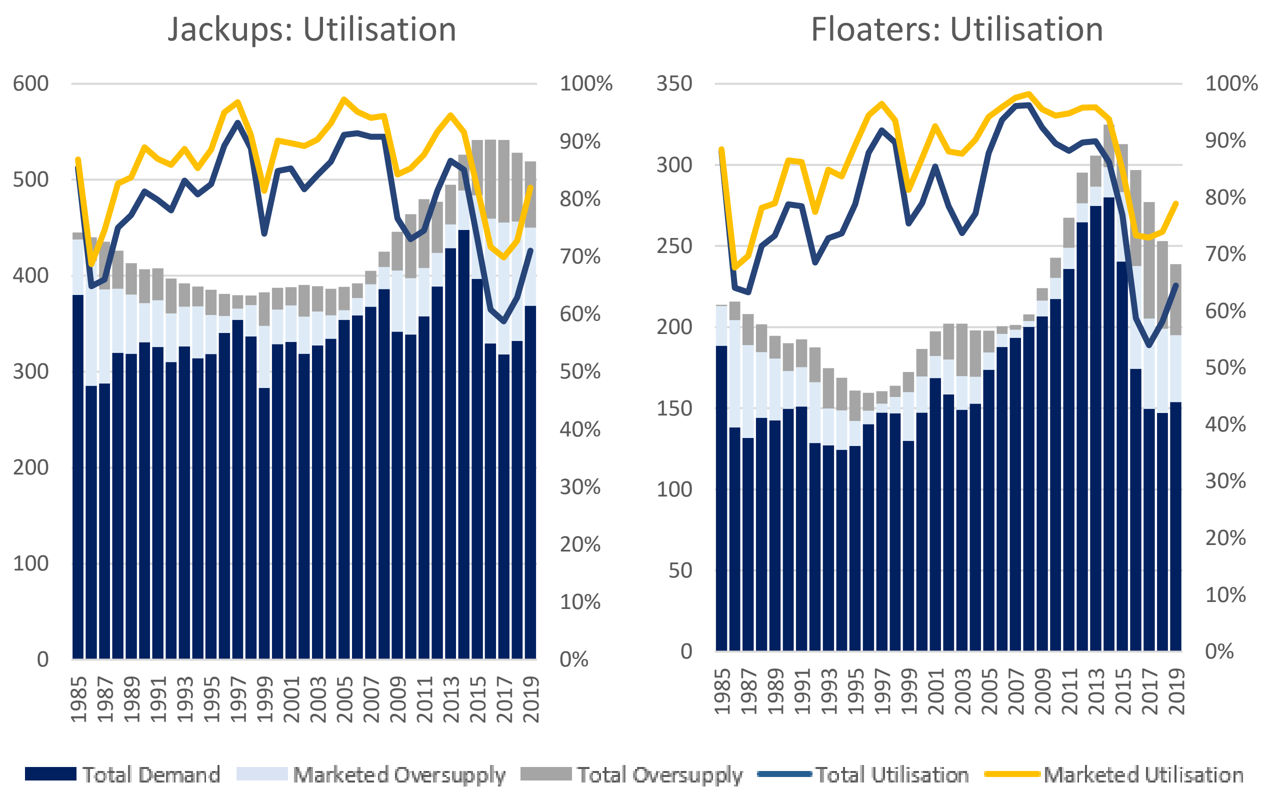

Figure 8: Utilisation - Jackups vs Floaters (Authors' analysis, IHS Markit data 2020)

As can be seen in *figure 8*, the utilisation has shown almost the same patterns since 1985, indicating that we are looking at a mature market. However, following a drop that began in 2013, the industry experienced an all-time low in 2017 for both jackups and floaters. Despite recovering after this dip, the industry is still on a sub-average level, and have been so in the last five years. This could indicate that the industry is either late in its maturity or early in the decline phase.

Full market saturation would read as the *Total Utilisation* being at 100% and the stacked bars would only consist of demand, i.e. there would be no types of oversupply.

It must be kept in mind that the global fleet supply adjusts to the long term trends in demand. As a result, when the utilisation is nearing 100% and is expected to stay high for the foreseeable future, we can expect offshore oil drilling companies to build new rigs to supply the growing demand. Vice versa, If the demand falls and is expected to remain low, the most inefficient rigs will be scrapped. However, the construction of a rig is a significant investment and can take several years, as a result, full market saturation is more likely over shorter periods in niche markets and only if the demand increases quickly (Kaiser & Snyder, 2012). Because changes to the supply happen slowly, the current utilisation is a good measure of market saturation.

4.3 Shakeout

Looking across the global offshore drilling industry, companies' market shares vary a lot across regions and segments. This means that companies are often specialised to some degree. Maersk Drilling, for instance, has almost two-thirds of its fleet consisting of Jackup rigs and in 2019 almost half of its revenue is generated in Norway (Maersk Drilling, 2019). A very different competitor is a company like Transocean, which has a fleet consisting of only floaters that operate all around the globe.

To get an overview of the competitive state of the markets that Maersk Drilling operates in, one can look at the global market as well as the niches.

Figure 9 shows the combined market share of the three largest competitors for various segments. On a global scale in a market of 128 competitors, the three largest competitors have

20.67% market share (IHS Markit, 2020). While that might indicate a competitive environment, the picture changes as we look at more specific markets. Diving into the Norwegian market we can see that the top three competitors now have 63.83% market share.

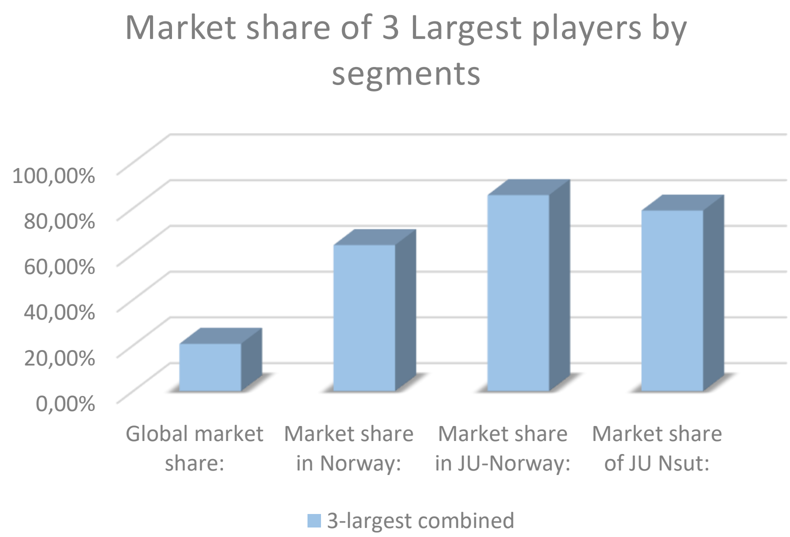

Figure 9: Market share by segment (Authors' analysis, IHS Markit data 2020)

This number further increases when we look at the jackup-segment in Norway and the segment of jackups capable of drilling in Norway. Here we see market shares of 85.71% and 78.95% respectively. The latter number represents jackups that have been given a governmental Acknowledgement of Compliance to drill in Norway but are drilling elsewhere.

Looking at Maersk Drilling's position in these categories it is clear to see where the company's focus is at. In *figure 10*, Maersk Drilling's market share is compared with the two largest competitors of each category.

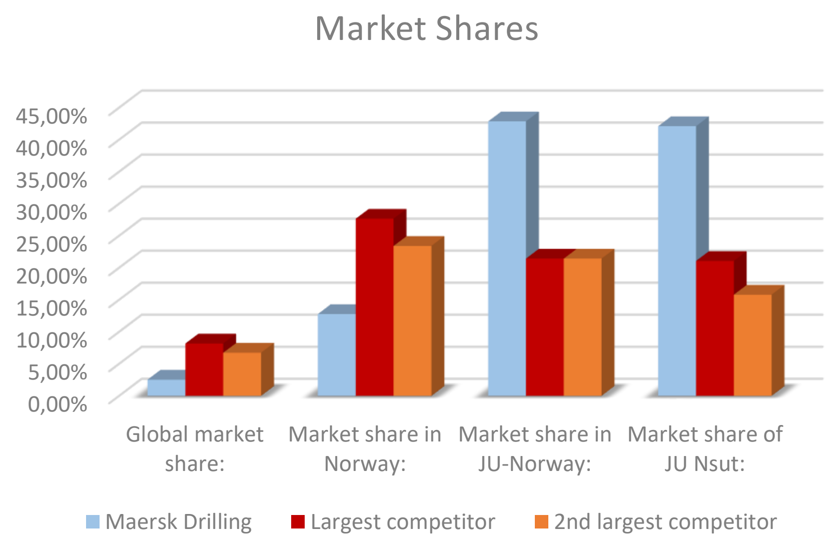

Figure 10: Market share - Maersk Drilling vs peers (Authors' analysis, IHS Markit data 2020)

To put a measure of the level of competitiveness on the numbers above, one can use the Herfindahl-Hirschman Index (HHI). The HHI scores the industry or market between full competition and monopoly. A score of 10,000 represents a monopoly where one player controlling 100% of the market, while a score close to zero means very high competition between many market players (Hirschey & Bentzen, 2014).

The U.S. Department of Justice uses the following intervals (The United States Department of Justice, 2018):

- HHI score of <1,500 = High competition
- HHI score of 1,500 – 2,500 = Moderately concentrated market
- HHI score of >2,500 = Highly concentrated market

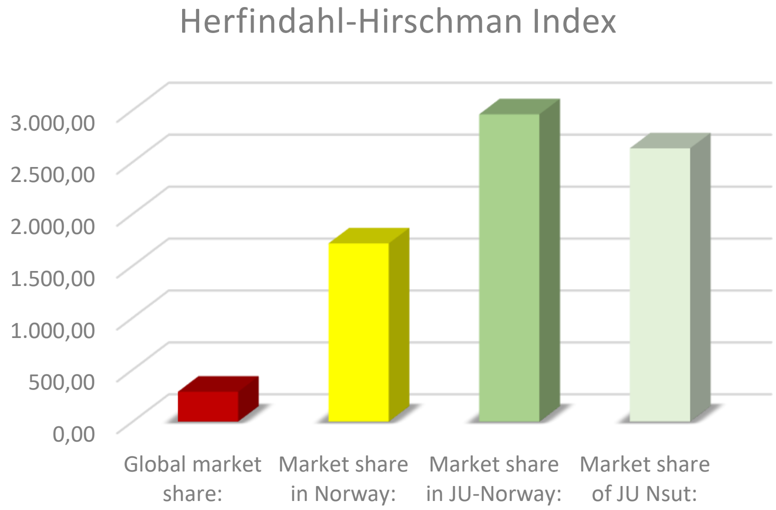

Figure 11: Herfindahl-Hirschman Index (Authors' analysis, IHS Markit data 2020)

As illustrated in *figure 11*, the global market has a healthy level of competition, while the Norwegian market is less competitive and fewer competitors have a larger share of the market. However, looking at Maersk Drilling's heartland, the Norwegian jackup-market, this is dominated by a few large players. This indicates a mature industry, where players have identified their strengths and found a suiting niche.

4.4 Dominant Design

Offshore drilling rigs are constantly being modified and have developed massively. *Figure 12* is an illustration of how the jackups have developed from their invention until today.

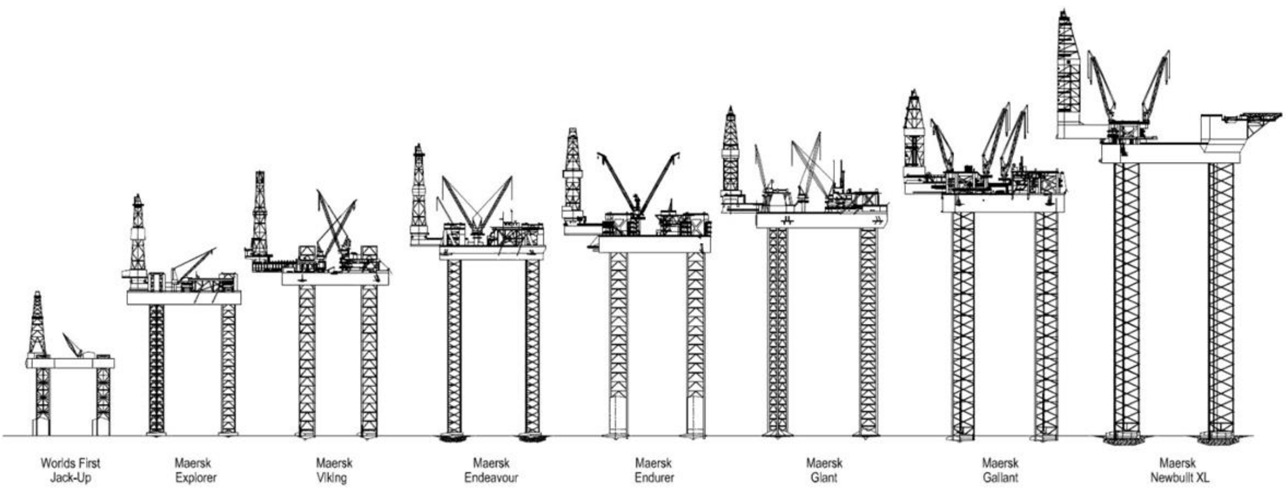

Figure 12: Jackup rigs' evolution (Maersk Drilling Demerger Document 2019)

Jackups have existed longer than floating rigs and as they cover a smaller geographical area than floaters, almost all types of environments have been explored. As a result, one could argue that the jackup-rigs might have reached their dominant design indicating a fully matured industry (Suarez & Utterback, 1995).
Looking at the floating rigs segment, however, a lot of territories are left unexplored (Rystad Energy, 2019). A lot of this unexplored area has remained so because the current rigs are unable to drill at such water depths. As a result floating rigs are still being designed to explore new areas. Currently, Maersk Drilling's competitor, Transocean, is building two new drill-ships, that will be able to drill at water depths of up to 20,000 feet (Transocean, 2018). This is previously unheard of, as the current world record for deepest well is held by Maersk Drilling and was drilled at a water depth of just under 12,000 feet. This indicates that the industry is not fully matured.

4.5 Summary of the industry age estimation

The oil industry is highly cyclical and is affected by a significant amount of external drivers. There is a linear relationship between GDP growth and energy demand and currently oil and gas are representing the majority of the energy mix. However, over the last 20 years, oil and gas have represented almost the same portion of the energy mix while renewables have grown significantly. Furthermore, it is expected that oil and gas' share of the energy mix will decrease in the near future, indicating an industry between its maturity and decline. The politics in developed countries have also changed in favour of renewables, indicating that the offshore oil & gas industry is nearing its decline.
The market saturation is measured in the utilisation rates of drilling rigs. The utilisation rate of offshore drilling rigs has generally been quite cyclical as for the demand for oil and gas. Since 1985 the changes to utilisation have shown very similar patterns, indicating a mature market. However, following a drop that began in 2013, the industry experienced an all-time low in 2017 for both jackups and floaters. The industry is still on a sub-average level, and have been so in the last five years. This could indicate that the industry is either late in its maturity or early in the decline phase.
By looking at the Herfindahl-Hirschman Index, it becomes clear that there is a significant difference to the competitive intensity between the global market and the niches. A difference will be inevitable, however, in this case, the difference is significant. Looking at the global market the competition is high, but in a niche market such as Norway, there are

relatively few players who own most of the market share. This indicates a mature industry where players have identified their strengths and found a suiting niche.

Jackup rigs have existed since the 1950s and have for the last 70 years been improved. This thesis considers today's design to be very close to the so-called dominant design. This indicates an industry that is late in its maturity phase. However, on the floater side, we see rig designs developing still. As the majority of the global deep-water areas are yet to be explored, floating rigs have to be able to operate on deeper and deeper water. This could indicate that the industry is not yet fully matured.

4.6 Financial Characteristics of the Offshore drilling industry and ILC's decline phase

The summary above explains that based on four selected criteria, the industry is at the late maturity phase, and maybe even at the beginning of its decline phase. To verify this conclusion, this thesis looks at five financial features that typically characterise a company in decline (not necessarily all of the features are possessed) (Damodaran, 2009). By looking at these features in Maersk drilling and its peers we can get an indication of the ILC-placement.

1. Stagnating or declining revenue

An indication of a declining industry is if the companies within it have stagnating or declining revenue streams over an extended period. Even companies with growing revenue streams can be in a declining industry if the growth is lower than the inflations rate. This is a sign of operational struggle. Determining the ILC-phase based on this feature for a single company is typically not generalisable for the whole industry, but if this is seen among the industry leaders, it might be a cause for concern (Damodaran, Valuing Distressed and Declining Companies, 2009)

Revenue YoY growth *(in %)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**
Maersk Drilling	(8.8%)	(37.4%)	(0.7%)	(14.5%)
Awilco Drilling Plc.	(70.7%)	81.8%	(57.1%)	(32.5%)
Noble Corporation Plc.	(31.3%)	(46.3%)	(12.5%)	20.6%
Seadrill Ltd.	(26.9%)	(34.1%)	(40.0%)	10.8%
Pacific Drilling S.A.	(29.1%)	(58.4%)	(17.2%)	(13.2%)
Transocean Ltd.	(43.7%)	(28.6%)	1.5%	2.3%
Valaris Plc.	(31.7%)	(33.6%)	(7.5%)	20.4%
Diamond Offshore Drilling Inc.	(33.9%)	(7.2%)	(27.1%)	(9.5%)

Table 3: Historical revenue growth for Maersk Drilling and peers (Authors' analysis)

As displayed in the table above, the revenue of the offshore drilling companies has overall been decreasing over a longer period of time, with the exceptions of Transocean in FY18 to

FY19 and Valaris in FY19. The declining trend in revenue was primarily due to falling oil prices, which led to reduced investment in oil and gas exploration by the E&P companies (Maersk Drilling, 2018).

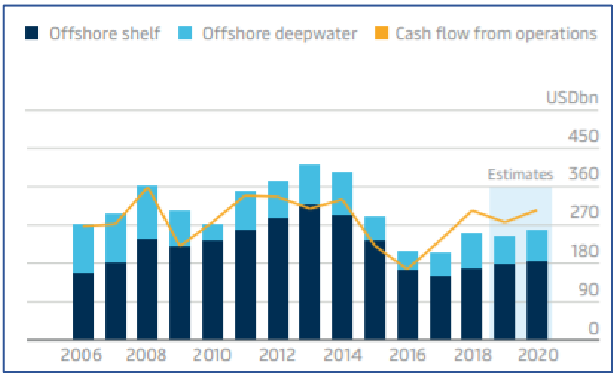

Figure 13: Total cash-flows for top-25 listed upstream oil and gas companies (Maersk Drilling Annual report 2019)

Following years of cost reductions and limited capital investments, the E&Ps are starting to generate positive free cash flows after dividends and share buy-backs in 2017. As a result, the E&Ps increased their capital expenditures (capex) in FY18 and FY19, which is expected to continue into FY20 (Maersk Drilling, 2019). The increased level of spending led to a recovery in utilisation (Figure 8), however despite the increase in utilisation the overall revenue for the offshore drilling industry still declined. This was according to Maersk Drilling (2019) mainly due to the effect of lower day rates.

Based on the historical decline in revenue, the offshore drilling industry would arguably be positioned in the early decline phase of the ILC. As previously mentioned, it must be noted that the industry is highly cyclical. According to the International Energy Agency's (IEA) World Energy Outlook 2019, global energy demand is expected to grow at approximately 1% per annum until 2040, whereas the demand for oil and gas is expected to grow 0.9% per annum until 2040. As a result of the future expectations to oil and gas demand, and thus the revenue for the offshore drilling industry, the industry is regarded as being part of the late maturity phase or beginning decline.

2. Shrinking or even negative margins

It is a natural effect that the margins shrink when the revenue decreases. Typically companies reduce prices when revenue is declining. This naturally leads to lower margins, and if the company maintains the same fixed costs and maybe even invest in increased marketing, the margins shrink even further. This is a somewhat accurate representation of the margins within the offshore drilling industry (Damodaran, 2009).

EBIT margin *(in %)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**Average FY16-19**
Maersk Drilling	34.6%	15.0%	14.6%	2.1%	20%
Awilco Drilling Plc.	15.5%	60.1%	12.0%	(19.4%)	24%
Noble Corporation Plc.	30.4%	(3.3%)	(13.0%)	(3.9%)	10%
Seadrill Ltd.	42.8%	18.6%	(24.8%)	(29.5%)	10%
Pacific Drilling S.A.	18.0%	(101.8%)	(103.9%)	(196.1%)	(71%)
Transocean Ltd.	29.4%	20.3%	7.4%	(3.2%)	20%
Valaris Plc.	33.7%	3.1%	(10.9%)	(27.5%)	7%
Diamond Offshore Drilling Inc.	20.3%	15.3%	(7.3%)	(28.7%)	5%

Table 4: EBIT margin for Maersk Drilling and peers (Authors' analysis)

In line with the declining revenue, operating margins within the industry have also decreased significantly over the last four years, as displayed in the table above. The challenging market conditions with low oil prices in FY17 and FY19 led to declining activity levels in the industry. Consequently, the number of idle rigs increased, which led to decreased gross profits.
Overall, the shrinking margins within the offshore drilling industry can primarily be attributed to the declining activity and revenue. As a result, the ILC placement cannot be based solely on the historical development in operating margin. Instead, we deem it more appropriate to look at revenue as a guide for the ILC placement. Consequently, the indication is that the offshore drilling industry is in its late maturity phase or beginning of its decline.

3. Financial leverage

It is almost a given, that companies facing the challenges of feature 1 and 2 will at some point struggle to pay their debt obligations. Furthermore, they will have difficulty refinancing or borrowing money, as lending money to such a company is a bad investment (Damodaran, Valuing Distressed and Declining Companies, 2009).
The description above, is a fair representation of the offshore drilling industry, as most companies are finding difficulties paying their obligation as presented by their interest coverage ratio:

Interest coverage ratio *(Interest expenses / EBITDA)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**
Maersk Drilling A/S	6.6	4.3	10.5	8.7	8.9	4.4
Awilco Drilling Plc.	14.4	17.1	3.0	13.4	4.3	3.0
Noble Corporation Plc.	6.0	9.3	5.9	1.8	1.2	1.4
Seadrill Ltd.	3.1	3.8	4.4	3.1	0.9	0.2
Pacific Drilling S.A.	4.4	3.7	2.3	(0.2)	0.1	(2.6)
Transocean Ltd.	7.9	10.0	5.3	2.7	1.7	1.3
Valaris Plc.	14.6	9.8	6.2	2.4	1.1	0.1
Diamond Offshore Drilling Inc.	18.3	11.4	7.0	3.9	2.1	0.6

Table 5: Historical interest coverage ratio of Maersk Drilling and peers (Authors' analysis)

While some companies as Maersk Drilling and Awilco Drilling are finding no difficulties covering their interest payments, other firms such as Seadrill, Pacific Drilling and Valaris are barely, if even, able to cover them. Combining this reality with the high level of debt identified in chapter 7.2.2 and 7.2.3, most of the offshore drilling companies could be characterised as on the verge of bankruptcy. Back in FY18 Seadrill (Jones, 2018) and Pacific Drilling (Hals, 2018) even filed for a chapter 11, where the U.S. court later approved both firm's plans to exit its Chapter 11 bankruptcy. This approval involved shedding billions of dollars of debt and converting debt into equity.

Based on the overall leverage and ability to cover interest payments, this thesis argues that the offshore drilling industry is in decline.

4. Asset divestitures

For companies that are struggling with low or negative margins, asset divestitures might be a way to generate positive cash flow. The assets might even be worth more in the hands of another company, why the company actually generates not just cash, but also value by divesting the asset. Furthermore, as discussed earlier, companies that experience negative margins early in the declining phase might do so because they prioritise exploiting the positive margins in maturity phase by growing with debt, rather than preparing for the decline. In this situation, the company likely have built up substantial leverage, and therefore need liquidity to pay its creditors and avoid insolvency leading to bankruptcy (Damodaran, 2009). To analyse the level of asset divestitures within the offshore drilling industry, we use the historical rig attritions and additions as a lead indicator. We use this because most of the invested capital within the industry is tied to the drilling rigs, thus the primary source of asset divestitures will likely be the attrition of drilling rigs.

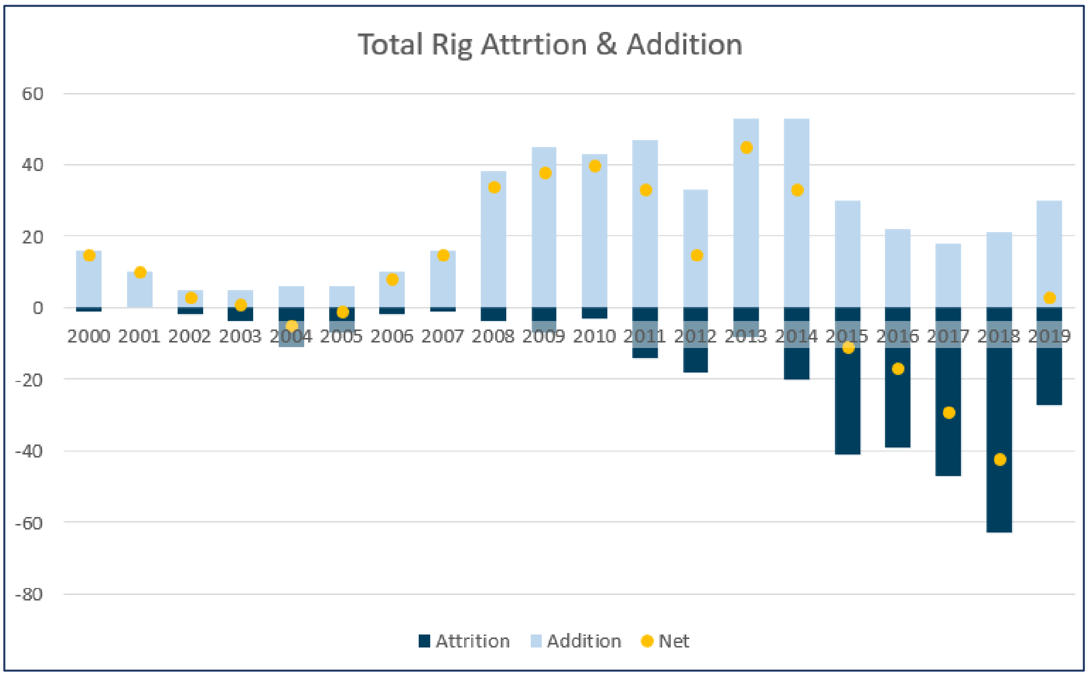

Figure 14: Total rig attrition and addition within the offshore drilling industry (Authors' analysis, IHS Markit data 2020)

As displayed in *figure 14* above, the number of rig divestitures has increased significantly from FY15 to FY18. Combining this increase with the leverage ratios of the industry firms as well as their difficulties covering interest payments, this might indicate that the companies are disposing their assets in order to pay their creditors.

However, the increased number of disposed rigs has to be interpreted with care because of two reasons. First, the period leading up to FY15 shows a significant increase in rig additions, thus the later increase in disposals might be a natural change to the global fleet by scrapping rigs that are worn-out. Second, as the industry is cyclical, the high level of divestitures during FY15-FY18 might be explained by the industry being in a low-cycle. This might also be indicated by the number for FY19, where the net position of added rigs was positive. Based on these uncertainties and findings, the level of asset divestitures indicates that the offshore drilling industry is found to be in either the maturity or declining phase.

5. Significant dividend payouts or share buybacks

As the industry becomes less profitable, the number of investments that can generate a higher return than the cost of capital becomes fewer and fewer. When this happens, the shareholders will require larger payouts in order to invest elsewhere. This phenomenon is primarily seen in healthy companies within the declining phase, as the creditors would otherwise demand the company to pay down debt first (Damodaran, 2009).

However, as most firms within the offshore drilling industry are finding difficulties covering their interest payments, significant dividend payouts or share buybacks does not seem to be relevant or possible. This argument is further enhanced by an analysis of the historical dividend payments and share buybacks for the peer group. From FY14 to FY19, none of the offshore drilling companies have entered a share repurchase program. However, on the contrary, multiple companies have issued new equity to complete their exit from Chapter 11 bankruptcy (Jones, 2018). In addition, no company has paid any dividends since FY16, where only Noble Corporation paid USD 0.19 per share.

As a result of the financial situation, dividend payments and share repurchase are ruled out for most of the industry companies. Instead, companies must spend their excess cash to bring down debt. This financially distressed situation indicates, that the majority companies, and thus the industry, has entered the declining phase of the ILC.

Dividends *(in USD)*	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**
Maersk Drilling	-	-	-	-	-
Awilco Drilling Plc.	-	-	-	-	-
Noble Corporation Plc.	1.28	0.19	-	-	-
Seadrill Ltd.	-	-	-	-	-
Pacific Drilling S.A.	-	-	-	-	-
Transocean Ltd.	1.05	-	-	-	-
Valaris Plc.	-	-	-	-	-
Diamond Offshore Drilling Inc.	-	-	-	-	-

Table 6: Dividend payments for Maersk Drilling and peers (Authors' analysis)

4.6.1 Summary of the financial characteristics of the offshore drilling industry and ILC's decline phase

Specific financial features characterise companies in ILC-decline. The indications of the analysis of these features yield that the industry is placed between the late maturity phase and early decline. The indications are summarised in *table 7* below.

Table 7: Summary of the financial ILC analysis (Authors' analysis)

Industry Measure/Metrics	ILC phase
1.Stagnating or declining revenue	**Late maturity phase/ early decline**
2.Shrinking or even negative margins	**Late maturity phase/ early decline**
3.Financial leverage	**Declining phase**
4.Asset divestitures	**Late maturity phase/ early decline**
5.Significant dividend payouts or share buy-backs	**Declining phase**

5. Industry Growth Forecast

This chapter will analyse the demand and supply of the global oil and gas market and then take an in-depth look at the Norwegian segment. The reason being that the Norwegian market is a key market for Maersk Drilling. By analysing the different regions and segments, we get an indication of the growth/decline rate of the different rigs in Maersk Drilling's fleet. Not only will this support an estimated terminal growth rate later on in the DCF-model, but it will also assist the understanding of where potential real options can be identified.

In the first part of this chapter, the last 20 years will be analysed to understand how the industry has developed over the last two decades. The drivers that will be analysed are the demand for energy, production of oil & gas and exploration & production expenditure.

Secondly, the outlook for the oil and gas industry, and the NCS specifically, is estimated. The estimate will be based on expert reports and modelled data from energy databases.

5.1 Historical 20-year trend

With a constantly growing population and increasing living standards across the globe, the demand for energy is growing as well. Globally, fossil fuels are by far the largest source of energy, so naturally, when the global energy demand grows, the demand for fossil fuels experience the largest absolute increase. The global energy demand is a product of the global economy and with economic growth comes energy demand growth (Sharma, Smeets, & Tryggestad, 2019).

Looking at the energy demand in million ton of oil equivalent (Mtoe) by region and the change within the regions (*table 8* to the right), it is clear to see how the drivers discussed earlier affects the change. The most developed regions such as North America and Europe have maintained almost the same level of demand, while less developed economies that have experienced significant growth in the period and their demand for energy has increased immensely. On a relative level, the Middle East has experienced the highest increase. But the far larger region, Asia Pacific, has experienced an increase at almost the same relative level, resulting in an absolute change that makes the demand in this region three times larger than Europe.

	2000	2018	%-Change
North America	2.678	2.714	1,34%
Central & South America	449	660	46,99%
Europe	2.027	2.000	-1,33%
Africa	489	838	71,37%
Middle East	365	763	109,04%
Eurasia	742	934	25,88%
Asia Pacific	3.012	5.989	98,84%
International bunkers	274	416	51,82%
Total	10.036	14.314	42,63%

Table 8: Demand in Mtoe by region (Authors' analysis, IEA's World Energy Outlook 2019)

As seen in *table 9* to the right, fossil fuel's share of the energy mix has increased from 80% to 81% from 2000 – 2018. The overall increase in energy demand has been led by an increase in all types of energy, except for solid biomass that has decreased slightly.

	2000	2018	%-Change
Coal	2.317	3.821	64,91%
Oil	3.665	4.501	22,81%
Natural Gas	2.083	3.273	57,13%
Nuclear	675	709	5,04%
Renewbles	659	1.391	111,08%
- Hydro	225	361	60,44%
- Modern bioenergy	374	737	97,06%
- Other	60	293	388,33%
Solid biomass	638	620	-2,82%
Total	10.037	14.315	
Fossil fuel share	80%	81%	

Table 9: Demand in Mtoe by type (Authors' analysis, IEA's World Energy Outlook 2019)

One thing to notice is the growth rates of renewable energy sources is significantly higher than any other source. However, absolute growth has been far larger for fossil fuels – hereunder oil and gas. To support this increased demand for oil and gas, global production has increased consistently. For the last 20 years, the daily global production of oil and gas has increased every year as can be seen in *figure 15* below.

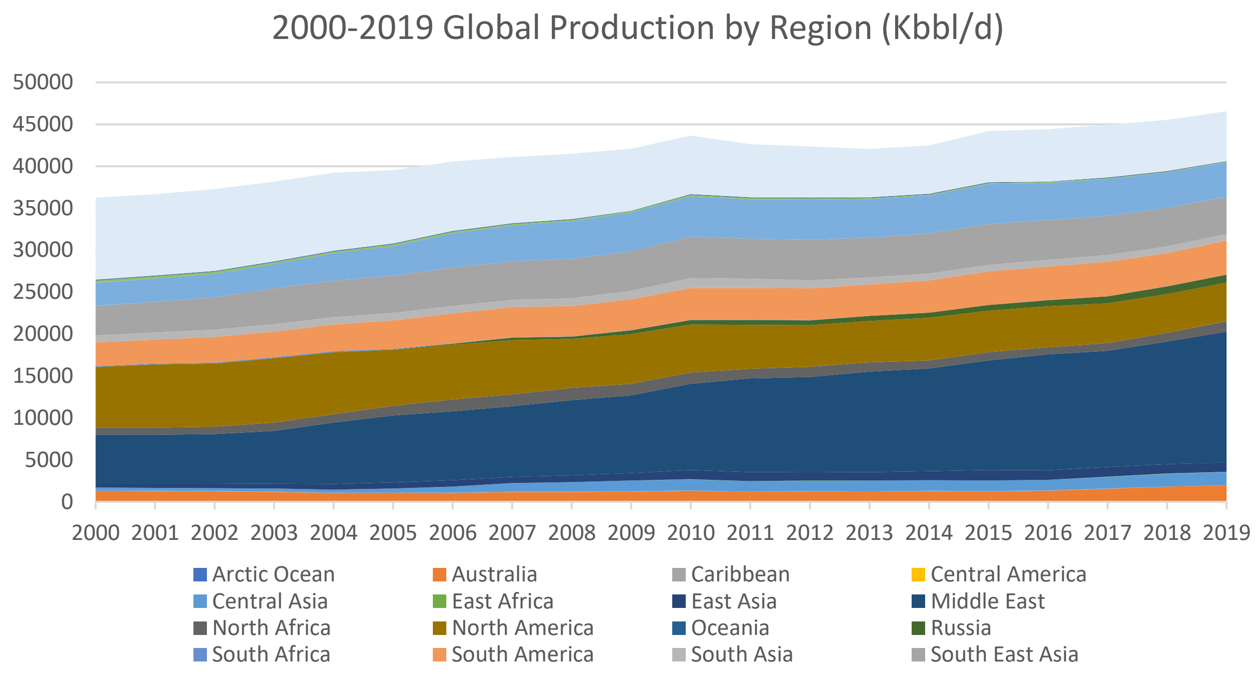

Figure 15: Global production by region (Authors' analysis, Rystad Energy data 2020)

However, growing production has mainly been led by the Middle East. In the Middle East, the political environment allows for heavily increased productions compared to the more risk-averse approach in regions such as Europe. Furthermore, the Middle East is heavily reliant on its oil and gas production as it is a main source of its GDP.

As black energy sources such as oil and gas are often being frowned upon by the general population in the western world, politicians have tried to slowly phase out the production of fossil fuels. As a result, the European production of oil has been significantly reduced over the last 20 years as can be seen in *figure 16*.

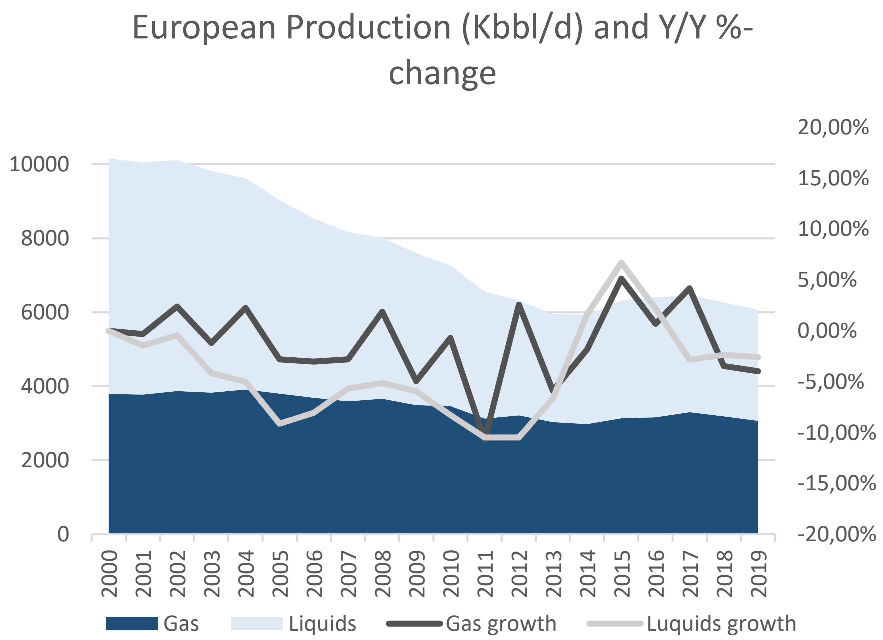

Figure 16: European production by type (Authors' analysis, Rystad Energy data 2020)

Taking a closer look at the reduction in Europe (*Figure 17)*, it is clear that this is mainly led by diminishing production in the UK.

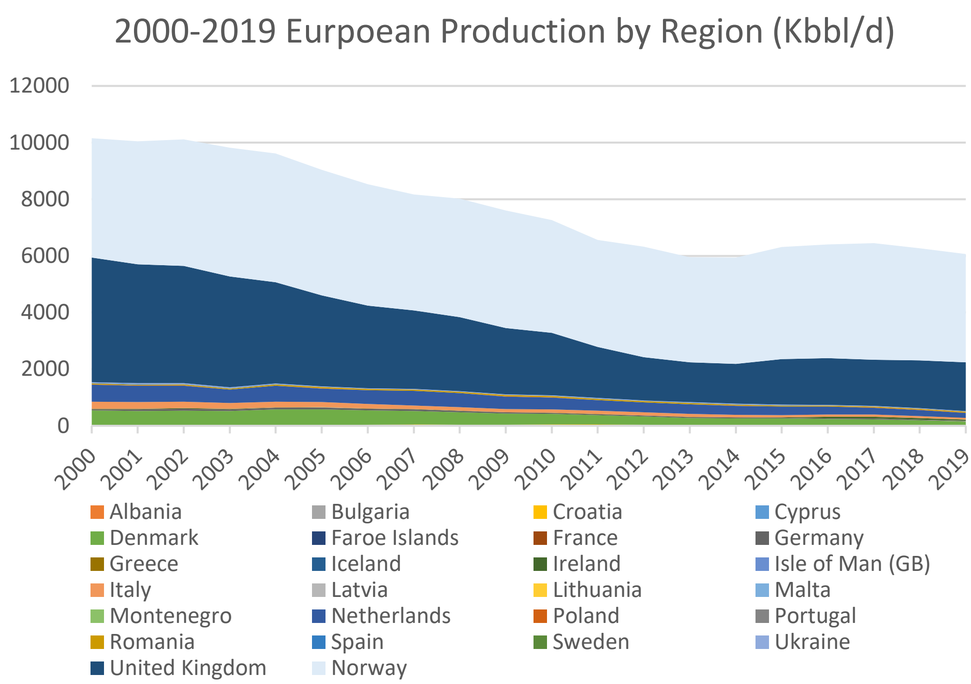

Figure 17: European production by region (Authors' analysis, Rystad Energy data 2020)

However, the largest European producer, Norway, has remained stable over the last 20 years.

Looking at the production in *figure 18*, it seems like Norway is a very strong market. But it is important to realise that high production does not necessarily equal high demand for drilling. As some producing reservoirs are very large, they will continue to produce oil and gas for many years but might not require a lot of drilling activity. However, as reservoirs are running out, oil companies will have to look for new reservoirs through exploration drilling.

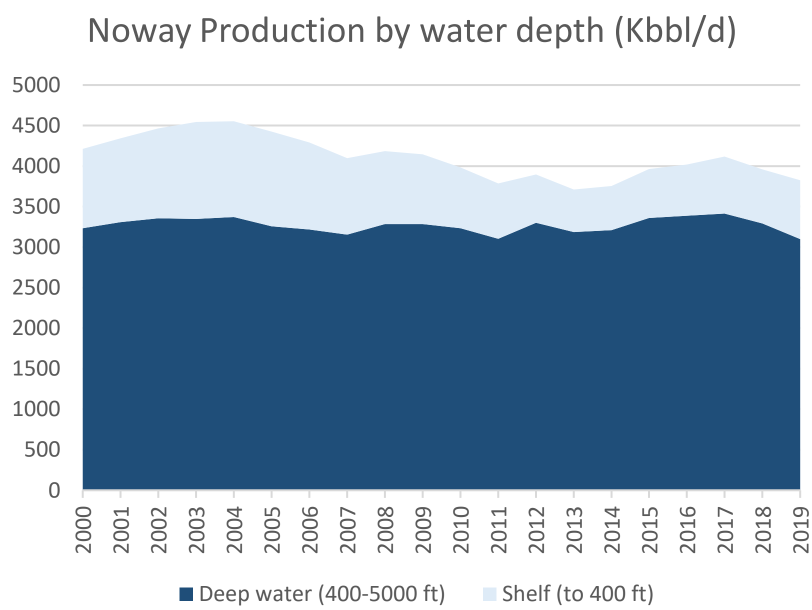

Figure 18: Norwegian production by water depth (Authors' analysis, Rystad Energy data 2020)

To depict this, one can look at the oil companies' exploration and production expenditure (*Figure 19)*. The expenditure has fluctuated significantly as a result of changes to the oil price as well as the status of significant oil reservoirs' life cycles. With the oil price increase in the years 2000 – 2008 we also see the oil companies expenditure increase as they wish to increase production. The financial crisis in 2008 then led to a decrease from 2009 – 2010, but as the oil price quickly recovered, the expenditure started to grow again. However, when the oil price crashed in 2014, the expenditure fell sharply and did not increase before 2017.

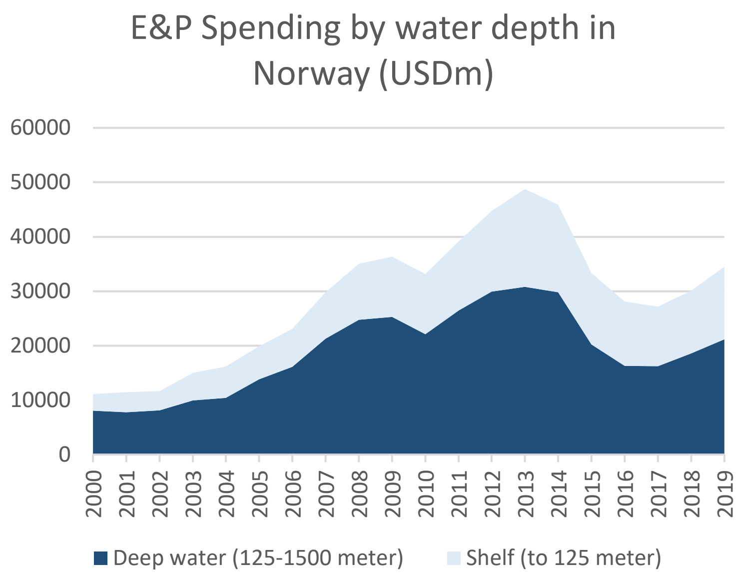

Figure 19: E&P spending by water depth in Norway (Authors' analysis, Rystad Energy data 2020)

5.2 Outlook on energy mix and oil & gas demand

Global energy demand

Looking at the global energy demand for the last 20 years, there are no indications that the energy demand will decrease. The International Energy Agency has created three scenarios of how the energy demand could turn out over the next 20 years. Below are the three scenarios for global energy demand as well as the energy mix.

The first scenario is the base-case which follows the stated policies. This scenario shows solid growth in total energy demand over the next 20 years. The growth is mainly driven by renewables and gas, while oil and coal remain at current levels. *The second* scenario is sustainable development, in which the green transition is accelerated. In this scenario, coal is decreasing to about half of the current levels while renewables grow to more than three times today's level. *The third* and last scenario is one which follows the current policies. This scenario is the high case scenario where the world will continue to grow with the same politics as today. In this scenario, the demand for all sources of energy grows.

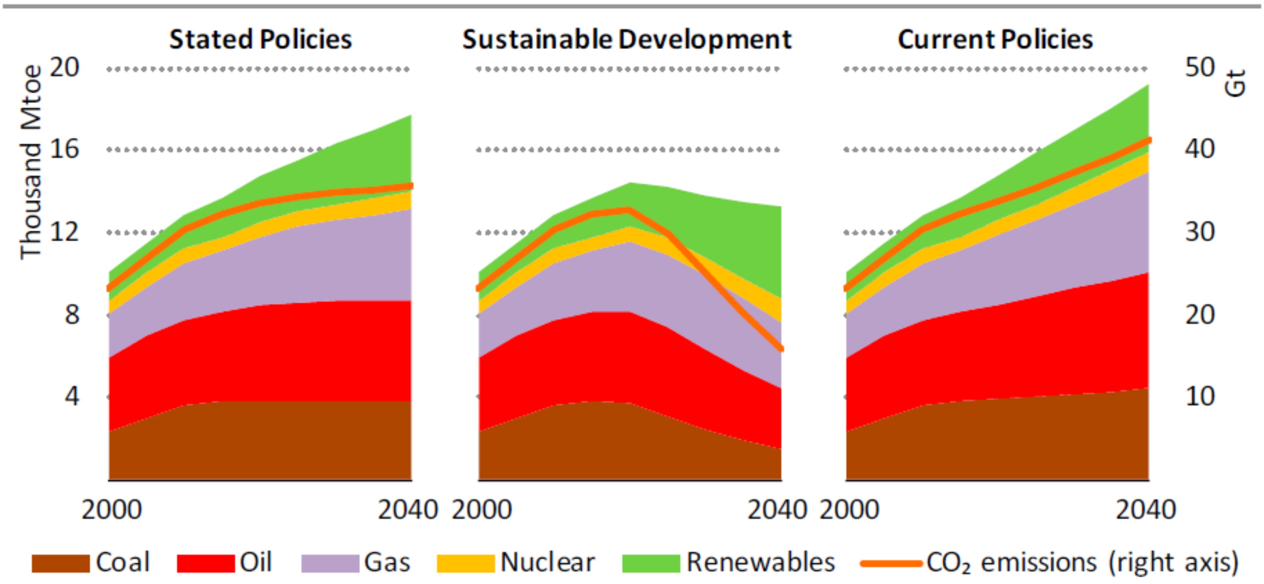

Figure 20: Energy demand scenarios (IEA's World Energy Outlook, 2019)

The regional demand will develop differently depending on which scenario will play out. As can be seen in the table below Africa's energy demand can turn out very differently depending on whether the stated policies or the sustainable development scenario plays out.

Primary Energy Demand Mtoe			Stated Politics			Sustainable Development		
	2000	2018	2030	2040	2018-2040 % Change	2030	2040	2018-2040 % Change
North America	2.678	2.714	2.717	2.686	-1,03%	2.377	2.087	-23,10%
Central & South America	449	660	780	913	38,33%	669	702	6,36%
Europe	2.027	2.000	1.848	1.723	-13,85%	1.689	1.470	-26,50%
Africa	489	838	1.100	1.318	57,28%	689	828	-1,19%
Middle East	365	763	956	1.206	58,06%	802	880	15,33%
Eurasia	742	934	980	1.031	10,39%	858	807	-13,60%
Asia Pacific	3.012	5.989	7.402	8.208	37,05%	6.232	6.085	1,60%
International bunkers	274	416	528	639	53,61%	425	420	0,96%
Total	**10.036**	**14.314**	**16.311**	**17.724**		**13.741**	**13.279**	

Table 10: Primary Energy demand by region (Authors' analysis, IEA's World Energy Outlook 2019)

In line with the primary energy demand as illustrated in *table 10* above, is the oil demand. The chart below shows the global oil demand under the three scenarios. In both the current policies and stated policies-scenarios, the oil demand will increase over the next 20 years. However, in the sustainable development, we see a sharp reduction in oil demand.

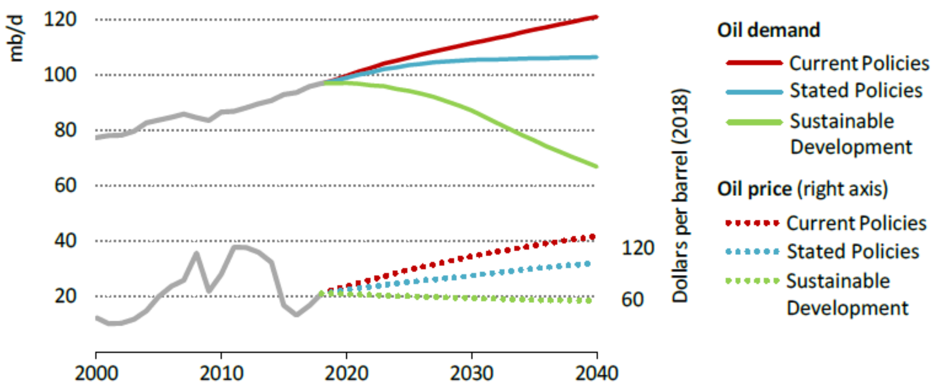

Figure 21:Oil demand and price scenarios (IEA's World Energy Outlook, 2019)

The regional drivers of the stated politics in *figure 21* above are specified in *table 11* below. Here we can see how the governments intended plans will affect oil demand across regions, showing a green transition in North America and Europe while developing regions such as Africa continuously will experience an increased oil demand.

The decreasing demand in Europe means that the European suppliers will be hit hard. As shown in the previous chapter the UK has already reduced the production significantly, and other European suppliers such as Norway can be forced to follow the same route.

Oil demand in Mtoe/d			**Stated Politics**				
	2000	**2018**	**2025**	**2030**	**2035**	**2040**	**2018-2040 % Change**
North America	23,50	22,80	22,50	21,50	20,30	19,10	-16,23%
Central & South America	4,50	5,80	6,10	6,20	6,40	6,50	12,07%
Europe	14,90	13,20	12,40	11,10	9,70	8,70	-34,09%
Africa	2,20	3,90	4,90	5,50	6,20	7,00	79,49%
Middle East	4,30	7,50	8,40	8,80	9,60	10,20	36,00%
Eurasia	3,10	3,90	4,30	4,30	4,20	4,20	7,69%
Asia Pacific	19,40	31,60	35,80	38,00	38,90	39,20	24,05%
International bunkers	5,40	8,20	9,30	10,00	10,70	11,40	39,02%
Total	**77**	**97**	**104**	**105**	**106**	**106**	

Table 11: Oil demand by region (Authors' analysis, IEA's World Energy Outlook 2019)

Outlook for oil and gas in Norway

As just touched upon above, the European demand is expected to fall over the next 20 years. Currently, the largest buyer of Norwegian oil is the EU. As a result, it is not surprising that the production will decrease within the next 20 years.

The forecasted production, as can be seen in *figure 22* below, shows that the NCS has a few good years left, but will deteriorate after 2025. Especially the production on lower water depths will be affected by the decline.

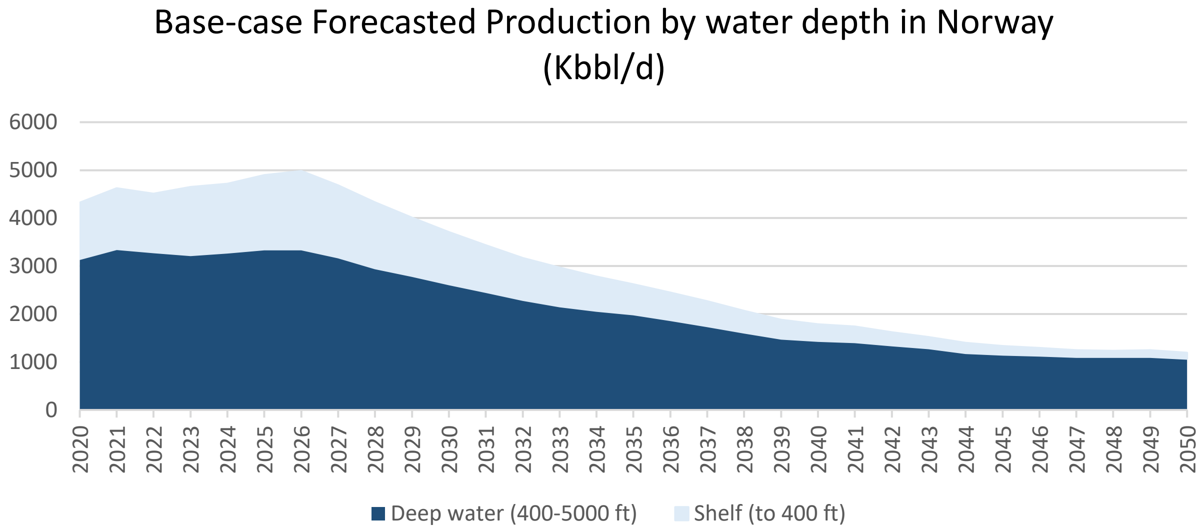

Figure 22: Forecasted production in Norway (Authors' analysis, Rystad Energy Data 2020)

Despite the decline in production, the oil companies remain modestly positive with a more or less stable expenditure, mainly driven by government subsidies as explained in chapter 4.1. We do, however, see a decline in the expenditure on lower waters, as most of the reservoirs in these areas have been explored already (*Figure 23)*. This implies less activity for ultra-harsh environment jackup-rigs.

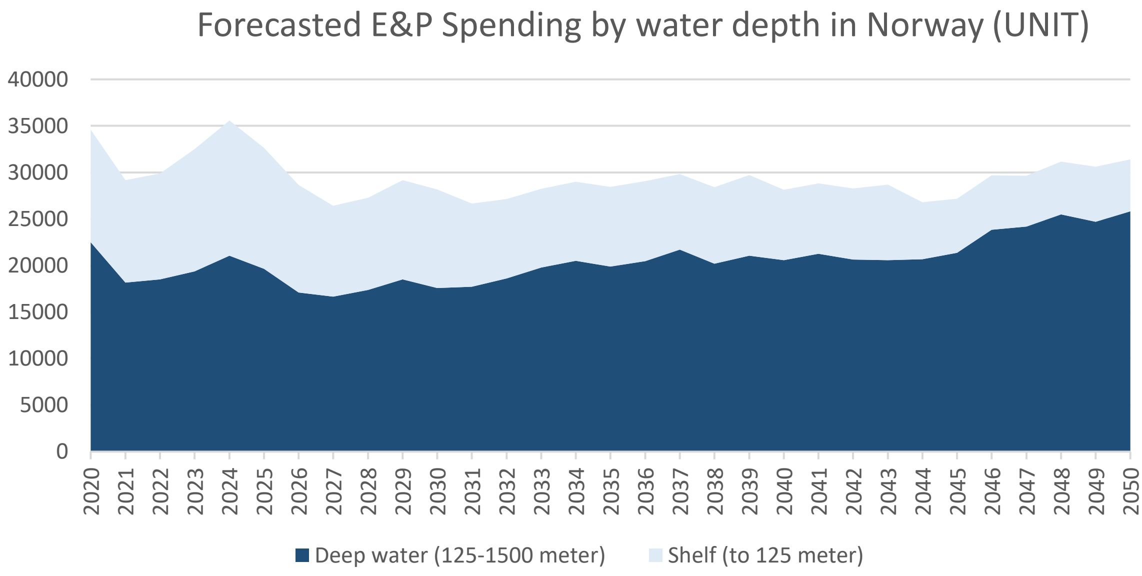

Figure 23: Forecasted E&P Spending in Norway (Authors' analysis, Rystad Energy data 2020)

Even though the implications are negative for the activity on lower water depths on the NCS, there are some positives. IEA is among the optimists, believing that future discoveries and low breakeven levels (Appendix 2b) mean that the production decline after 2025 will be fairly slow at just 2% each year on average until 2040 (International Energy Agency, 2019).

5.3 Summary and implications of industry growth analysis

For the last 20 years, fossil fuels have been the largest source of energy. From the year 2000 to 2018 the demand for oil grew by 22.8% to 4,510 Mtoe, making oil the single largest source of energy. In the same period, gas demand grew by 57% to 3,273 Mtoe making it the third-largest source, only surpassed by oil and coal. This trend has led to a continuously growing global production of oil and gas.

It is expected the global demand for both oil and gas will increase over the next 20 years, but at a much more moderate level than previously. The demand is mainly driven by developing regions such as Africa and Southeast Asia. Contrary, the demand in Europe is expected to decline with more than 34% over the next 20 years. The implication of this, is decreased production from European producers such as Norway and the UK.

Through subsidies, the Norwegian government is expected to retain moderate activity levels, mainly led by exploration drilling. However, this will mainly take place on deeper waters, leaving the ultra-harsh jackups in a vulnerable spot.

6. Maersk Drilling

This chapter will look at Maersk Drilling, which is the company that will be used as a case study. The chapter will cover the history and the present of the firm, the financial performance as well as the operational performance.

6.1 Introduction to the firm

This part will introduce the basics of Maersk Drilling, before moving to the more analytical parts where the financial and operational performance will be analysed.

6.1.1 Maersk Drilling History

Maersk Drilling can be traced back to 1962 when Maersk together with Shell and Gulf created the Danish Underground Consortium (DUC). The collaboration explored the opportunities to produce oil from the North Sea. In 1972 they produced their first drop of oil. The same year Maersk Drilling was established and took part in a Joint venture with Dearborn-Storm

Drilling to create Maersk Storm Drilling. The Joint Venture consisted of two semisubmersible rigs that were owned by Maersk Drilling but operated by Dearborn-Storm Drilling Company. Shortly after the Joint Venture was established, Maersk Drilling founded a training a knowledge creation centre in the USA. This was called the Atlantic Pacific Marine Corporation (APMC). APMC led to accelerated knowledge creation and resulted in the construction of the largest Jackup rig in the world when it was delivered in 1975. This success led to the construction of several rigs in the coming years (Maersk Drilling, 2019).

In 1976 Maersk Drilling established a 50/50 joint venture with the Egyptian General Petroleum Corporation (EGPC). This joint venture allowed Maersk Drilling to expand its global reach and further diversify its portfolio. The Joint venture existed until 2017 when Maersk Drilling sold its share to EGPC (Maersk Drilling, 2020).

In the period 1978-1986 Maersk Drilling commenced another newbuild program, in which Maersk Giant and Maersk Guardian were built. Both rigs were jackups made for harsh environment and capable of drilling on water depth of up to almost 400 feet. Four years later, in 1990, Maersk Drilling entered the Norwegian market and drilled the first well ever with a Jackup in this region. As a result of the growing appetite for Jackups in Norway, Maersk Drilling ordered three more harsh environment jackups in the years after entering the Norwegian market. Furthermore, Maersk Drilling strengthened its reputation by demonstrating its technical abilities in the harsh environment by using the Maersk Giant rig as both the exploration rig and the production facility. In addition to the three jackups, Maersk Drilling ordered another six, of which four was suited for harsh environments to become the undisputed market leader in Norway. These rigs were delivered in the period 2007-2009 (Maersk Drilling, 2019).

Having positioned itself strongly in Norway and the rest of the North Sea, Maersk Drilling decided to expand to the global ultra-deep-water (UDW) segment. By 2015 Maersk Drilling had managed to compile eight UDW-rigs consisting of four semisubmersibles and four drillships. Due to the fast growth of Maersk Drilling and the wish to continue this growth, a new headquarter was established in Lyngby. Shortly after moving into the new headquarter Maersk Drilling received four new UHE Jackups designed for NCS and a regular jackup that would go on a 5 years contract immediately after delivery.

Having built one of the most advanced and modern fleets in the industry, Maersk Drilling decided to look for new ways to created additional value. It was decided that Maersk Drilling had the capabilities to handle a bigger part of the value chain. Maersk Drilling called this addition to their business model “integrated services”. Integrated services meant that Maersk Drilling would handle the orchestration of the wellbore services and do some of the work as well. This essentially eliminated the need for numerous sub-contractors that would otherwise take care of well-related services. This offering has led to alliances with both AKER BP and Seapulse (Maersk Drilling, 2019).

6.1.2 Maersk Drilling today

Today Maersk Drilling is the market leader in the jackup segment on the NCS and in the North Sea. With approximately 50% market share on the NCS and 22% market share in the rest of the North Sea, Maersk Drilling is unrivalled. Since Maersk Drilling’s entrance on the NCS, the company has drilled more than 400 wells, which is approximately 250 wells more than the second most experienced competitor (Rystad Energy, 2020).

Besides the market-leading position on NCS and in the North Sea, the company has a strong ultra-deepwater-fleet consisting of eight ultra-deepwater rigs for benign environments. Maersk Drilling is currently the record holder for deepest well ever drilled and is set to beat this in 2020 (Burkhardt, 2020).

Apart from positioning, Maersk Drilling is also a front runner when it comes to operational excellence. Through almost 50 years of experience, Maersk Drilling has created strong relationships with its customers, which has led to valuable opportunities to co-develop the most efficient operational model. Currently, Maersk Drilling is delivering near-perfect operational and financial uptime when drilling (Maersk Drilling, 2019).

6.1.3 Fleet

Maersk Drilling’s fleet consists of 22 rigs, of which 14 are jackups, four are semisubmersibles and four are drillships. The median age for Maersk Drilling’s fleet is 11 years, against the industry average of 15 years for jackups, five years against the industry average of eight years for drillships and 11 years against the industry average of 13 for semisubmersibles. The rigs are among the highest specs and most modern ones in the industry. The high-quality fleet is one of the features that characterise Maersk Drilling. This fleet allows Maersk Drilling to work globally on the most advanced wellbores and projects that only very few competitors are able to. A complete fleet overview is provided in appendix 1.

6.2 Financial analysis

To conduct a discounted cash flow valuation, it is necessary to forecast the value drivers of a firm's free cash flow. However, in order to come up with a reasonable forecast, one must understand the historical profitability, as it defines the future expectations for the firm (Petersen, Plenborg, & Kinserdal, 2017). As a result, this part of the thesis will emphasise the historical performance of Maersk Drilling from 2015-2019.

6.2.1 Preparation of the analytical income statement and balance sheet

To assess the true financial performance of a company, it is essential to reformulate the income statement and balance sheet. The reorganisation of the financial statements entails the separation of operating activities from the financing activities. The operating activities are what makes the company inimitable, and thus the main driver behind its value creation. Financing activities, on the other hand, are more imitable and not the primary driver behind a firm's ability to create value (Petersen et al., 2017).

The analytical income statement reflects the performance of a company's core business, regardless of how it is financed. It can be measured before and after tax, whereas EBIT represents operating profits before tax and NOPAT represents it after tax (Petersen et al., 2017).

The analytical balance sheet is in accordance with the analytical income statement, divided into operating and financing activities. This entails, that items marked as operating activities in the analytical income statement, must be categorised in the same manner in the analytical balance sheet. The overall investments in the company's operating activities are denoted as invested capital. It is defined as "the net amount a firm has invested in its operating activities, which require a return" (Petersen et al., 2017, p. 114). The analytical income statement and balance sheet of Maersk Drilling are displayed in appendix 3, including a commentary of the restated accounting items.

6.2.2 Decomposition of return on invested capital

Historical profitability is a central component when defining future expectations to a firm. To analyse the historical profitability of Maersk Drilling, we use the well-renowned Du-Pont model, which breaks return on equity into two parts: return on invested capital and financial leverage. Return on invested capital or ROIC, is an important measure in the profitability analysis, as it identifies whether the return is driven by improved operating margins or capital utilisation (Petersen et al., 2017). Consequently, ROIC is decomposed into two ratios, the operating profit margin and turnover rate of invested capital. These will be analysed in the chapters below.

6.2.3 Operating margin

The operating margin states the operating profit as a percentage of revenue, and all thing being equal the higher the margin the better. As previously stated, the operating margin can be defined before and after tax. The financial analysis below will take its starting point by using the margin before tax. There are two reasons for this choice. First, as the analysis will include a peer comparison, using the EBIT margin will eliminate the effect of country-specific tax legislation. Second, as previously stated in the financial ILC analysis, the offshore drilling industry has in recent years faced challenging market conditions, which has led to significant impairment losses and reversals. To take this into consideration, using the EBIT margin was deemed the most appropriate.

Maersk Drilling *(in %)*	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**
Revenue growth	26%	(9%)	(37%)	(1%)	(14%)
Gross margin	56%	64%	53%	50%	42%
EBITDA margin	56%	61%	48%	44%	34%
EBIT Margin	35%	35%	15%	15%	2%
NOPAT margin	27%	(30%)	(104%)	67%	(2%)
Key drivers:					
(as a % of revenue)					
Production costs	(55%)	(44%)	(36%)	(47%)	(50%)
SG&A costs	n.a.	(4%)	(5%)	(6%)	(8%)
Depreciation and amortisation	(21%)	(26%)	(33%)	(29%)	(32%)
Impairment losses/reversals	(1%)	(66%)	(123%)	57%	(3%)
Special items	0%	1%	0%	(1%)	(1%)

Table 12: Break down of Maersk Drilling's operating margin (Authors' analysis)

During the period from 2015 to 2019, Maersk Drilling experienced a significant decrease in their EBIT margin of approximately 33ppts, from an operating margin of 35% in FY15 to a margin of 2.1% in FY19. The decrease in operating profits can be broken down on an annual level. From FY16 to FY17, the decrease of approximately 20ppts in operating profits was mainly caused by challenging market conditions with low oil prices, which led to declining activity levels.

As a result, the total number of floaters on contract decreased by 14ppts compared to FY16, whereas the same number for jackup rigs was 3ppts (A.P. Moeller-Maersk Group, 2017).

The increased number of idle rigs negatively impacted the gross profit, as the production costs, relative to revenue, increased from 36% in FY16 to 47% in FY17.

Going forward from FY17 through FY18, it looked like operating margin had reached a stable level of 15%. However, as the revenue for FY19 declined by 14ppts, the operating margin decreased as well. The significant decrease in revenue for FY19 was a result of the expiry of legacy contracts, which meant that average day rates decreased by 18ppts compared to FY18 (Maersk Drilling, 2019). As a result, the production costs relative to revenue increased by 8ppts, when compared to FY18.

In addition to the decline in gross profit, increased SG&A also attributes to the decrease in operating profits. SG&A costs increased by USD 13m in FY19, which was due to the full-year effect of new functions added to the organisation. The new functions were established to support Maersk Drilling as a stand-alone listed company and were completed in FY19 (Maersk Drilling, 2019).

EBIT margin *(in %)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**Average FY16-19**
Maersk Drilling	34.6%	15.0%	14.6%	2.1%	20%
Awilco Drilling Plc.	15.5%	60.1%	12.0%	(19.4%)	24%
Noble Corporation Plc.	30.4%	(3.3%)	(13.0%)	(3.9%)	10%
Seadrill Ltd.	42.8%	18.6%	(24.8%)	(29.5%)	10%
Pacific Drilling S.A.	18.0%	(101.8%)	(103.9%)	(196.1%)	(71%)
Transocean Ltd.	29.4%	20.3%	7.4%	(3.2%)	20%
Valaris Plc.	33.7%	3.1%	(10.9%)	(27.5%)	7%
Diamond Offshore Drilling Inc.	20.3%	15.3%	(7.3%)	(28.7%)	5%

Table 13: EBIT margin for Maersk Drilling and peers (Authors' analysis)

The decreasing trend in operating profit does not only apply to Maersk Drilling but the industry overall. This is also presented in the table above, which shows the historical development in operating margins for the offshore drilling companies. Compared to its peers, Maersk Drilling presents one of the highest operating margins within the industry with an average of 20% from FY15-FY19. Other companies such as Noble, Seadrill and Pacific have historically struggled to make their operations profitable, which forced the companies to file for a Chapter 11 bankruptcy (Hals, 2018).

Based on the operating margin, Maersk Drilling can be characterised as one of the industry leaders, which grant them a lucrative position entering the declining phase of the ILC.

6.2.4 Invested capital turnover

The turnover rate discloses a firm's efficiency in managing its invested capital, and all thing being equal the higher the ratio the better. Historically, Maersk Drilling's invested capital turnover has fluctuated between 0.37 and 0.25. In FY19, the turnover of invested capital reached a low point, where each USD the group invested in capital, generated a revenue of USD 0.25. As displayed in the table below, the fluctuating trend in Maersk Drilling's invested capital turnover can mainly be attributed to the aforementioned impairment losses and reversals on the drilling rigs. Furthermore, as the tangible assets historically account for 97%-99% of the invested capital, the turnover of the remaining items have a minimum impact on the group's overall turnover.

Maersk Drilling *(in USDm and %)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**
Revenue	2,297	1,439	1,429	1,222
Impairment losses and reversals	(1,510)	(1,769)	810	(34)
Average invested capital	7,074	5,339	4,713	4,862
Tangible assets (% of invested capital)	98%	97%	98%	99%
Breakdown of invested capital turnover				
Invested capital turnover	0.32	0.27	0.30	0.25
Intangible assets	31.68	14.84	20.27	28.09
Tangible assets	0.33	0.28	0.31	0.25
Current operating assets	4.05	0.09	0.09	0.08
Operating liabilities	-3.91	-3.39	-3.52	-2.93

Table 14: Breakdown Maersk Drilling's Invested capital turnover (Authors' analysis)

As with the operating margin, Maersk Drilling's managing of invested capital is among the best within the industry. Awilco Drilling is the only company to present a higher historical average of invested capital turnover. Excluding Awilco Drilling, Maersk Drilling have from FY16-19 on average generated an additional USD 0.06 of revenue for each USD invested, when compared to its closest competitor.

Invested capital turnover *(Revenue / avg. invested capital)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**Average FY16-19**
Maersk Drilling	0.32	0.27	0.30	0.25	0.29
Awilco Drilling Plc.	0.30	0.56	0.28	0.19	0.33
Noble Corporation Plc.	0.21	0.12	0.12	0.16	0.15
Seadrill Ltd.	0.17	0.13	0.11	0.19	0.15
Pacific Drilling S.A.	0.15	0.07	0.08	0.11	0.10
Transocean Ltd.	0.19	0.15	0.15	0.15	0.16
Valaris Plc.	0.25	0.15	0.13	0.15	0.17
Diamond Offshore Drilling Inc.	0.27	0.27	0.21	0.19	0.23

Table 15: Average Invested capital turnover (Authors' creation)

6.2.5 Return on invested capital

ROIC measures the profitability of a firm's operations in relation to its invested capital. It is used to measure whether the return on the business is at a satisfactory level when compared to the required return from investors. As for the operating margin and turnover of invested capital, the higher the return the better (Petersen et al., 2017).

As indicated by the previous analysis of the operating margin and invested capital turnover, Maersk Drilling's ROIC before tax has a decreasing trend. From FY16 to FY19 the return on invested capital before tax declined by 12.3ppts, while the number was 12.1ppts for ROIC after tax. The overall decrease in Maersk Drilling's ROIC is mainly related to the declining operating profits, which were as a result of the aforementioned market conditions. In addition, a decreased utilisation of capital in FY17 and FY19 also led to lower returns on invested capital before tax. While the returns on invested capital before tax yielded a positive result, the opposite is the case for ROIC after tax. As previously stated, the significant impairment losses and reversal during FY16-FY18 had a great impact on the NOPAT margin, which explains the majority of the difference in ROIC before and after tax. The average ROIC after tax from FY16-FY19 is -4.6%, which means Maersk Drilling generated a negative return of USD -0.046 for each dollar invested in its operations. This implies that the returns of the company are at an unsatisfactory level.

Maersk Drilling *(ROIC decomposition)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**Average FY16-19**
Invested capital turnover	0.32	0.27	0.30	0.25	0.29
EBIT margin	34.6%	15.0%	14.6%	2.1%	16.6%
NOPAT margin	(30.4%)	(104.4%)	66.8%	(1.8%)	(17.5%)
ROIC, before tax	11.2%	4.1%	4.4%	0.5%	5.1%
ROIC, after tax	(9.9%)	(28.1%)	20.2%	(0.4%)	(4.6%)

Table 16: ROIC decomposition (Authors' analysis)

To evaluate if Maersk Drilling's ROIC is at a satisfactory level, we apply a method suggested by Petersen et al. (2017). The method includes a comparison of ROIC after tax to the firm's cost of capital, as subtracting WACC from ROIC expresses the economic profit. Under the assumption that Maersk Drilling's cost of capital historically has been constant, at the later estimated WACC (Chapter 7.2) of 9.08%, FY18 is the only year where the group creates an economic profit. The economic profit generated in FY18 is, however, not a result of improved operations, but instead a result of an USD 810m impairment reversal.

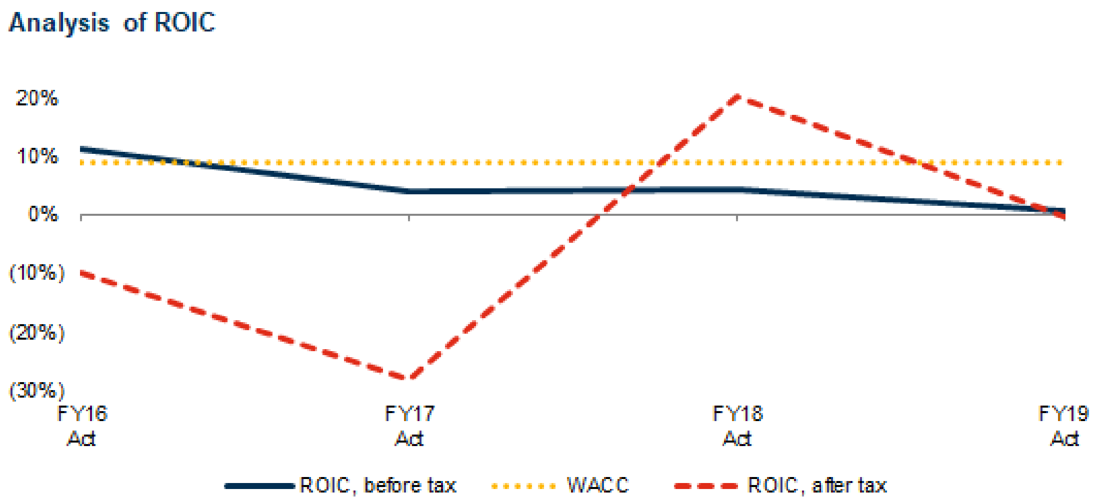

Figure 24: Maersk Drilling's ROIC and estimated WACC (Authors' analysis)

While the overall ROIC for Maersk Drilling has not been at a satisfactory level, a quick comparison to the peers shows, that the Maersk Drilling is one of the best performing firms within the industry. As displayed in the table below, Maersk Drilling has, with the exception of Awilco Drilling, from FY16-FY19 on average generated an additional return of 3%, compared to its closest competitor Transocean. Based on the ROIC decomposition, Maersk Drilling appears to be one of the most profitable companies within the offshore drilling industry.

ROIC, before tax *(EBIT margin * Invested capital turnover)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**Average FY16-19**
Maersk Drilling	11.2%	4.1%	4.4%	0.5%	5%
Awilco Drilling Plc.	4.6%	33.8%	3.4%	(3.6%)	10%
Noble Corporation Plc.	6.3%	(0.4%)	(1.5%)	(0.6%)	1%
Seadrill Ltd.	7.4%	2.4%	(2.7%)	(5.7%)	0%
Pacific Drilling S.A.	2.7%	(6.6%)	(8.0%)	(22.3%)	(9%)
Transocean Ltd.	5.6%	3.0%	1.1%	(0.5%)	2%
Valaris Plc.	8.3%	0.5%	(1.5%)	(4.1%)	1%
Diamond Offshore Drilling Inc.	5.4%	4.1%	(1.5%)	(5.5%)	1%

Table 17: Return on invested capital for Maersk Drilling and peers (Authors' analysis)

6.2.6 Return on equity

In the analysis above, we have solely focused on measuring the profitability of Maersk Drilling's operations. In this chapter, we will analyse the impact of financial leverage on the profitability, which is referred to as return on equity (ROE). The decomposition of Maersk Drilling's ROE is displayed in the table below:

Maersk Drilling *(ROE decomposition)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**
NOPAT margin	(30%)	(104%)	67%	(1.8%)
Invested capital turnover	0.3	0.3	0.3	25.1%
ROIC after tax	(10%)	(28%)	20%	(0.4%)
Net borrowing cost after tax in %	6%	1%	4%	(8.2%)
Net debt (avg.)	(1,464)	(2,148)	(301)	1,115
Book value of equity (avg.)	8,761	7,487	5,014	3,747
Spread	(4%)	(27%)	25%	(9%)
Financial leverage	(17%)	(29%)	(6%)	30%
Return on equity	**(9%)**	**(20%)**	**19%**	**(3%)**

Table 18: Decomposition of Maersk Drilling's return on equity (Authors' analysis)

From FY16-FY18, Maersk Drilling's ROE exceeds its ROIC, which indicate that the financial leverage has a positive effect on the company's returns. However, the decomposition of Maersk Drilling's ROE does not make much sense during FY16-FY18 because of the group's negative net debt[1]. By using a negative net debt, the estimated net borrowing costs yields a positive number, that indicates that the group is earning interest on its net debt, which is not the case. Furthermore, as financial leverage is negative, the original relationship between leverage and spread is now reversed. This means that a negative spread will yield a higher return on equity, which does not make sense. As a result, an analysis of the ROE from FY16-18 is misleading. This is also supported by Damodaran (2017), who finds that ROE is a useless measure when the financial leverage is negative.

However, Maersk Drilling's ROE in FY19 is analysable, as net debt for the year is positive. The group's ROE for FY19 equals -3%, thus the impact of financial leverage is negative as ROIC for the year is -0.4%. This can be explained by the negative spread between the ROIC and net borrowing costs where the financial leverage leads to a decreased profitability.

6.3 Operational Analysis

This chapter will look at the segments and regions that Maersk Drilling operate in. Firstly, the chapter will look into how Maersk Drilling performs in its business segments. Secondly, the chapter will dig into how Maersk Drilling performs in the geographical markets it operates in. After this, Maersk Drilling's market share and key segments are analysed across rig types and regions.

[1] The negative net debt was due to interest-bearing loans receivables from A.P. Moller Maersk (Maersk Drilling, 2019)

6.3.1 Business Segments

As stated in the introduction to Maersk Drilling, its key business segment is the jackup segment, where 14 of its 22 rigs are allocated.

Jackups

Within the segments of jackups, Maersk Drilling operates in three sub-segments; *Ultra-harsh environment (UHE) Jackups, harsh environment (HE) jackups* and *benign premium jackups (BE)*. The subsegments are defined by three categories of rig specification enabling them to operate in three different environments. These environments are described in the introduction to the industry (benign, harsh and ultra-harsh). Different kind of jackups are at different levels of demand, and some types are more resilient to market volatility than others. The charts below show the demand and supply balance for the three sub-segments on an industry level and for Maersk Drilling during the last three years.

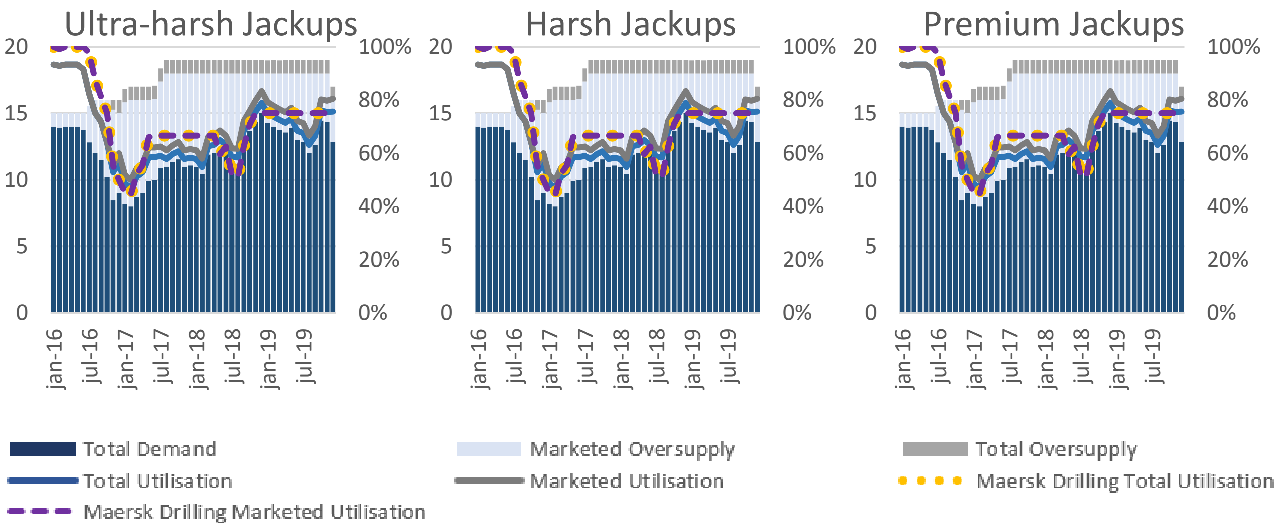

Figure 25: Utilisation by jackup-segment (Authors' analysis, IHS Markit data 2020)

The first thing to notice in the charts above is that Maersk Drilling has generally outperformed the market in both the ultra-harsh and the harsh segment while underperforming in the premium segment. This is not surprising when considering that Maersk Drilling is known as an industry player that focuses on difficult environments. It can also be deducted that the utilisation of the premium jackup segment on an industry-basis has remained relatively stable peaking at 80% marketed utilisation and troughing at 60%. The harsh environment jackups have been more volatile with marketed utilisation rates between 60% and 95%. The ultra-harsh segment saw a significant dip at the beginning of 2016 falling from over 90% utilisation to 50%, before increasing to about 80% in ultimo 2019.

Floaters

Within the floating segment, Maersk Drilling operates with both semisubmersibles and drillships. All of Maersk Drilling's floating rigs are made for benign environment only. To the right-hand side is a chart showing the demand and supply balance for benign floating rigs on an industry level and for Maersk Drilling. It is interesting to see how Maersk Drilling despite being a relatively new player in the floating segments, have managed to outperform the market over several years. It can also be seen that the market utilisation has been equal to the total utilisation at all times. This show that Maersk Drilling constantly have had their rigs marketed and no rigs have been stacked away. To keep the rigs marketed at all times, signals that the management believes in the company's ability to secure work within a relatively short time horizon.

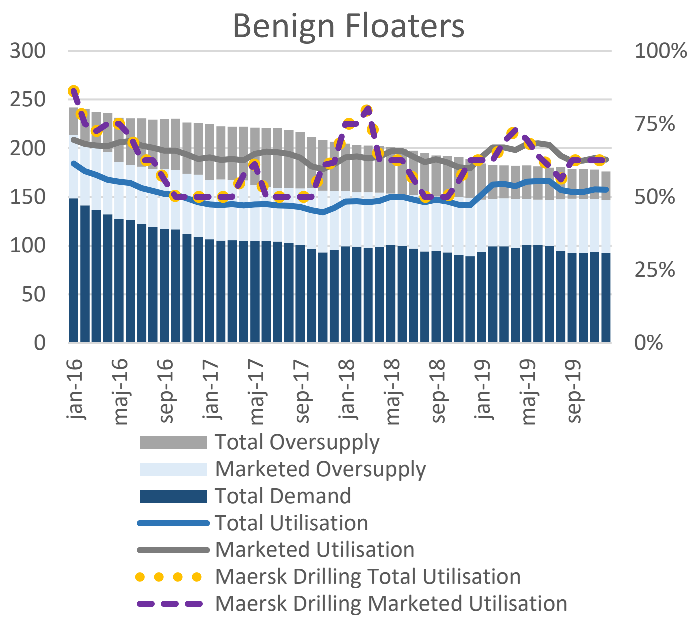

Figure 26: Floaters utilisation (Authors' analysis, IHS Markit data 2020)

Revenue generated by segment

In 2019 jackups generated a revenue of USD 800m, while floaters generated USD 395m. This means that a jackup on average have generated USD 57m in revenue while a floating rig on average generated USD 49m. Considering the generally higher day rates for floaters, this implies that Maersk Drilling is either underperforming with its floating rigs of overperforming with its Jackups. Part of this imbalance is a result of the fact that Maersk Drilling's jackup-fleet consists of very high spec and advanced jackups demanding a higher day rate than the average.

6.3.2 Geographical Markets

While Maersk Drilling is offering its services almost all over the globe, some regions are more important than others. Three key regions to Maersk Drilling are Norway, the rest of the North Sea and West Africa.

Norway

As described in the introduction to Maersk Drilling, Norway is the company's heartland. Maersk Drilling played an essential role in developing the jackup segment in this market and as a result, the company has significantly more experience in the region, than any other competitor. The NCS is a special region in the sense that the operating environment is considered ultra-harsh. As a result, the requirements are significantly higher than in any other regions. As described in the industry introduction, rigs must obtain an Acknowledgement of Compliance-certificate (AoC) to operate. To obtain such a certificate, the rigs must be of the highest quality in terms of materials used, equipment installed and personnel trained. Furthermore, there are certain language requirements, demanding that selected key personnel can speak Norwegian. Maersk Drilling is highly reliant on the AoC as it creates further barriers for competitors to enter this market.

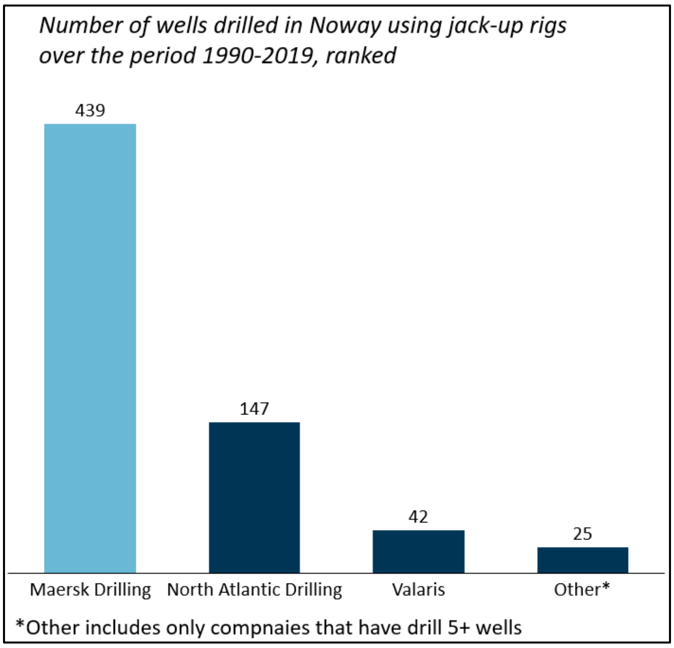

Figure 27: Wells drilled in Norway (Authors' analysis, Rystad Energy Data 2020)

Figure 27 the right shows the number of wells drilled with jackups on the NCS by Maersk Drilling and the nearest competitors. It is clear that Maersk Drilling has drilled significantly more wells than any other company.

Looking at the importance of the NCS to Maersk Drilling's operations it is not surprising that this region is also generating the most revenue. In FY19 the Norwegian business segment generated USD 559m in revenue, representing 46% of Maersk Drilling's total revenue. For FY18 the numbers were USD 630m and 44%, respectively (Maersk Drilling, 2019).

Rest of North Sea.

After the NCS the rest of the North Sea is the most important region. In this region, the UK is the largest country in terms of revenue generated followed by Denmark. In FY19 the combined revenue created in the region was USD 193m representing 16% of Maersk Drilling's total revenue and in FY18 it generated USD 199m representing 14% of the total revenue. The operational environment in the North Sea is considered to be harsh, as explained in the introduction to the industry. It is not as harsh as the NCS, but it is far from all rigs that can operate here. To drill in the UK, rigs are required to obtain a *UK oil & gas certificate*. This certificate is essentially the same as an AoC, but the requirements for the rig and its crew are not as high (Maersk Drilling, 2019).

Africa

While the NCS and the rest of the North Sea are the key regions for Maersk Drilling's jack-ups, these are harsh environments, which means that Maersk Drilling's floaters cannot operate in these regions. For Maersk Drilling's international floaters, Africa has been an important market over the last many years. Africa is a benign environment, where Maersk Drilling has been able to secure a lot of deepwater and ultra-deepwater operations for both its semisubmersibles and its drillships. Especially Angola and Ghana on the west coast have been important to Maersk Drilling's floater segment. However, in the last two years, Maersk Drilling has only marketed its drillships in West Africa as it was unsuccessful in securing work for its semisubmersible in 2017.

Africa generated USD 269m in FY19 representing 22% of Maersk Drilling's total revenue, while in 2018 the region generated USD 372m representing 26% of the total revenue (Maersk Drilling, 2019; Maersk Drilling 2018).

6.3.3 Market shares across segments and geographical markets

In the offshore oil drilling industry, there are several ways of measuring market shares. Often the market share is measured as the company's number of rigs relative to the total number of rigs within the market. However, this measure does not reflect anything about how good the companies are at signing contracts and actually getting work. Another measure for market share is revenue generated in the various markets. But as day rates typically are kept private it is impossible to find how much revenue each rig or segments generate. As a result, this paper will look at two measures, which in combination presents a more nuanced picture of the companies' market share and ability to secure work for their rigs. Instead of measuring the absolute number of rigs, this paper will look at the number of *marketed rig years.* Marketed rig years is a measure of how much operating time a company is offering to the market (IHS Markit, 2020). The benefit of this measure is that it only gauges the actual supply as it excludes rigs that are not available to the market. After establishing the market share of marketed rig years, the same methodology will be used for *contracted rig years.* This is a measure of how many rig years the companies have been able to contract.

The table below displays all the 22 segments (defined in appendix 2a) in which Maersk Drilling have marketed their services. The table shows Maersk Drilling's share of the total amount of marketed rig years in each segment from 2015-2019. The segments include all segments in which Maersk Drilling have offered their services within the last 5 years. Maersk Drilling's key segments are highlighted in blue. On the right-hand side is the absolute market size measured in rig years.

		Maersk Drilling's Share of Marketed Rig Years:						
Rig type	**Geography**	**2015**	**2016**	**2017**	**2018**	**2019**	**4 year change**	**Market Size 2019 (Rig years)**
Jackup	Norway	50,91%	46,32%	53,90%	47,79%	51,06%	0,2%	11,75
Jackup	UK	4,28%	7,22%	17,93%	18,91%	19,96%	15,7%	17,94
Jackup	North Sea Excl. Norway & UK	16,51%	28,33%	32,56%	35,61%	27,32%	10,8%	8,82
Jackup	SE Asia	3,06%	3,63%	3,83%	2,15%	1,93%	-1,1%	51,93
Jackup	W Africa	2,53%	0,00%	0,00%	0,00%	0,00%	-2,5%	18,15
Jackup	Far East	0,00%	0,00%	0,05%	0,00%	0,00%	0,0%	54,14
Semisubmersible	Mexico	0,00%	0,00%	0,00%	0,00%	9,45%	9,5%	4,02
Semisubmersible	SE Asia	0,00%	0,00%	4,99%	11,74%	13,61%	13,6%	7,35
Semisubmersible	US GOM	6,63%	10,25%	3,18%	0,00%	0,00%	-6,6%	4,5
Semisubmersible	W Africa	6,78%	12,47%	10,73%	0,00%	0,00%	-6,8%	3
Semisubmersible	Aus/NZ	2,84%	0,00%	0,00%	0,00%	0,00%	-2,8%	5,35
Semisubmersible	Med/Black Sea	16,23%	22,47%	27,03%	28,57%	33,22%	17,0%	3,01
Semisubmersible	S America	0,00%	0,00%	1,25%	0,00%	0,00%	0,0%	11,22
Semisubmersible	Caspian	25,00%	25,00%	22,17%	22,68%	25,00%	0,0%	4
Semisubmersible	C America	0,00%	0,00%	36,88%	46,95%	38,27%	38,3%	1,62
Drillship	SE Asia	14,60%	0,54%	0,00%	0,00%	4,25%	-10,4%	4
Drillship	Indian Ocean	0,00%	0,00%	0,00%	0,00%	1,89%	1,9%	6,88
Drillship	US GOM	6,27%	7,30%	4,00%	3,94%	4,38%	-1,9%	22,85
Drillship	W Africa	2,61%	3,98%	4,28%	7,84%	10,09%	7,5%	26,67
Drillship	Far East	6,99%	0,00%	0,00%	0,00%	0,00%	-7,0%	3,74
Drillship	S America	0,00%	2,09%	0,00%	0,00%	0,00%	0,0%	16,39
Drillship	C America	0,00%	13,28%	54,97%	73,68%	0,00%	0,0%	0,3

Table 19: Maersk Drilling's market share of marketed rig years (Authors' analysis, IHS Markit data 2020)

From the table above it is clear that the jackup-segment in Norway, UK, and the rest of the North Sea are key segments for Maersk Drilling. Maersk Drilling is especially dominant in Norway where they over the last five years have represented about half of all marketed supply. Another trend that can be deducted, is the increase in activity of the floater segments. Especially the drillships in West Africa and Semisubmersibles in South East Asia. It should be noted that West Africa is a relatively large region in terms of drilling activity with almost 27 rig years' worth of marketed supply.

As mentioned at the beginning of this chapter, the table above does not say anything about Maersk Drilling's ability to contract its rigs. However, the table below shows Maersk Drilling's market share of the demand. The first thing to notice is that despite having marketed its rigs in 22 segments, Maersk Drilling has only secured contracts in 17 of these.

Maersk Drilling's Market Share of Contracted Rig Years:								
Rig type	Geography	2015	2016	2017	2018	2019	4 year change	Market size 2019
Jackup	Norway	49,60%	46,35%	58,52%	49,74%	49,31%	-0,3%	10,12
Jackup	UK	1,99%	2,51%	17,31%	13,59%	18,04%	16,1%	13,47
Jackup	North Sea Excl. Norway & UK	16,95%	32,33%	23,18%	38,96%	34,76%	17,8%	5,84
Jackup	SE Asia	4,01%	3,90%	3,50%	3,29%	3,10%	-0,9%	32,29
Semisubmersible	Mexico	0,00%	0,00%	0,00%	0,00%	25,33%	25,3%	1,5
Semisubmersible	SE Asia	0,00%	0,00%	6,70%	5,91%	10,88%	10,9%	2,39
Semisubmersible	US GOM	7,82%	1,01%	0,00%	0,00%	0,00%	-7,8%	3,26
Semisubmersible	W Africa	7,77%	5,91%	0,00%	0,00%	0,00%	-7,8%	1,14
Semisubmersible	Aus/NZ	2,99%	0,00%	0,00%	0,00%	0,00%	-3,0%	3,78
Semisubmersible	Med/Black Sea	17,45%	46,08%	39,22%	40,16%	42,02%	24,6%	2,38
Semisubmersible	S America	0,00%	0,00%	1,00%	0,00%	0,00%	0,0%	3,96
Semisubmersible	Caspian	25,00%	25,00%	25,00%	23,53%	25,00%	0,0%	4
Drillship	SE Asia	8,82%	0,00%	0,00%	0,00%	0,00%	-8,8%	2,06
Drillship	Indian Ocean	0,00%	0,00%	0,00%	0,00%	1,40%	1,4%	5,73
Drillship	US GOM	7,12%	7,58%	5,27%	1,30%	0,00%	-7,1%	19,31
Drillship	W Africa	2,21%	5,10%	6,94%	15,82%	19,37%	17,2%	12,08
Drillship	S America	0,00%	1,17%	0,00%	0,00%	0,00%	0,0%	13,24

Table 20: Maersk Drilling's market share of contracted rig years (Authors' analysis, IHS Markit data 2020)

Looking at the Norwegian Jackup-segment again, we see that Maersk Drilling also has about half of the market share measured in contracted rig years. It is no surprise that Maersk Drilling is good at securing work in Norway though. What is interesting, however, is that Maersk Drilling has a market share of more than 19% in the West African drillship-segment. This is despite only representing 10% of the marketed supply. This shows Maersk Drilling's impressive skills in securing contracts for its rigs across all rig types.

7. DCF Valuation

Having established the strategic and financial characteristics of Maersk Drilling, this chapter will focus on the derivation of Maersk Drilling's equity value. The equity value is estimated by using the classical DCF-model, which is an essential step in the real option valuation. This chapter will firstly present the forecasted financials for Maersk Drilling and the underlying assumptions. Next, the company's cost of capital is derived, and finally, the equity value of Maersk Drilling is estimated.

7.1 Budgeting

The outcome of the DCF-model is determined by the expectations and forecasts incorporated into the pro forma statements. It is therefore important, that each forecasted item is supported by trustworthy sources and carefully conducted analysis. If not, the GIGO principle applies, where garbage inputs will yield a garbage output (Petersen et al., 2017).

Before starting the forecast of the key variable drivers, the length of the forecast period must be determined. Disagreements exist in regard to choosing the optimal length of the forecast period.

Koller et al. (2015) and Lundholm and Sloan (2007), both argue that the explicit forecast period must be long enough for the company to reach a steady state. However, while Koller et al. (2015) recommend using an explicit forecast period of 10 to 15 years, Lundholm and Sloan (2007) argue that it should be between 5 and 20 years, depending on the industry growth rate and company-specific competitiveness.

Koller et al. (2015) claim, that using a forecast period of fewer than five years will lead to a significant undervaluation of the company, or require deceptive assumptions for the continuing value's growth. Whereas using longer forecast periods will lead to increased forecast difficulty and decreased accuracy.

As discussed earlier, the revenue of Maersk Drilling is driven by two variables, that are in turn driven by a wide range of global economic drivers as portraited in the PESTEL-chart (Chapter 4.1). Consequently, choosing a forecast period of more than five years would yield a sharp increase in budget inaccuracy. Revenue forecast would be near impossible to predict, as the day rate is a product of many globally structural variables that are uncorrelated and unpredictable. As this thesis aims to forecast the budget in the most reliable way possible, a five-year forecast period was deemed the most appropriate.

The decision of choosing a five-year forecast period is also supported by the equity reports of HSBC (2019) and BNP Paribas (2019), which both use a five-year forecast period.

The five-year pro forma statements for Maersk Drilling were prepared using industry reports and forecasts, financial statements and conservative accounting assumptions.

7.1.1 Revenue

To forecast the revenue in an as accurate way as possible, this thesis relies on Rystad Energy's prediction for demand and day rates. As discussed earlier, the revenue is driven by these two variables, that are in turn driven by a wide range of global economic drivers as portraited in the PESTEL-chart (Chapter 4.1). Rystad Energy provides demand forecasts from an industry-wide perspective and all the way down to the rig-specific demand.

The approach to modelling the forecasted data to fit Maersk Drilling specifically has been to zoom into each segment that Maersk Drilling operates in. This essentially means looking at the day rates forecasted for the ultra-harsh environment jackups and then applying the average forecasted day rate to each of Maersk Drilling's rigs in these segments. The same approach has been used across the fleet. However, the day rate is only half of the story, when calculating the revenue. For the contracted days, which are the days where a rig can actually generate the day rate, this thesis used Rystad Energy's forecast at a rig specific level. Here it is important to note that Rystad Energy measures the demand in rig years, rather than contracted days. This means that some assumptions must be made to convert rig years of demand into contracted days. Here the thesis, in line with Rystad Energy, assumes that 332 operational days equals one rig year worth of demand (Rystad Energy, 2020). To assume that a rig can operate 365 days per year consistently is simply unrealistic as the rigs will need servicing, relocating and general repair work. The conversion from rig years to contracted days can be illustrated as such:

$$Contracted\ days = Rig\ years * 332$$

It is important to note here that a demand of 1 rig year (332 days) equals a utilisation rate of 100% in the given year, as the rig cannot supply more than one rig year per year. This means that a demand of 0.8 rig years equals 80% utilisation and $0.8 * 332 = 266$ days.

The actual revenue is then calculated by multiplying the contracted days with the day rates. As touched upon above, this has been done on a rig specific level to generate the most granular and precise prediction.

As can be seen in the table below, this shows a very nuanced overview of how each segment is performing, as well as Maersk Drilling as a whole. As mentioned in the market forecast (Chapter 5.2) the ultra-harsh environment is predicted to experience solid growth until 2024. 2020 is set to be a bad year with a total demand of just 4.6 rig years, but already in 2021, it is expected that the demand will be 7.0 rig years. However, due to falling day rates, the increase in demand is diminished.

The relative demand for harsh- and benign environment jackups is more volatile, due to the small portion of the fleet. Essentially the demand for a given segment can increase 100% if just a single rig is expected to get a full year contract in a segment with only two rigs in it.

Across all segments, the revenue for FY2020 is expected to be USD 955m. This will increase over the next two years and peak in FY2022 at USD1,418m followed by a decrease because of a fall in day rates.

Revenue forecast *Maersk Drilling*	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
Demand (in rig years)					
Floaters	5.9	6.6	7.0	7.0	5.9
HE, Jack-ups	0.8	2.0	2.0	1.0	1.0
UHE, Jack-ups	4.6	7.0	7.0	7.0	7.1
BE, Jack-ups	2.3	2.1	2.0	3.0	3.0
Contracted days (in days)					
Floaters	1,966	2,179	2,324	2,324	1,968
HE, Jack-ups	257	664	664	332	332
UHE, Jack-ups	1,542	2,324	2,324	2,324	2,366
BE, Jack-ups	775	688	664	996	996
Dayrates (USDm)					
Floaters	0.26	0.28	0.34	0.36	0.39
HE, Jack-ups	0.14	0.12	0.20	0.12	0.12
UHE, Jack-ups	0.23	0.23	0.19	0.16	0.16
BE, Jack-ups	0.08	0.08	0.08	0.09	0.08
Revenue (USDm)					
Floaters	501	619	792	834	775
HE, Jack-ups	35	76	135	40	40
UHE, Jack-ups	360	539	436	360	367
BE, Jack-ups	60	54	53	88	77
Group revenue	**955**	**1,289**	**1,418**	**1,322**	**1,259**

Table 21: Maersk Drilling's forecasted revenue FY20-24 (Authors' analysis, Rystad Energy data 2020)

7.1.2 Operational Expenditure

The opex have been based on Maersk Drilling's own estimates and brought into a rig specific level to match the approach used for revenue. The estimates are based on Maersk Drilling's numbers presented at their capital market day in 2019. These numbers are the daily opex across Maersk Drilling's rig segments for both contracted days and days where the rig is idle. The way to apply these numbers to estimate the annual opex for a rig is then to multiply the number of contracted days with the daily opex for a contracted rig, and adding the number of days without being contracted (idle days) multiplied with the daily opex of an idle rig as can be seen in the formula below:

$$Opex_{rig} = (Contracted\ days * daily\ operating\ opex) + (idle\ days * daily\ idle\ opex)$$

As for the revenue, the forecast is quite granular showing the opex across all segments as well as for the whole company, as per the table below. What is interesting about the opex is that it is unaffected by the day rates. As a result, the cost level is more stable than the revenue, with a minimum of USD 576m and a maximum of USD 705m in the period FY20-FY24. It should be noted that the daily opex are assumed to remain at the same level. This thesis concluded in chapter 4.4 the majority of Maersk Drilling's fleet has reached its dominant design, why we do not foresee any improvements to the daily opex.

For opex, demand is the main driver. Where revenue peaks in FY22, opex peaks in FY23. As a result, high demand and low day rates lead to diminishing margins. At the same time, more idle days leads to decrease costs, but an even larger decrease in revenue.

Production costs ***Maersk Drilling***	**FY20** **Bud**	**FY21** **Bud**	**FY22** **Bud**	**FY23** **Bud**	**FY24** **Bud**
Contracted days					
Floaters	1,966	2,179	2,324	2,324	1,968
HE, Jack-ups	257	664	664	332	332
UHE, Jack-ups	1,542	2,324	2,324	2,324	2,366
BE, Jack-ups	775	688	664	996	996
Idle days					
Floaters	690	477	332	332	688
HE, Jack-ups	1,071	664	664	996	996
UHE, Jack-ups	1,114	332	332	332	290
BE, Jack-ups	221	308	332	0	0
Operating opex rate (USDm)					
Floaters	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
HE, Jack-ups	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
UHE, Jack-ups	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
BE, Jack-ups	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Idle opex rate (USDm)					
Floaters	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
HE, Jack-ups	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
UHE, Jack-ups	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
BE, Jack-ups	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Production costs (USDm)					
Floaters	(281)	(301)	(315)	(315)	(282)
HE, Jack-ups	(31)	(48)	(48)	(34)	(34)
UHE, Jack-ups	(215)	(297)	(297)	(297)	(302)
BE, Jack-ups	(49)	(44)	(43)	(60)	(60)
Group production costs	**(576)**	**(691)**	**(703)**	**(705)**	**(677)**

Table 22: Maersk Drilling's forecasted operational expenditure FY20-24 (Authors' analysis, Rystad Energy data 2020)

To further underline the stability of opex, the forecasted estimates can be compared to the historical figures as seen below:

Maersk Drilling ***(in USD millions)***	**FY16** **Act**	**FY17** **Act**	**FY18** **Act**	**FY19** **Act**	**FY20** **Bud**	**FY21** **Bud**	**FY22** **Bud**	**FY23** **Bud**	**FY24** **Bud**
Revenue	2,297	1,439	1,429	1,222	955	1,289	1,418	1,322	1,259
Operating costs	(816)	(681)	(714)	(710)	(576)	(691)	(703)	(705)	(677)
Operating costs (as a % of revenue)	**(36%)**	**(47%)**	**(50%)**	**(58%)**	**(60%)**	**(54%)**	**(50%)**	**(53%)**	**(54%)**

Table 23: Maersk Drilling's historical and forecasted operational expenditure (Authors' analysis, Rystad Energy data 2020)

Above we can see that the general level both in absolute values and as a percentage of revenue is relatively stable. In terms of the opex relative to the revenue, FY2016 is the outlier among the shown years. This is a result of legacy contracts signed back in 2013 and 2014 where the oil price peaked, which meant that day rates were at an all-time high (Maersk Drilling, 2018).

7.1.3 Sales, general and administration costs

Historically, Maersk Drilling's SG&A costs have had an increasing trend, and from FY16 to FY19 the S&GA costs relative to revenue increased by approximately 4 ppts, which corresponds to an increase of circa USD 7m. The increase in SG&A costs is according to Maersk Drilling (2019), due to the full-year effect of new functions added to the organisation during 2018. The new functions were established to support Maersk Drilling as a stand-alone listed company and were completed in FY19. As the organisational changes are a result of a permanent demerger, it seems unlikely that the SG&A costs will resume back to the levels between FY16-FY18. Consequently, it was deemed appropriate to let the SG&A costs relative to revenue in FY19 be the indicator for the future level. This yields a forecasted SG&A cost of 7.9% of revenue.

SG&A costs *(Group)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
In USD millions	(90.0)	(66.0)	(84.0)	(97.0)	(76)	(102)	(113)	(105)	(100)
As a % of revenue	(3.9%)	(4.6%)	(5.9%)	(7.9%)	(7.9%)	(7.9%)	(7.9%)	(7.9%)	(7.9%)

Table 24: Maersk Drilling's SG&A costs (Authors' creation)

7.1.4 Depreciation and amortisation

To forecast depreciation and amortisation, Koller et al. (2015) suggest using one of three approaches. The first and second approach involves forecasting depreciation as a percentage of either revenue or PP&E and intangible assets, while the third approach entails inside knowledge about capex. As we do not have access to Maersk Drilling's internal capex budget and depreciation schedule this approach is not applicable. The choice between the two aforementioned methods is based on the development of capex. If capex are deployed gradually the choice between the two methods will not matter, however, if capex are deployed in lumps (e.g. acquisition of offshore drilling rigs every fifth year) using a percentage of PP&E will yield a better forecast. This is due to the fact, that depreciation and amortisation are directly linked to a specific asset, thus it should only increase if a capex has been made.

Instead, if depreciations are linked to sales, they will incorrectly increase in line with revenue, despite no capex being made.

Based on the historical capex highlighted in chapter 7.1.7, Maersk Drilling's deployed expenditures cannot be considered smooth. This is primarily due to the delivery of newly ordered rigs and rig-upgrades, which impact the capex heavily. As a result of the lumpy capex, the depreciation and amortisation will be forecasted as a percentage of PP&E and intangible assets.

Historically, Maersk Drilling's depreciations and amortisations, measured as a % of intangible and tangible assets, have been relatively stable at around 8% with the exception of FY18 where it was 9.6%. In FY18 the depreciations and amortisations were impacted by prior-year impairment losses of USD -1,769m, thus resulting in an outlier of 9.6%. By excluding the outlier in FY18, Maersk Drilling's depreciations and amortisations, measured as a % of intangible and tangible assets, ranged from 7.5% to 7.8%. As a result of the stable historical levels, it was deemed appropriate to let depreciation and amortisation (measured as a % of intangible and tangible assets) in FY19 be the indicator for the future level. This yields a forecasted depreciation and amortisation rate of 7.8% of intangible and tangible assets.

Depreciation and amortisation *(Group)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
In USD millions	(596.5)	(475.5)	(421.4)	(387.0)	(375.1)	(359.4)	(345.2)	(332.1)	(320.0)
As a % of intangible and tangible assets	(7.5%)	(7.7%)	(9.6%)	(7.8%)	(7.8%)	(7.8%)	(7.8%)	(7.8%)	(7.8%)

Table 25: Maersk Drilling's depreciation and amortisation FY14-FY19 (Authors' analysis)

7.1.5 Tax rate

To estimate NOPAT, we must determine the corporate tax rate of Maersk Drilling. For companies with foreign operations or subsidiaries abroad, the effective corporate tax rate is arguably the fairest estimate. This is because it is a weighted average of the company's corporate tax rates. However, as pointed out by Petersen et al., (2017) the effective tax rate is based on several underlying assumptions, which makes it unfavourable to use e.g. the borrowing expenses are allocated in accordance with the earnings from operations. Furthermore, the effective tax rate is implicated by different asset types and the respective tax depreciation legislation. Some of the implications are also displayed in the table below, which depicts the estimated effective tax rate of Maersk Drilling from FY14-19.

Corporate tax rate *(in %)*	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**FY20-24 Bud**
Effective tax rate, Maersk Drilling	(20.4%)	(0.1%)	(3.1%)	(4.9%)	34.5%	22%
Danish corporate tax rate	24%	22%	22%	22%	22%	

Table 26: Maersk Drillings estimated effective tax rate, the Danish corporate tax rate (Authors' analysis)

Maersk Drilling's estimated effective tax rate has experienced significant fluctuations in recent years, which makes it an unusable proxy for a future corporate tax rate. As a result, we have used the Danish marginal tax rate to estimate the tax on net operating profit. This is also in line with Petersen et al. (2017), who also favour the marginal tax rate over the effective tax rate. The Danish corporation tax rate has been reduced from 25% in 2014 to today's rate at 22%, due to the political implementation of 'Vækstplan DK' in 2013 (Finansministeriet, 2013). A similar political implementation may occur again, however, at the moment we assume a corporate tax rate of 22%.

7.1.6 Net working capital

Net working capital designates the essential net investments for ongoing operations. To forecast net working capital, we use the method suggested by Petersen et al. (2017) and Koller et al. (2015). The method involves forecasting each line item of NWC as a percentage of revenue, as revenue is the key value driver of operations. The NWC forecast will include an in-depth analysis of Maersk Drilling's most influential NWC items and their respective forecast. However, the forecast of less significant items will not be elaborated to the same extend.

Trade receivables

Trade receivables represent the biggest item of Maersk Drilling's net working capital. From FY15-FY19 trade receivables ranged between 13% and 24% of revenue with an average of 19%. During this period, Maersk Drilling has experienced a significant increase of approximately 5ppts in trade receivables relative to their revenue.

According to the annual reports (Maersk Drilling, 2018 & 2019), the increase in trade receivables cannot be assigned to a change in credit risk, as it appears unchanged. For drilling contracts, credit risk is minimised by conducting a credit assessment of the counterparty prior to contract-entering. Furthermore, depending on the creditworthiness, Maersk Drilling may seek protection, in the form of pre-payments, parent company guarantees etc. Despite the credit assessment appearing unchanged, it is unclear whether

Maersk Drilling has extended its customers' credit as a result of the challenging market conditions. This would explain the increase in trade receivables relative to revenue.

Trade receivables *(as a % of revenue)*	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**
Maersk Drilling	17%	13%	21%	24%	22%
Awilco Drilling Plc.	4%	34%	18%	21%	25%
Noble Corporation Plc.	15%	14%	17%	19%	21%
Seadrill Ltd.	17%	15%	14%	17%	12%
Pacific Drilling S.A.	15%	12%	13%	15%	13%
Transocean Ltd.	19%	22%	22%	20%	21%
Valaris Plc.	14%	13%	19%	20%	26%
Diamond Offshore Drilling Inc.	17%	15%	17%	16%	26%

Table 27: Trade receivables as a % of revenue (Authors' analysis)

As displayed in the table above, Maersk Drilling is not the only company among its peers, who has experienced an increase in trade receivables relative to revenue. Other companies such as Valaris Plc, Diamond Offshore Drilling Inc. and Transocean Ltd. appear to have the same tendencies. Consequently, it appears that the increased level of trade receivables relative to revenue is the new market conditions for offshore drilling companies. As a result of these findings and the unexplainable increase in trade receivables relative to revenue, we find the recognised level of FY19 as the best estimate for the future development in trade receivables. This yield a rate of 22% of revenue.

Trade payables

Trade payables represent the second largest item of Maersk Drilling's net working capital. From FY15-FY19 trade payables ranged between 6% and 15% of revenue with an average of 11%. During this period, Maersk Drilling has experienced a significant increase of approximately 6ppts in trade payables relative to their revenue. This implies, that the group has extended its supplier credit, which improves liquidity. As with trade receivables, Maersk Drilling has not commented on the development of trade payables. Consequently, it is difficult to understand the historical development and thus forecasting the future estimates.

Despite these limitations, we can use the peer group to identify, whether the increasing trend in trade payables relative to revenue only applies to Maersk Drilling or if it is a general industry trend. As displayed in the table below, all the industry peers have to some extend recognised an increase in trade payables relative to revenue from FY15-FY19. It appears that an increased level of trade payables relative to revenue is the new market conditions for offshore drilling companies, thus supporting the impression that Maersk Drilling's increase is not company-specific.

Trade payables *(as a % of revenue)*	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**
Maersk Drilling	(9%)	(6%)	(11%)	(14%)	(15%)
Awilco Drilling Plc.	(2%)	(1%)	(1%)	(11%)	(3%)
Noble Corporation Plc.	(7%)	(5%)	(7%)	(12%)	(8%)
Seadrill Ltd.	(3%)	(3%)	(3%)	(7%)	(6%)
Pacific Drilling S.A.	(4%)	(2%)	(4%)	(6%)	(11%)
Transocean Ltd.	(6%)	(5%)	(7%)	(9%)	(10%)
Valaris Plc.	(6%)	(5%)	(23%)	(12%)	(14%)
Diamond Offshore Drilling Inc.	(3%)	(2%)	(3%)	(4%)	(7%)

Table 28: Trade payables as a % of revenue (Authors' analysis)

As displayed in the table above, Maersk Drilling's trade payables relative to revenue has increased every year since FY16 and is at its all-time high in FY19. This yields the debate about whether the level is expected to increase further in the future. However, as we have no information regarding Maersk Drilling's terms of payment or explanation of the historical development, we find the recognised level of FY19 as the best estimate for the future. This yields a rate of -15% of revenue.

Remaining NWC items

The historical trends of the remaining net working capital items have been relatively stable, and the overall range of deviation from FY15-FY19 is between 1-3 ppts of revenue. As a result, we find it a fair assumption that the remaining net working capital items will follow their respective levels recognised in FY19 relative to revenue.

Overall, the net working capital requirements are forecasted at -2.8% of revenue, which is the same rate, that was recognised in FY19. Based on the analysis above, the net working capital requirements for 2019 is considered the best estimate for the future. The entire forecast for Maersk Drilling's NWC is displayed in appendix 5, whereas a summary table of the main NWC items is displayed below:

Key NWC items *(as a % of revenue)*	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**Average FY15-19**	**FY20-24 Bud**
Trade receivables	17%	13%	21%	24%	22%	19%	22%
Trade payables	(9%)	(6%)	(11%)	(14%)	(15%)	(11%)	(15%)
Net working capital	**(2.4%)**	**0.9%**	**3.6%**	**0.5%**	**(2.8%)**	**(0.1%)**	**(2.8%)**

Table 29: Summary of Maersk Drilling's most comprehensive NWC items (Authors' analysis)

7.1.7 Capital expenditures

Capex are often forecasted by applying the method of Koller et al. (2015) and Petersen et al (2017). The method involves the forecast of intangible and tangible assets as a percentage of revenue and deriving the capex by summing the increase in asset value with the forecasted depreciation and amortisations.

Despite the method being the most widely used, it was deemed inapplicable to the case of Maersk Drilling. The reason being, that the historical development in Maersk Drilling's intangible and tangible assets relative to revenue, is quite unstable due to significant impairment losses and reversals.

Maersk Drilling *(USD in millions)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**
Revenue	1,998	2,518	2,297	1,439	1,429	1,222
Intangible & tangible assets	7,936	6,142	4,395	4,945	4,793	4,593
Intangible & tangible assets *(% of revenue)*	397%	244%	191%	344%	335%	376%

Table 30: Maersk Drilling's intangible and tangible assets relative to revenue (Authors' analysis)

As a result, this thesis has used Maersk Drilling's capex guidance from the annual report (2019) to forecast future capex. For FY20 Maersk Drilling expects capex of around USD 150-200m. Consequently, we forecast an average between the low case of USD150m and high case of USD200m equal to USD175m for FY20. This number consists of an expected USD150m in periodic services including repair work and an additional 25m of upgrades to the Maersk Integrator jackup (Maersk Drilling, 2019).

In the period 2021 to 2024 Maersk Drilling states that the expected average annual run-rate maintenance capex equals USD150m. This number comprises of maintenance and repair work of the rigs (Maersk Drilling, 2019). In addition to the maintenance capex, this thesis allocates additional expansion expenditures of USD27,5m for rig upgrades. This number is based on the average number of upgrades conducted over the last 10 years, multiplied by the average cost of similar upgrades in the market in the last 5 years (IHS Markit, 2020). The reason why this thesis uses the average cost of the last five years is because shipyard costs were heavily inflated in the period 2012-2015 and are therefore not representative of future costs (Bassoe Offshore, 2020). The total capex is assumed to be stable at USD177.5m per year from 2021-2024.

The forecast derived above is based upon the assumption, that Maersk Drilling is not expected to grow by acquiring new rigs or increase their capex towards significant rebuilds of their fleet. While this assumption might seem controversial when sat against the forecasted revenue growth in chapter 7.1.1, it does make sense. It makes sense because Maersk Drilling already has the required number of rigs to supply the forecasted demand. Historically, many of the rigs have been idle or been running with low utilisations rate. Consequently, the forecasted revenue growth is not expected to give rise to the acquisition of new rigs or significant fleet rebuilds.

Based on the analysis above, Maersk Drilling's forecasted capex is as follows:

Maersk Drilling ***(In USD millions)***	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
Capital expenditures	(307)	(520)	(182)	(309)	(175)	(178)	(178)	(178)	(178)
Depreciation and amortisation	(597)	(475)	(421)	(387)	(375)	(359)	(345)	(332)	(320)
Capex as a % depreciation and amortisation	51%	109%	43%	80%	47%	49%	51%	53%	55%

Table 31: Historical and forecasted capital expenditures (Authors' analysis)

Compared to the historical level of capex, the budget might seem relatively optimistic. However, it's important to note that the historical levels of capex are heavily influenced by prior acquisitions of rigs, which is not expected in the foreseen future.

For example, in FY17 where the capex was impacted by the instalment for the Maersk Invincible (Maersk Drilling, 2018). In FY19, the capex (USD 309m) was related to an unusually high number of rig upgrades and yard stays in connection with special periodic services (SPS) for nine rigs (Maersk Drilling, 2019). In comparison, the Maersk Drilling has scheduled three SPSs for FY20. As a result of these historical outliers, we find the level of capex in FY18 as the best proxy for the future. This is due to the fact, that the capex in FY18 were related to minor upgrades and maintenance, which is in line with the future expectations to the capex of the company.

As Maersk Drilling is not expected to acquire any rigs in the foreseen future, the forecasted depreciations are expected to exceed the capex. And while this might be an indication, that the forecasted capex is not sufficient to compensate for the annual asset-wear, it's important to remember that the industry is characterised as being asset-heavy. Once the drilling rig has been installed, the maintenance requirements are minimal, thus leading depreciations to exceed capex. This trend is also reflected in the historical capex relative to depreciations. And for the aforementioned guidance year of capex in FY18, the capex represents just 43% of the deprecations, whereas the ratio for the forecast period ranges from 47%-55%.

Based on the overall assessment of the forecasted capex and depreciations, we find the forecasted estimates reasonable.

7.1.8 Net debt

Net debt is not necessary to forecast when conducting a DCF valuation since the equity value is derived by using the most recent reported amount of net debt.

Despite it not being necessary for the DCF valuation, it is however still necessary for estimating the liquidation value of the later defined abandonment option. Net debt is forecasted in line with Petersen et al. (2017), who suggest forecasting net debt as a percentage of invested capital.

Historically, Maersk Drilling's net debt relative to invested capital has ranged from -41% to 23%. The significant difference is mainly due to intercompany receivables from A.P. Moller Maersk back in FY16 and FY17. If the net debt is adjusted for the significant intercompany receivables, the historical net debt relative to invested capital ranges from 23% to 37%, whereas the 37% peak back in FY17 primarily was a result of significant impairments on PP&E, as gross debt decreased by USD 345m from FY16 to FY17. As a result, the true range of Maersk Drilling's net debt relative to invested capital lay within 23%-25%. In addition, the level of net debt relative to invested capital has stabilised in FY18 and FY19 at around 23%, thus we find it a fair assumption that the recognised level of FY19 is the best estimate for the future development in net debt. This yields a forecast rate at a net debt of 22.8% of invested capital.

Net debt forecast *Maersk Drilling*	**31 Dec 16** Act	**31 Dec 17** Act	**31 Dec 18** Act	**31 Dec 19** Act	**31 Dec 20** Bud	**31 Dec 21** Bud	**31 Dec 22** Bud	**31 Dec 23** Bud	**31 Dec 24** Bud
Net debt *(USDm)*	(2,552)	(1,745)	1,143	1,087	1,042	998	959	925	893
Net debt *(% of invested capital)*	(41%)	(39%)	23%	23%	23%	23%	23%	23%	23%
Loan receivables, A.P. Maersk	(4,134)	(3,390)	(2)	-					
Net debt, adjusted	1,582	1,645	1,145	1,087					
Net debt, adjusted *(% of invested capital)*	25%	37%	23%	23%					

Table 32: Summary of Maersk Drilling's net debt (Authors' analysis)

7.1.9 Budget control

To check the reasonability of the estimated budget, Koller et al. (2015) suggest comparing the historical profitability with the forecasted, as this will highlight any potential anomalies. The table below presents the decomposition of Maersk Drilling's historical and forecasted

ROIC.

ROIC decomposition *Maersk Drilling*	FY16 Act	FY17 Act	FY18 Act	FY19 Act	FY20 Bud	FY21 Bud	FY22 Bud	FY23 Bud	FY24 Bud	Average FY16-19	Average FY20-24
Revenue (USDm)	2,297	1,439	1,429	1,222	955	1,289	1,418	1,322	1,259	1,597	1,249
Average invested capital (USDm)	7,074	5,339	4,713	4,862	4,668	4,475	4,295	4,133	3,986	5,497	4,311
Invested capital turnover	0.32	0.27	0.30	0.25	0.20	0.29	0.33	0.32	0.32	0.29	0.29
Inverse invested capital turnover	3.08	3.71	3.30	3.98	4.89	3.47	3.03	3.13	3.17	3.5	3.5
EBIT margin	35%	15%	15%	2%	(8%)	10%	18%	13%	13%	17%	9%
NOPAT margin	(30%)	(104%)	67%	(2%)	(6%)	8%	14%	11%	10%	(17%)	7%
ROIC, before tax	11%	4%	4%	1%	(2%)	3%	6%	4%	4%	5.1%	3.1%
ROIC, after tax	(10%)	(28%)	20%	(0%)	(1%)	2%	5%	3%	3%	(4.6%)	2.5%

Table 33: Budget control, ROIC decomposition (Authors' analysis)

Historically, the fluctuating trend of Maersk Drilling's invested capital turnover can mainly be attributed to the aforementioned impairment losses and reversals, as the revenue has been declining each year since FY16. In FY19, the invested capital turnover decreased to a low point of 0.25, where each USD the Group invested in capital, generated a revenue of USD 0.25. Going forward from FY19 into FY20, the invested capital turnover is expected to keep decreasing, as the revenue is expected to decline by 22%, whereas the level of invested capital is not expected to decrease accordingly.

However, as the market conditions, and thus revenues, are expected to improve by FY21-FY22, Maersk Drilling's turnover of invested capital is anticipated to return to the historical levels ranging from 0.29 to 0.33. By FY23-FY24 it is expected that Maersk Drilling's invested capital turnover stabilises at 0.32, despite revenue being forecasted to decline. This is mainly due to the decreasing trend of Maersk Drilling's invested capital, where limited capex are expected.

Overall, the average invested capital turnover for the forecast period is 0.29, which is the same as for the historical period. Furthermore, the stabilisation of invested capital turnover at 0.32 in FY23-FY24, seems to be somewhat in line with the rate recognised in FY16, which represents a year without any major impairment losses or revenue decline.

The NOPAT margins of Maersk Drilling have historically been very fluctuating as a result of the challenging market conditions, which led to significant declines in revenue as well as impairment losses and reversals. Consequently, using the historical NOPAT margins to validate the budget would be misleading. Instead, we determined to use the EBIT margin.

In FY19, Maersk Drilling's EBIT margin reached a low point of 2% and going forward into FY20 the EBIT margin is expected to decrease even further. For FY20, the EBIT margin is expected to be -8%, which is mainly related to the expected decrease in revenue of 22%.

However, as the market conditions are expected to improve by FY21-FY22, so is the operating margins of Maersk Drilling. Consequently, the forecasted EBIT margins for FY21 and FY22 amount to 10% and 18%, respectively.

From FY23-FY24 the day rates are expected to experience a minor decrease, thus leading to a slight decline in revenue. As a result, Maersk Drilling's EBIT margins are also expected to decrease to a stable level of 13%.

Overall, the average EBIT margin for the forecast period is 9%, which is 8ppts below the historical average. While this might indicate an overly conservative budget, it is important to note, that the industry is cyclical thus the historical period includes the FY16 EBIT margin of 35%, whereas the forecasted period includes the FY20 EBIT margin of -8%. By examining the historical and forecasted median EBIT margins, we find that the historical EBIT margins are 2ppts higher than the forecasted. However, due to the demerger, Maersk Drilling increased their SG&A costs, which explains some of the minor differences in profitability.

Based on the analysis above, it can be derived that Maersk Drilling's ROIC before tax is negative for FY20, while it accordingly with the improved market conditions in FY21-FY22 increases to 3% and 6%, respectively. As for FY23-FY24 the invested capital turnover and operating margins are expected to stabilise, thus yielding a stable ROIC before tax of 4%, which is line with the historical average. Consequently, we find the overall budget a reasonable estimate.

(The overall budget for Maersk Drilling is presented in appendix 5a and 5b)

7.2 Cost of capital

This chapter will focus on the derivation of Maersk Drilling's cost of capital, which includes the estimation of the company's cost of equity and cost of debt. The purpose is to calculate all of the required inputs for the Capital Asset Pricing Model and the cost of debt, which is later used in the computation of Maersk Drilling's WACC.

7.2.1 Cost of equity

7.2.1.1 Beta

In order to estimate the beta of Maersk Drilling, we use the method suggested by Koller et al. (2015). As argued by Koller et al. (2015) the estimation of beta is an imprecise process, hence using an industry beta rather than the equity, reduces the effect of idiosyncratic shocks[2], and yields a more representative estimate. Consequently, Maersk Drilling's equity beta is found by relevering the industry beta with the company's target capital structure. The beta of Maersk Drilling is estimated by applying the following four-step process.

7.2.1.2 Determining the industry beta

1. Estimating equity beta for Maersk Drilling's peers:

First, we estimate the equity beta for Maersk Drilling and its peers by plotting 60 months (5 years) of stock returns against the MSCI World Index returns[2]. The reason why we use monthly data, a five year measurement period and the MSCI World Index returns is explained in appendix 4a, where the regression outputs are placed as well.

The table below displays the summary statistics of the regression outputs:

Regression summary	Beta equity	R-squared	t-stat	Lower 95%	Upper 95%
Maersk Drilling A/S*	2.74	0.79	5.5	1.6	3.9
Awilco Drilling plc	1.21	0.08	2.2	0.1	2.3
Noble Corporation plc	2.66	0.26	4.5	1.5	3.8
Seadrill Limited	2.89	0.08	2.25	0.3	5.5
Pacific Drilling S.A.	1.49	0.01	0.60	(3.5)	6.5
Transocean Ltd.	2.71	0.56	5.2	1.7	3.8
Valaris plc	3.25	0.32	5.2	2.0	4.5
Diamond Offshore Drilling Inc.	2.51	0.30	5.03	1.51	3.51

*Estimation include less than 12 months of data points.

Table 34: Summary of regression output – beta (Authors' analysis)

As displayed in the table above, the equity beta among Maersk Drilling's peers range between 1.21 to 3.25. By using two standard errors as a guide, most of the beta estimates are statistically significant. The only exception is the beta of Pacific Drilling S.A, which statistically insignificant with a t-stat of 0.6. As a result, the beta of Pacific Drilling will be excluded from the industry beta estimation.

The regression analysis yielded an estimated equity beta of 2.74 for Maersk Drilling with a corresponding t-stat of 5.5. By using two standard errors as a guide, the beta estimate of Maersk Drilling is statistically significant.

Despite these findings, the estimated beta equity of Maersk Drilling will not be included in the derivation of the industry beta. This is due to a short sample of monthly returns, where less than 12 data points were included in the regression. As pointed out in appendix 4a, a

[2] Morgan Stanley Capital International

representative beta estimation is based on 60 data points, which is equivalent to five years of monthly returns (Koller et al., 2015). Since Maersk Drilling have not been listed for more than a year, the regression is based on less than 12 data points. Consequently, the estimate is excluded from the derivation of the industry beta.

As previously stated, beta estimation is an imprecise process, hence plotting the 12-month rolling beta can be used to visually inspect for structural changes e.g. changes in capital structure, business strategy etc. Potential changes in the rolling beta can be used as an argument for changing the beta measurement period. To inspect the potential structural changes, we have estimated the 12-month rolling beta over the last five years for Maersk Drilling's peers. The result is displayed in the diagram below and shows that the level of beta among the industry peers has remained relatively stable with the exception around mid-FY17. In mid-FY17 the offshore drilling industry faced challenging market conditions, and multiple companies were on the verge of bankruptcy, thus explaining the peek in beta. At the beginning of FY18, the betas began retracting to prior levels, and have remained relatively steady since. As a result, we do not find it appropriate to change the measurement period of beta.

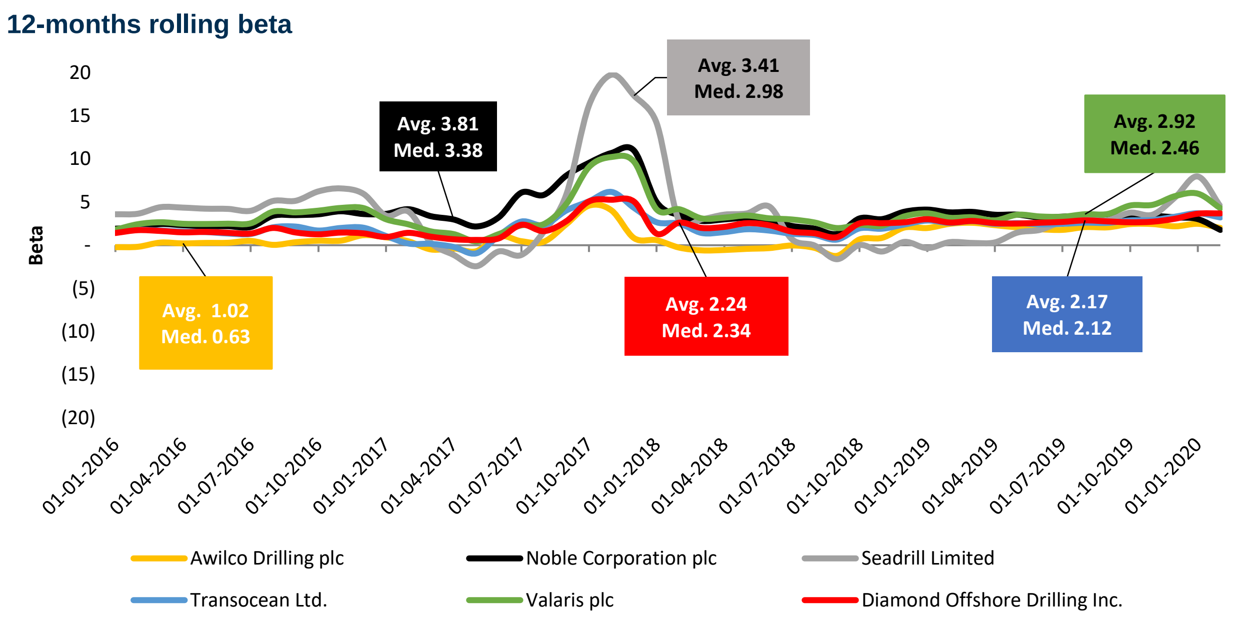

Figure 28: 12-month rolling beta (Authors' analysis)

2 + 3) Determining β_u for peers and estimating the industry beta.

Next step of finding the industry beta involves determining the unlevered beta for each of the peers. The unlevered beta, or beta assets as it is also referred to, reflects the market risk of the company without the influence of debt. By unlevering the equity beta, we find the operating risk in the industry (Petersen et al., 2017). To find the unlevered beta, the beta equity is divided with the leverage ratio, market-debt-to-equity (Koller et al., 2015).

$$\beta_u = \frac{\beta_e}{(1 + \frac{Net\ debt}{Equity})}$$

By applying the formula above, we get the following unlevered betas of Maersk Drilling's peers as well as the estimated industry beta:

Industry Beta *(as of 31 Jan 20)*	**Beta, equity**	**Net debt / Equity**	**Beta, Assets**
Awilco Drilling plc.	1.21	-0.54	2.61
Transocean Ltd.	2.71	3.02	0.67
Valaris plc.	3.25	5.43	0.51
Diamond Offshore Drilling Inc.	2.51	2.90	0.64
Industry beta, median			**0.660**
Industry beta, average			**1.109**
Outliers			
Noble Corporation plc.	2.66	20.04	0.13
Seadrill Ltd.	2.89	36.00	0.08

Table 35: Beta assets and Industry beta (Authors' analysis)

As can be seen in the table above, we have removed Noble Corporation and Seadrill from the peer group, as a result of their high net debt-to-equity ratios of 20.04 and 36.0 respectively. The high leverage ratios resulted in misleading estimates for beta assets of 0.13 and 0.08 respectively.

Furthermore, it is worth noticing Awilco Drilling's negative market value of net debt, which results in an unlevered beta which exceeds the levered beta. Although this might seem confusing, it does make sense as the value of cash never changes. Consequently, the stock volatility is lowered by the effect of a net cash position (Damodaran, 2014).

Despite these irregularities, we find an average industry beta of 1.11. In comparison, Damodaran (2020) estimate a beta for the oil production and exploration industry of 1.08, which involves a peer group of 269 firms including Maersk Drilling. The findings of Damodaran (2020) do not apply to the case of Maersk Drilling, as the peer group is not solely based on pure players in the offshore drilling industry. However, using Damodaran's industry beta as a guide, we find our estimated industry beta of 1.11 reasonable.

4. Determining Maersk Drilling's $\boldsymbol{\beta_e}$

Now that we have determined the unlevered industry beta, we can estimate Maersk Drilling's equity beta. This is done by relevering the industry beta with Maersk Drilling's target capital structure, which in chapter 7.2.3 is found to be D/E=0.47. Maersk Drilling's equity beta can subsequently be estimated as followed: (Koller et al., 2015):

$$\beta_e = \beta_u * \left(1 + \frac{Net\ debt}{Equity}\right)$$

$$\beta_{e,unadjusted\ Maersk\ Drilling} = 1.11 * (1 + 0.47) = 1.63$$

Based on the computation above, Maersk Drilling's pre-adjusted beta equity is found to be 1.62.

As argued by Koller et al. (2015) smoothing techniques can be applied to improve the beta estimate. For well-defined industries, an industry beta will be sufficient, but for industries where a few direct comparables exist, a smoothing of beta is highly relevant. Smoothing reduces the effect of extreme observations and reverts the beta to the mean (Koller et al., 2015).

As pointed out in the derivation of the industry beta as well as in the strategic and financial analysis, Maersk Drilling's constellation is quite unique compared to its peers. Because of this, only a few, direct comparables exist, hence we find it appropriate to apply a simple smoothing process (Koller et al., 2015).

$$\beta_{e,adjusted} = 0.33 + 0.67 * \beta_{e,unadjusted}$$

$$\beta_{e,adjusted\ Maersk\ Drilling} = 0.33 + 0.67 * 1.63 = 1.42$$

By applying a simple smoothing, Maersk Drilling's adjusted beta equity amounts to 1.42. To validate the estimated beta, one would typically rely on the findings of equity reports as well as estimates provided by financial databases such as Thompson One and Yahoo Finance. However, as the financial databases estimate beta, using five-years of historical returns, these do not provide an estimate for Maersk Drilling's beta. Furthermore, by examining equity reports from JP Morgan, Morgan Stanley, BNP Paribas, DNB and HSBC, we found that HSBC (2019) was the only equity researcher who disclosed their beta estimate. HSBC's equity report (2019) reported a beta for Maersk Drilling of 1.35, which is somewhat in line with our estimate. In addition, the estimated beta of 1.42 indicates that Maersk Drilling's operational and financial risk both can be characterised as high (Petersen et al., 2017). This seems to be in line with the previous findings of the strategic and financial analysis in chapter 4 of the thesis.

Based on the analysis above, we find the determined beta of 1.42 a reasonable estimate.

7.2.1.3 Market risk premium

The market risk premium refers to the difference between the expected return on the market portfolio and the risk-free bonds. There are overall two methods in which the market risk premium can be determined, the ex-post and the ex-ante approach. The ex-post approach examines the historical difference between the stock market returns and the risk-free returns, while the ex-ante approach infers the risk premium from analysts' consensus earnings estimates (Petersen et al., 2017).

In general, there are many finance professionals, who disagree upon which method to use, when determining the market risk premium. Despite these disagreements, there is a consensus among analyst, professors etc. that the appropriate range for the market risk premium is around 4.5% to 5.5% (Koller et al., 2015)

Academic papers such as the one presented by Fernandez, Martinez, & Acín (2019) find an average market risk premium ranging from 5.3% to 6% during 2015-2019. Fernandez et al's. (2019) paper is published on an annual basis and contains the statistics of a survey about the market risk premium used in different countries. The survey is sent to finance professors, analysts and managers of companies obtained from previous correspondence.

Fernandez' survey, Denmark	2015	2016	2017	2018	2019
Market risk premium, Average	5.5%	5.3%	6.1%	6.0%	6.00%
Market risk premium, Median	5.5%	5.0%	6.3%	6.2%	6.00%
Market risk premium, Standard deviation	1.2%	1.7%	0.8%	0.8%	1.50%

Table 36: DK's market risk premium (Fernandez et al., 2019)

Damodaran (2020) is another source, who is often referenced when estimating the market risk premium. Damodaran (2020) find that the Danish market risk premium ranges from 5.5% to 6.8% during 2015-2019.

Damodaran estimates, Denmark	2015	2016	2017	2018	2019
Market risk premium	6.8%	6.2%	5.5%	6.7%	5.8%

Table 37: DK's market risk premium (Damodaran., 2019)

The findings of Fernandez et al's., (2019) and Damodaran (2020) are relatively close for 2019. Nevertheless, we have decided to use the market risk premium found by Fernandez et al's., (2019), as it is based on a high number of financial theorists and practitioners[3]. Consequently, the cost of equity will be computed using a market risk premium of 6%.

7.2.1.4 Risk-free rate

To estimate the risk-free rate, we use the yield from the Danish 10-year government bond. We use a Danish government bond because the currency of the chosen bond needs to be the same as the currency in which the company's stock is denominated Koller et al. (2015). By applying this method, we ensure that inflation is modelled consistently between the discount rate and the cash flow. Furthermore, we use a government bond with a maturity of 10-years because of its liquidity result in a price and yield premium that reflects a more fair current value. This should be seen in contrast to the 30-year government bond, which matches the cash flow streams better, but its illiquidity means that price and yield premium may not reflect its current value (Koller et al., 2015)

As a result, we use the yield from the Danish 10-year government bond, which as of the 31 Jan 20 equals -0.44%. However, as argued by Petersen et al., (2017) the current yield level is artificially low due to monetary policies. Consequently, a historical average of the yield on a 10-year treasury bond seems like a more fair estimate for the risk-free rate. In line with Petersen et al. (2017), we have estimated the 20-year average yield on the Danish 10-year government bond. This yields a risk-free rate of 2.69%, which will be used in the computation of cost of equity and cost of debt.

Goverment Bond 10Y *(20-year average interest rate)*	**31 Dec 2014**	**31 Dec 2015**	**31 Dec 2016**	**31 Dec 2017**	**31 Dec 2018**	**31 Dec 2019**	**31 Jan 2020**
Denmark	4.2%	3.8%	3.5%	3.2%	3.0%	2.7%	2.69%

Table 38: DK's historical risk-free rate (Authors' analysis)

7.2.1.5 Estimating Maersk Drilling's cost of equity

Based on the estimated parameters above, we can derive Maersk Drilling's costs of equity, which is given by CAPM:

$$R_{e,Maersk\ Drilling} = 2.69\% + 1.42 * 6\% = 11.21\%$$

[3] For 2019 the number of Danish respondents was 135.

Based on CAPM, Maersk Drilling's cost of equity yields to 11.21%.

7.2.2 Cost of debt:

This chapter will analyse and estimate the debt variables of Maersk Drilling's cost of capital. More specifically the chapter will look at the tax rate and the credit spread, as the risk-free rate has been discussed above.

7.2.2.1 Corporation tax

Interest costs are tax-deductible; hence the corporate tax rate has an impact on the required rate of return on net debt and thereby a company's cost of capital (Petersen et al., 2017). As stated previously in the financial forecast, for companies with foreign operations or subsidiaries abroad, the effective corporate tax rate is arguably the fairest estimate for the corporate tax rate. However, as the effective tax rate is based on several underlying assumptions, it is unfavourable to use. As a result, we use the Danish marginal tax rate to estimate the tax-deductible interest costs. This yields a corporate tax rate of 22%, which is in line with the one used to estimate the tax on net operating profit.

7.2.2.2 Credit spread

The required return on net debt includes three variables: the risk-free rate, the firm's credit spread and the corporate tax rate. These variables are expressed in the formula for the cost of debt, which is stated below (Petersen et al., 2017):

$$r_d = \left(r_f + r_s\right) * (1 - t)$$

Since the risk-free and corporate tax rate already have been determined, we only need to focus on estimating Maersk Drilling's credit spread.

There are two common methods to determine a company's credit spread. The first method is to use the yield to maturity of a company's issued debt. However, as Maersk Drilling has not issued any debt, this method is inapplicable. The second method involves using the company's credit rating to determine the yield spread, which then can be added to the risk-free rate to estimate the credit spread. Credit ratings are often performed by rating agencies such as S&P, Moody's and Fitch, and involve a detailed quantitative and qualitative analysis of the company and its belonging industry. Since Maersk Drilling only recently have been listed, it has not been rated by the rating agencies. This means we have to estimate a synthetic rating for Maersk Drilling. A synthetic rating is an assigned rating based upon a company's interest coverage ratio. Damodaran (2019) have provided two tables to estimate the synthetic rating and the default spread that goes with the rating. The two tables are split into high and low market capitalisation firms, where low firms are defined as a firm, whom's market capitalisation is below USD 5bn and vice versa. Damodaran's (2020) method is based on historically rated companies and their respective interest coverage ratios. The tables from Damodaran (2020) can be found in appendix 9.

As of the 31 January 2020, Maersk Drilling's market capitalisation was USD 2.3bn, whereas the FY19 interest coverage ratio[4] was 4.4x. This corresponds to a credit rating of Baa2 and a credit spread of 3.1%. This seems like a reasonable estimate when compared to Maersk Drilling's credit-rated peers who can barely cover their interest expenses, in addition to being heavily geared.

Reported figures for FY19	Interest coverage ratio	Net debt to EBITDA	Moody's rating
Maersk Drilling A/S	**4.4**	**2.6**	**n.a.**
Awilco Drilling Plc.*	3.0	-9.8	n.a.
Noble Corporation Plc.	1.4	10.4	Caa2
Seadrill Ltd.	0.2	33.0	Caa3
Pacific Drilling S.A.*	-2.6	-3.3	Caa2
Transocean Ltd.	1.3	8.9	Caa1
Valaris Plc.	0.1	120.2	Caa3
Diamond Offshore Drilling Inc.	0.6	24.9	Caa1

* Awilco Drilling Plc. reported net debt of USDm -41m in FY19. Pacific Drilling S.A reported EBITDA of USDm -258m in FY19

Table 39: Analysis of Interest coverage ratio, net debt/EBITDA & Moody's credit rating (Moody's, 2020)

The estimated credit rating of Baa2 and a credit spread of 3.1%, yields a pre and post-tax cost of debt of 5.8% and 4.54%, respectively.

$$R_{d,Maersk\ Drilling} = (2.69\% + 3.13\%) * (1 - 22\%) = 4.54\%$$

This estimate seems reasonable when compared to HSBC' equity report (2019), that finds a pre-tax cost of debt of 6% for Maersk Drilling.

7.2.3 Capital structure:

Now that we've estimated Maersk Drilling's cost of debt and equity, we can combine the two expected returns into one number. In order to do this, we must determine the target weights of net debt and equity to enterprise value on a market-value basis. The capital structure must be based on market values as they reflect the true opportunity costs of lenders or investors. However, as pointed out by Koller et al., (2015) and Petersen et al., (2017), the

[4] Interest coverage ratio $= \frac{EBITDA}{Financial\ expenses}$

market value of debt is not always readily available, thus valuing debt securities at book value or discounting the cash flows, serves as best proxy estimates. Furthermore, as Maersk Drilling has not issued any debt, their net debt at 31 Jan 19 serves as a proxy for the current market value. The market value of equity is determined by multiplying the market price of Maersk Drilling's stock at 31 Jan 20 by the number of outstanding shares.

The cost of capital is based on target weights, rather than current weights, since the current capital structure of a company may not reflect the prospective level over the life of the company. Furthermore, the current capital structure might be subject to short-term deviations in the stock price, thus resulting in a deceptive cost of capital. Consequently, the cost of capital should rely on target weights. To estimate a company’s target capital structure, Koller et al. (2015) suggest determining the company’s current capital structure, compare it to the capital structure of peers and reviewing the management’s explicit and implicit statements about the business financing and its impact on the target capital structure. The table below displays the capital structure of Maersk Drilling’s and its peers as of 31 Jan 2020:

Capital structure 31 Jan 20 *(USD in millions)*	**Equity, book value**	**Equity, market value**	**Net debt, market value**	**Net debt / Equity**	**Equity / EV**	**Net debt / EV**
Maersk Drilling A/S	3,680	2,309	1,087	0.5	68%	32%
Awilco Drilling Plc.	251	77	(41)	(0.5)	215%	(115%)
Noble Corporation Plc.	3,659	202	4,045	20.0	5%	95%
Seadrill Limited	1,850	137	4,943	36.0	3%	97%
Pacific Drilling S.A.	1,069	306	845	2.8	27%	73%
Transocean Ltd.	11,867	2,790	8,426	3.0	25%	75%
Valaris Plc.	9,310	1,012	5,493	5.4	16%	84%
Diamond Offshore Drilling Inc.	3,232	638	1,847	2.9	26%	74%
Industry, median				**3.0**	**25%**	**75%**
Industry, average				**8.8**	**48%**	**52%**

Table 40: The capital structure of Maersk Drilling and its peers as of 31 Jan 20 (Authors’ analysis)

As presented in the table above, Maersk Drilling’s capital structure is quite different from its peers with a net-debt-to-equity ratio of 0.47, whereas the industry median and average are at 2.9 and 5.6 respectively. One might wonder, why Maersk Drilling’s net debt level is significantly lower than its peers.

There are a few reasons why this might be the case. Firstly, the age of the company can play a role, as Maersk Drilling is considered an old company in the industry, it has been able to reduce the debt obligations from its growth period. Furthermore, one could speculate that Maersk Drilling might have had beneficial financing options, as the company was a part of the A.P. Moeller group until April 2019. However, the most logical reason for the different debt ratios is the company's appetite for risk. As the market was booming during the recovery of the financial crisis in 2008 many drilling companies decided on aggressive growth strategies. As this was the general trend in the industry companies were increasing their leverage significantly as they were ordering new vessels. As a result of the increased demand for newbuild vessels, the shipyards increased construction prices, which led to many drilling companies paying overprices for their vessels. However, not all companies were this bullish during the recovery period, which led to the different degrees of leverage. To make things even worse, the oil market crashed in late 2014, resulting in depressed day rates and low demand. Naturally, this hit the companies that had grown aggressively harder as their debt obligations were larger and they had often paid a too high price for their assets, which meant that divestiture of these would result in significant losses (Bassoe Offshore, 2020).

As a result of the deviation between Maersk Drilling's capital structure and its peers, the industry capital structure does not serve as a valid estimate for the target capital structure.

Despite these findings, Maersk Drilling has disclosed a target leverage ratio in their annual report from 2019, which can be used as a guidance for deriving the target capital structure: *"Maersk Drilling will generally work towards a leverage ratio (net debt divided by EBITDA before special items) of around 2.5x... If value-adding investment opportunities that require additional funding arise, or if EBITDA is reduced in a business down cycle, the leverage may exceed the target level of around 2.5x for a period of time. The focus here will be to reduce net debt to reach the targeted leverage level of around 2.5x"* (Maersk Drilling, 2019, p. 25*).*

As of 31 December 2019, Maersk Drilling's leverage ratio was 2.6x, which is fairly close to their target of 2.5x. Combining this with the decreasing trend in Maersk Drilling's net debt, we find it a reasonable assumption that Maersk Drilling has arrived at its new target capital structure. Consequently, the target weights will be based on the net-debt-to-equity ratio as of the 31 Jan 20, which corresponds to 0.47x.

Maersk Drilling, net debt *(USD in millions)*	**31 Dec 16** Act	**31 Dec 17** Act	**31 Dec 18** Act	**31 Dec 19** Act
Net debt	(2,552)	(1,745)	1,143	1,087
Loan receivables, A.P. Maersk	(4,134)	(3,390)	(2)	-
Net debt, adjusted	**1,582**	**1,645**	**1,145**	**1,087**

Table 41: Maersk Drilling's gross and net debt adjusted – FY16-19 (Authors' analysis)

7.2.4 Maersk Drilling's cost of capital

Based on the estimated cost of equity and debt as well as the target capital structure, we can estimate Maersk Drilling's costs of capital to be as follows:

$$WACC_{Maersk\ Drilling} = \ 68\% * 11.21\% + 32\% * 4.54\% = 9.08\%$$

Based on the formula for the cost of capital, Maersk Drilling's WACC yields to 9.08%. While this estimate might seem high, it is still in line with research conducted on the field. Back in 2016, PwC conducted a market survey about the level of cost of capital among Danish listed corporations. The result yielded a median WACC, ranging from 7.5% to 9%.
Furthermore, equity reports based on Maersk Drilling from HSBC (2019) and BNP Paribas (2019), report a cost of capital of 7.9% and 10% respectively. Whereas the estimate from HSBC (2019) include a market risk premium of 5%, thus explaining the deviation from our results. Based on these findings, we find our estimate for Maersk Drilling's cost of capital reasonable.

7.3 Terminal growth rate

As determined earlier, Maersk Drilling is operating in an industry, which is on the verge of entering the declining ILC phase. Many of the companies in the industry have been delivering negative returns over the last 10 years, while others have managed to deliver a positive return, but not without struggle. This thesis argues that Maersk Drilling is a healthy company with strong liquidity, low debt, excellent operational abilities and a versatile fleet. Together this does put Maersk Drilling in a very good position.
However, due to the declining transitioning of the industry, this thesis argues that the terminal growth rate should be below the typical economic growth rate plus inflation (Koller et al., 2015). With the position that Maersk Drilling has obtained in the market, there is good reason to believe that the company will be among the last ones standing and that the company will be able to transition into another industry that could support the assumption of going concern. Consensus estimates from HSBC (2019) and Morgan Stanley (2019) put the terminal growth rate for Maersk Drilling at 1%, while BNP Paribas (2019) is less optimistic at 0% growth.
However, this 0-1% terminal growth rate is a product of Maersk Drilling's total activity. In other words, the rate is a weighted value based on various growth rates that co-exist internally in Maersk Drilling. This thesis then argues that when using the DCF-model on the

company as a whole, 1% is an appropriate terminal growth rate because of Maersk Drilling's versatile fleet.

7.4 DCF value estimate

Throughout chapter 7 this thesis has conducted all the preliminary calculations for the DCF valuation. The free cash flow of Maersk Drilling was forecasted for the period FY20-FY24 and a horizon year for FY25 with a conservative terminal growth rate of 1%. The forecasted free cash flow, which can be seen below, was then discounted by the WACC which was estimated in chapter 7.3.1. As it can be seen in the output below this resulted in a valuation of Maersk Drilling's equity of USD 2,104m on the 31st of December 2019. On the 31st of January, this equals USD 2.120m which corresponds with a share price of USD 51.04 (DKK 345.10).

Discounted cash flow model, Maersk Drilling ***(USD in millions)***		**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
NOPAT		(57)	105	199	139	125
Add back depreciation and amortisation		375	359	345	332	320
Less increase in Δ Net working capital		(7.5)	9.4	3.6	(2.7)	(1.8)
Cash flows from operating activities		**311**	**474**	**548**	**468**	**443**
Less Capex		(175)	(178)	(178)	(178)	(178)
Free cash flow to the firm		**136**	**297**	**370**	**291**	**266**
WACC	9.08%	9.08%	9.08%	9.08%	9.08%	9.08%
Discount factor (dt)		0.92	0.84	0.77	0.71	0.65
Terminal growth rate	1.0%					
Present value of FCFF	1,037	125	249	285	205	172
FCFF, steady state	269					
Terminal value	3,326					
Present value of terminal value	2,154					
Estimated enterprise value	3,191					
Net debt	1,087					
Estimated market value of equity as of 31 Dec 19	**2,104**					
Time adjustment	1.01					
Estimated market value of equity as of 31 Jan 20	**2,120**					
No. of outstanding shares (in millions)	41.5					
Estimated share price as of 31 Jan 20 (USD)	**51**					
FX rate (31 Jan 20)	6.76					
Estimated share price as of 31 Jan 20 (DKK)	**345.10**					

Table 42: Discounted cash flow model - Maersk Drilling (Authors' analysis)

7.4.1 Sensitivity analysis

While the estimate above is the most accurate according to the assumptions this thesis argues for, it should be noted that these are still assumptions. Therefore, a sensitivity analysis has been conducted to show how changes to our assumptions might change the valuation of Maersk Drilling.

Below is a table showing how the valuation will change with increases or decreases of 1% in WACC, as well as 0,5% changes in the terminal growth rate.

Sensitivity analysis - Value of equity *(In USD millions)*								
		WACC						
		6.1%	**7.1%**	**8.1%**	**9.1%**	**10.1%**	**11.1%**	**12.1%**
Terminal period growth rate	**(0.5%)**	2,569	2,225	1,961	1,753	1,583	1,443	1,326
	0.0%	2,799	2,398	2,097	1,862	1,673	1,519	1,390
	0.5%	3,070	2,597	2,250	1,983	1,772	1,601	1,460
	1.0%	3,394	2,829	2,424	**2,120**	1,882	1,692	1,536
	1.5%	3,789	3,103	2,626	2,274	2,005	1,792	1,619
	2.0%	4,281	3,431	2,860	2,451	2,143	1,903	1,710
	2.5%	4,910	3,830	3,137	2,654	2,299	2,027	1,811

Table 43: Sensitivity analysis - Maersk Drilling (Authors' analysis)

8. Real Options Valuation

The following chapter will introduce the framework that will be used to conduct the Real option valuation. Furthermore, the framework will be put to use and finally, the option value will be calculated.

8.1 Framework

This paper argues that a traditional DCF valuation is not adequate because of the uncertainty in the oil drilling industry. The demand forecast suggests that the oil drilling industry can expect a significant amount of demand over the next few decades. However, it is uncertain which business segments and region the demand will stem from. As a result, it makes sense to assume that more versatile rigs are less exposed to the demand uncertainty, while rigs with high asset specificity are more exposed. With the management's ability to adjust the fleet structure, this paper argues that Maersk Drilling has some degree of managerial flexibility. The managerial flexibility means that the management of Maersk Drilling can select between several options, depending on how the given business segment develops. In case the management predicts that certain business segments will decline in the future, they can decide to reduce their exposure to certain business segments by modifying rigs or directly scaling down by selling rigs. Vice versa if they predict that a business segment will be more profitable, they can increase their exposure by modifying current rigs or acquiring new ones. It must be noted, that some business segments are harder than others to expand into. Entering some segments might require a new skill set, a new customer portfolio etc.

With this option to increase and decrease the company's exposure to selected business segments, this paper argues that to find a more accurate valuation, the managerial flexibility must be taken into account. It is important to note that the option value does only exist in those areas of Maersk Drilling where the management has the flexibility to choose between different plans that generate different value given the scenarios that play out.

This paper argues that the management can create moderate flexibility value. This is due to their ability to choose between different plans depending on how the business develops. Also, they have a high degree of access to inside information about their operations. In terms of operating location, Maersk Drilling's management has moderate flexibility. If the rigs are under contract, the management is obligated to fulfil this. If the rates in the meantime increase elsewhere, Maersk Drilling will lose out on the opportunity to market any rigs under contract there. Vice versa, if the rates fall, they have secured a day rate higher than market price. However, since the oil price crash in 2014, the contract durations have been shortened significantly (IHS Markit, 2020). As a result, the management now has the option to change plans for the rigs more frequently, as rigs roll off contracts more often.

The figure on the right shows how managerial flexibility and the management's access to new information will affect the value created by the option to choose between different plans.

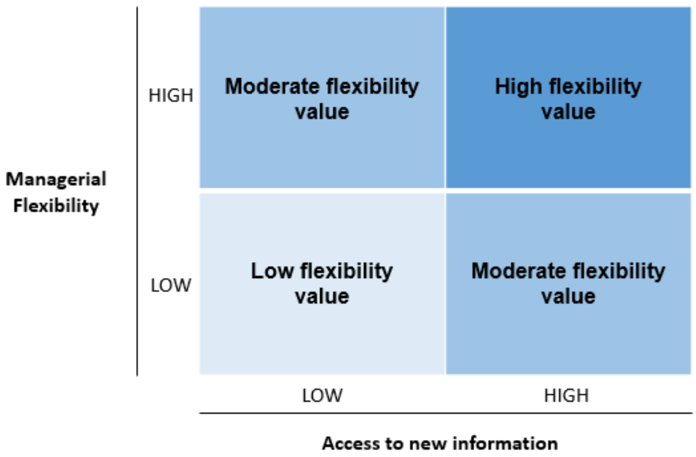

Figure 29: Value of flexibility matrix (Koller et. Al 2010)

Certain opportunities make the option more valuable as it provides the management with information before anyone else. For instance, if Maersk Drilling is working on an exploration well for a potentially large oil field, the management will be the first to know if the well is dry or wet. In case the market expected the well to be wet, but it turns out to be dry, the management will be the first one to know that the demand will not be as high as anticipated. As a result, the management will likely decrease the exposure to this segment. Vice versa, if the well is wet, but the market expected this area to be dry, the management has a better chance of estimating how many development wells will be needed, than the competition. With this knowledge, it can be decided how heavily to market their rigs in this area, and if the

increasing demand is deemed sustainable, even expand the fleet in the segment. Furthermore, Maersk Drilling knows better than anyone, how easy or difficult it is to get their rigs contracted. If the commercial department realises that some segments are getting harder to secure work for, the management might want to decrease their exposure to this segment.
Based on the identified managerial flexibility above, the real option valuation of Maersk Drilling will be conducted by using the following approach:

Step 1: Identify real option	**Step 2:** NPV of BU without flexibility	**Step 3:** Model uncertainty: Event tree	**Step 4:** Model flexibility: Decision tree	**Step 5:** Estimate contingent NPV
Objectives:	Calculate base-case NPV of BU	Understand how the NPV changes with uncertainty	Understand how managerial flexibility affects value	Value the BU.
Method:	Standard DCF-valuation	Event tree	Transformation of event tree	Real option valuation

Figure 30: Framework for real option valuation (Authors' creation, inspired by Kotler et al., 2015)

This paper utilises a five-step approach in the real option valuation, which is inspired by the four-step approach created by Koller et al. (2015).
In step one, the objective is simply to identify the option. This is done by looking at the various business segments, business units and projects in Maersk Drilling. Once an overview of this has been established, the management's ability to choose between different paths going forward is analysed to identify whether or not there is an actual option within the segment, unit or project. Once an option has been identified, the model moves forward to step two. In this step, the objective is to conduct a valuation of the business segment without flexibility. This is done through the use of a traditional discounted cash flow analysis. After the valuation has been conducted without managerial flexibility, step three expands this into an event tree. The objective is to map scenarios of how the value of the business segment, unit or project can develop. The managerial flexibility is then added in step four, where the event tree is converted into a decision tree. In this step, the payoff values and the option value are calculated. Finally, in step five the ROV is conducted by combining the results of the DCF-model from chapter 7.4 and the option value calculated in step 4. This shows the contingent valuation.

8.2 Step 1: Identify real option

When identifying an option, one must be more specific than looking at the whole company as an option. Managerial flexibility is much more likely to occur when looking at an isolated business segment, unit or project. According to Smit and Trigeorgis (2006) and Triantis (2005), one can argue that Maersk Drilling is not a single unit, but rather a portfolio of real options. Each real option is impacted by different effects and their value will, therefore, develop differently.

As discussed, both in the market forecast and in the operational analysis, some of Maersk Drilling's business segments are exposed to more uncertainty than others. Eight of Maersk Drilling's 22 rigs are made for the ultra-harsh environment and have a high degree of asset specificity. In other words, they are very reliant on the demand in Norway. As a result, the underlying asset value can change significantly if the demand and/or day rates change.

The Norwegian market is so regulated, it is very difficult to enter. This gives the assets increased value as the rigs are very rare due to the AoC-certificates they have obtained.

With an increase in demand and day rates in the Norwegian jackup segment, Maersk Drilling would naturally try to get more exposure to this segment. However, all of their ultra-harsh jackups are already marketed in Norway and the lead time on building a new ultra-harsh jackup is more than two years. Furthermore, there are very few ultra-harsh jackups on the market, which means very limited optionality to acquire rigs second hand. Based on this information, this paper argues, that there is no real option to expand or defer the investment. Where this paper does see an option though, is to abandon the business segment. As the management is the first to get information about the success of operations, as well as the level of efforts needed to sign contracts, this paper argues that they have the option to exit the segment before the ILC-transition to decline fully materialises. Depending on the management's prediction and ability to sell or modify the rigs, this exit could be a partial or complete exit. As discussed earlier in the chapter, the assets are rare and the entry barriers into Norway are high. This means that an acquisition of Maersk Drilling's ultra-harsh rigs is the fastest and easiest way into the market. It is important to note that timing is crucial and as soon as the market has its hands on all information, the exit option becomes harder to exercise, as the underlying asset value decreases.

8.3 Step 2: NPV of BU without flexibility

Now that we've identified the real option, the next step is to calculate the underlying asset value of real option without flexibility. In line with Copeland and Antikarov (2001), this paper utilises the DCF-model to calculate the underlying asset value of the ultra-harsh environment business unit (henceforth UHE BU). As the free cash flow is an essential part of the DCF-model, the following chapter will walk through the derivation of the UHE BU's free cash flow. Afterwards, the free cash flows from the extracted business unit are discounted in the same manner as for the entire company, to see how much of the total value is actually generated by this BU.

Revenue and operational expenditures, UHE:

As a result of the detailed revenue budget used in the forecast of group revenue, the business unit's share of revenue can easily be extracted. This is due to the fact, that demand was forecasted on a rig specific level and the day rates were calculated on a segment level. This means that the revenue is calculated by simply multiplying the average day rate for ultra-harsh environment jackups with the forecasted demand for Maersk Drilling's eight rigs in this segment. The forecasted revenue can be seen below:

Revenue forecast *UHE BU*	**FY18 Act**	**FY19 Act**	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
Demand (in rig years)	n.a.	n.a.	4.6	7.0	7.0	7.0	7.1
Contracted days (in days)	n.a.	n.a.	1,542	2,324	2,324	2,324	2,366
Dayrates (USDm)	n.a.	n.a.	0.233	0.232	0.188	0.155	0.155
Revenue (USDm)	630	559	360	539	436	360	367
Revenue YoY growth	n.a.	(11%)	(36%)	50%	(19%)	(17%)	2%
UHE % of group revenue	44%	46%	38%	42%	31%	27%	29%

Table 44: Revenue forecast – UHE BU (Authors' analysis)

According to the forecast above, the revenue is expected to peak in FY21, before decreasing with approximately USD100m in the following two years. This decrease is driven by a fall in day rates as demand remains constant.

As for the revenue, the opex was calculated on a segment level, meaning we can find the opex for each of the ultra-harsh rigs with this formula:

$$Opex_{rig} = (Contracted\ days * daily\ operating\ opex) + (idle\ days * daily\ idle\ opex)$$

In the table below, the forecasted opex can be seen:

Production costs forecast *UHE BU*	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
Contracted days	1,542	2,324	2,324	2,324	2,366
Idle days	1,114	332	332	332	290
Operating opex rate (USDm)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
Idle opex rate (USDm)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Production costs (USDm)	(215)	(297)	(297)	(297)	(302)

Table 45: Production costs forecast – UHE BU (Authors' analysis)

As for Maersk Drilling as a whole, the opex for the UHE BU is forecasted to remain stable. Due to the low demand in FY20, the opex is relatively low to the remaining years. As demand from FY21-FY24 is stable the opex remains at a level around USD300m in the rest of the forecasted period.

SG&A costs, UHE:

Since Maersk Drilling does not provide a complete overview of the performance of each business segment, it has not been possible to use historical data to forecast each line item. As a result, the SG&A costs for the UHE BU are estimated using revenue allocation and the group's budget from chapter 7.1.3. This is in line with activity-based costing (ABC), where overhead and indirect costs are assigned to related products or business units using the activity level (Seal et al., 2018). In this thesis, we used revenue as the activity measure.

Based on revenue allocation, the SG&A costs for the UHE BU are forecasted to account for 29%-42% of the group-level. The forecast for the UHE is displayed in the table below:

SG&A forecast - UHE *(In USD millions)*	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
UHE BU % of group revenue	38%	42%	31%	27%	29%
SG&A costs, Group	(76)	(102)	(113)	(105)	(100)
SG&A costs, UHE	(29)	(43)	(35)	(29)	(29)

Table 46: SG&A costs forecast – UHE BU (Authors' analysis)

Depreciation and amortisation, UHE:

For the group, depreciation and amortisation were forecasted as a percentage of PP&E and intangible assets. The forecasted percentage was determined using the historical levels and yielded an estimate of 7.8%. To forecast depreciation and amortisation for the UHE BU, we assume that the assets are depreciated at the same rate as forecasted for the group. This assumption is mainly due to the lack of information regarding the lifetime of UHE Jackups compared to other rig types as well as the historical depreciation for the BU.

Net working capital, UHE:

As previously stated, Maersk Drilling does not provide an overview of the BU's current balance sheet items, thus the BU forecast of net working capital cannot be based on historical levels or trends. Consequently, it was deemed a fair assumption to let Maersk Drilling's forecasted net working capital serve as the indicator for the UHE's net working capital requirements. The forecasted net working capital relative to revenue for the UHE BU will thus be the same as the company's, but the absolute amount will depend on the revenue of the BU.

Key NWC items *(as a % of UHE revenue)*	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**FY20-24 Bud**
Trade receivables	17%	13%	21%	24%	22%	22%
Trade payables	(9%)	(6%)	(11%)	(14%)	(15%)	(15%)
Net working capital	**(2.4%)**	**0.9%**	**3.6%**	**0.5%**	**(2.8%)**	**(2.8%)**

Table 47: NWC forecast, UHE BU (Authors' analysis)

Capital expenditures, UHE:

To forecast the capex for the UHE BU, we rely on the capex guidance of Maersk Drilling (Maersk Drilling, 2019). For the capex, Maersk Drilling has guided that an ultra-harsh environment rig requires USD20m every fifth year in maintenance capex. On an average annual run-rate that equals $\frac{8*20}{5} = USD32m$ where 8 is the number of rigs, 20 is the expenditure and 5 is the frequency in years.

With regards to expansion capex, this thesis argues that it is fair to allocate the company's total expansion capex (USD 27.5m per year) to the business unit based on the number of drilling rigs. In other words, the expansion capex can be expected to be $\frac{8}{21} * 27{,}5 = USD10{,}5m$ per year. Based on the analysis above, the capex of the UHE BU is forecasted as the following:

Capex forecast *UHE BU*	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
Intangible & tangible assets		1843	1634	1943	1912	1805	1706	1615	1531	1454
Capital expenditures	-	-	-	-	-	43	43	43	43	43

Table 48: SG&A costs forecast – UHE BU (Authors' analysis)

Net debt, UHE:

Despite net debt not being a necessary part of the DCF valuation, it is however still necessary for the estimation of the liquidation value of the abandonment option. To estimate the net debt of the UHE BU, we use the percentage of non-current assets of the UHE BU relative to the group and allocate the equivalent amount of debt. This approach is based on the fact, that most of Maersk Drilling's debt is related to the financing of offshore drilling rigs. Consequently, we find it a reasonable assumption that the amount of net debt for the BU is equal to its amount of non-currents assets relative to the groups. The allocation of net debt to the UHE BU is displayed below:

Net debt forecast - UHE *(In USD millions)*	**FY19 PF**	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
Intangible and tangible assets, Group	4,793	4,593	4,411	4,243	4,089	3,946
Intangible and tangible assets, UHE	1,912	1,805	1,706	1,615	1,531	1,454
% of Group non-current assets	40%	39%	39%	38%	37%	37%
Net debt, Group	1,087	1,042	998	959	925	893
Net debt, UHE	**433**	**409**	**386**	**365**	**346**	**329**

Table 49: Forecasted net debt, UHE (Authors' analysis)

Cost of capital and terminal growth rate, UHE:

The discount rate used for the UHE BU, is the same as for the group, as the aim is simply to divide the cash-flows between the business units. The purpose is not to separate the operational risk between the business units as if they were all operating on a stand-alone basis. Consequently, we argue that the business units are to be seen as accounting units, rather than individual firms.

As per the chapter on market forecast, we expect the activity in the ultra-harsh jackup-segment to decrease after FY2025. This thesis argues that because the ultra-harsh jackup-segment can only be used on the NCS, the terminal growth rate is solely relying on this market, which we deem short-lived, resulting in a lower growth rate than the company as a whole.

Market reports and databases suggest an average annual decline of 2% in production until at least 2040. On a long-term basis, this thesis argues that it is fair to assume that the terminal growth rate will follow production at a 2% annual decline.

(The overall budget for the UHE BU can be seen in appendix 6a and 6b)

NPV of BU without flexibility:

Based on the forecast assumptions above, the stand-alone value of the UHE BU without flexibility is estimated to be USD332m. This estimate might seem low, as the business unit historically has performed very well. However, the estimate is a result of the negative expectations of the future for the Norwegian jackup market as discussed in chapter 5.2. The low valuation of the UHE BU is mainly driven by the expected decline in day rates after FY23 and onward as well as the negative terminal growth rate.

Discounted cash flow model, UHE BU ***(USD in millions)***		**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
NOPAT		(26)	45	(23)	(72)	(65)
Add back depreciation and amortisation		150	141	134	126	120
Less increase in Δ Net working capital		(6)	5	(3)	(2)	0.2
Cash flows from operating activities		**118**	**192**	**108**	**53**	**55**
Less Capex		(43)	(43)	(43)	(43)	(43)
Free cash flow to the firm		**75**	**149**	**65**	**10**	**12**
WACC	9.08%	9.08%	9.08%	9.08%	9.08%	9.08%
Discount factor (dt)		0.92	0.84	0.77	0.71	0.65
Terminal growth rate	(2.0%)					
Present value of FCFF	260	69	125	50	7	8
FCFF, steady state	12					
Terminal value (TV)	108					
Present value of terminal value	70					
Estimated enterprise value as of 31 Dec 19	**330**					
Time adjustment	1.01					
Estimated enterprise value as of 31 Jan 20	**332**					
FX rate (31 Jan 20)	6.8					
Estimated enterprise value as of 31 Jan 20 (DKKm)	**2,246**					

Table 50: Discounted cash flow model – UHE BU (Authors' analysis)

8.4 Step 3: Model uncertainty: Event tree

Having determined the NPV of the ultra-harsh environment business unit without flexibility. This paper will now look at modelling the uncertainty of the real option by using an event tree. The purpose of the event tree is to model the price behaviour of the underlying assets, which is then later used to obtain the option value. In this scenario, the price behaviour of the underlying assets is represented by the NPV of the UHE BU.

The preparation of the event tree excludes managerial flexibility. This means that there is *no* managerial flexibility included in the calculations and the nodes do *not* represent decisions nodes. As a result, when modelling the uncertainty, the volatility will be the denominator for how the value evolves. The value change of the business unit when moving from one period to the next is essentially determined by the volatility. As this thesis utilises the binomial option pricing model (Cox, Ross, & Rubenstein, 1979), the value of the underlying option can either increase or decrease when moving from one node to another. If the value increases, the change is calculated with an up-factor $u = e^{volatility\sqrt{t}}$ and if it decreases, the change is calculated with a down-factor $d = \frac{1}{e^{volatility\sqrt{t}}}$.

One of the challenges when using ROV is the estimation of volatility. As the UHE BU is not publicly traded, there is no information available to estimate the volatility on (Kodukula & Papudes, 2006). Furthermore, as the real option is subject to multiple sources of uncertainties, these need to be consolidated into a single estimate of volatility. The reason for this is that the binomial model lacks the ability to capture multiple sources of uncertainty. To address these issues, Copeland and Antikarov (2001) suggest using the logarithmic present value approach. They define the volatility of the underlying asset value as the standard deviation on its rate of return:

$$z = \ln \left(\frac{PV_1 + FCF_1}{PV_0}\right)$$

Where PV_1 is the present value of the underlying asset at t=1. FCF_1 states the free cash flow generated by the underlying asset at t=1 and PV_0 is the underlying asset value at t=0. This approach uses Monte Carlo simulations on the underlying asset's present value to derive a probability distribution for the rate of return. Thus, the volatility is defined as the standard deviation of z (Haahtela, 2011).

To run the Monte Carlo simulations, and determine the volatility of the rate of return, we have to define and quantify the key drivers of risk (Copeland and Antikrov, 2001). Copeland and Antikrov argue that simulations should be limited to the most influential variables, while other researchers such as Saenz-Diez et al. (2008) argue that all volatile variables should be included.

As the addition of Monte Carlo variables includes judgements and estimates about the variable's probability distribution and their belonging distribution parameters, an increased number of variables would likely raise the estimation error of the simulations. Consequently, we find it appropriate to follow Copeland and Antikrov's suggestion (2001).

As established in the financial and strategic analysis, day rates and rig demand are the primary drivers of uncertainty and profitability in the offshore drilling industry. Other variables such as daily opex might also be considered a key risk driver, but as established in chapter 7.1.2, the daily opex rate has historically been very stable.

Having defined the key drivers of risk, the next step is to quantify them. This involves defining the probability distribution of each variable and its belonging distribution parameters. To select the right probability distribution, we use the method suggested by Mun (2006) and Kodukula & Papudesu (2006), which entails reviewing the characteristics of the probability distributions and selecting the distribution, that best characterise the variable. The distribution parameters can be determined by using either the historical data of the key risk drivers or a subjective management estimate for the future (Mun, 2006).

As identified in chapter 4, the offshore drilling industry is in a transition, and the future is predicted to be uncertain. Consequently, we find it misleading to use historical data to estimates the future. The distribution parameters will, therefore, be estimated based on the forecasted day rates and demand as identified in chapter 8.3.

8.4.1 Correlation

When using Monte Carlo simulations to estimate the real options volatility, an important element to consider is, how the correlation between the key risk drivers affect the simulated volatility. Two correlation measures are used to address this subject, including the cross and serial-correlation (Newbold et al., 2013). This thesis concludes that both the cross- and serial correlation of our input variables are insignificant. The summary table of our estimates can be seen further below (Table 53). An in-depth analysis of the correlations can be seen in appendix 12a and 12b.

8.4.2 Probability distribution of UHE's day rate:

The probability distribution of the UHE's day rate is assumed to follow a lognormal distribution. This assumption is based on the underlying conditions of the lognormal distribution as well as the characteristics of the day rates for the UHE BU. According to Mun (2006), a lognormal distribution is commonly used in situations, where the variable is positively skewed such as with stock prices. A lot of financial data including the UHE day rate display this positive skewness because their value cannot be less than zero, but increase without any upper limit. In addition to the underlying condition of the lognormal distribution, research related to day rates also assumes they follow a lognormal distribution. This is reflected in the research of Skjerpen et. al (2018), who model and forecast the rig rates on the Norwegian Continental Shelf.

Having defined the probability distribution of the UHE BU's day rate, we have to estimate the distribution parameters, which include the mean and standard deviation. As previously stated, the mean and standard deviation is estimated based on the forecasted UHE BU's day rates. The table below states the forecasted average day rates for the UHE:

UHE BU *(USD in millions)*	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**	**Logarithmic Avg.**	**Logarithmic Std.**
Day rate	0.23	0.23	0.19	0.16	0.16	-1.7	0.20

Table 51: Forecasted average day rates for the UHE (Rystad Energy, 2020)

By default, the lognormal distribution uses the arithmetic mean and standard deviation. However, as argued by Mun (2006), it is more appropriate to use the logarithmic mean and standard deviation, if the mean and standard deviation is derived from a dataset. Consequently, the lognormal distribution of the UHE BU's day rate will have a logarithmic mean and standard deviation of 0.2% and -1.7%, respectively.

8.4.3 Probability distribution of UHE's demand:

The probability distribution of the UHE BU's demand is assumed to follow a triangular distribution. The reason being, that the characteristics of this distribution match those of the UHE BU's demand. A triangular distribution states a condition, where the minimum and maximum values are assumed to be fixed, and the most likely value falls in-between these (Mun, 2006). The minimum rig-demand is fixed at null, as demand cannot be negative. Furthermore, the maximum demand is fixed at eight, as this represents all of the UHE BU's supply. The most likely demand for UHE was estimated as the median of the forecasted demand. We used the median, as the demand in FY20 is significantly different from the other years. To take this 'outlier' into consideration, we used the median value of seven rig years.

UHE BU *(Rig years)*	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**	**Median**	**Min**	**Max**
Demand	4.64	7.00	7.00	7.00	7.13	7.00	0.00	8.00

Table 52: Forecasted demand for the UHE (Rystad Energy, 2020)

The analysis above, returns a triangular probability distribution of the UHE's demand, with a minimum, maximum and most likely value of 0, 8 and 7 rig years respectively.
In the next section, we'll combine the findings above into a single volatility estimate using Monte Carlo simulations. A summary of the estimated distribution parameters is displayed below:

UHE BU *(Monte Carlo assumptions)*	**Day rate** *(USDm)*	**Demand** *(Rig years)*
Distribution	Lognormal	Triangular
Logarithmic mean	-1.7	n.a.
Logarithmic standard deviation	0.2	n.a.
Maximum observation	n.a.	8
Minimum observation	n.a.	0
Likeliest value (median)	n.a.	7
Serial-correlation	0.74*	0.02*
Cross-correlation	-0.603*	

*Statistically insignificant

Table 53: Summary of the estimated distribution parameters (Authors' analysis)

8.4.4 Volatility of the UHE real option – Monte Carlo simulation

Based on the assumptions above, 50,000 Monte Carlo simulations were conducted in order to estimate the volatility of the UHE BU's return. We used 50,000 trials, since an increased number of trials, improves the accuracy of the overall estimate (Gustafsson, 2011). The conducted Monte Carlo simulations yielded an estimated volatility on the UHE BU's returns of 73%. This estimate will later be used in the derivation of the event tree. The output from the Monte Carlo simulations is displayed in appendix 7 and includes the summary statistics as well as the belonging probability distribution.

As the volatility measure of 73% was estimated with some degree of uncertainty, it was deemed appropriate to perform sensitivity analysis, to assess the robustness of the measure. The sensitivity analysis is carried out in the final step of the ROV in chapter 8.6.1.

8.4.5 Event tree

Based on the estimated volatility above, we set up an event tree. As can be seen in the table below the intrinsic value of the ultra-harsh business unit can develop in several ways. Note here that the change in the future intrinsic value is determined by the up and down factors on an annual basis. As a result, the up and down factors have been multiplied with the intrinsic value as of 31 Dec 2019, not the valuation date of 31 Jan 2020.

Whichever path the intrinsic value will follow, it will affect the outcome of the next step.

Event Tree						
Period:	***31.01.2020***	***2020***	***2021***	***2022***	***2023***	***2024***
Price (DCF):	332	685	1.421	2.949	6.119	12.697
		159	330	685	1.421	2.949
			77	159	330	685
				37	77	159
					18	37
						9

Table 54: Event tree (Author's analysis)

8.5 Step 4: Model flexibility: Decision tree

Having modelled the uncertainty in the previous step, this part will now add the effects of managerial flexibility, as identified in step 1. As a result, the event tree will now evolve to a decision tree. In other words, the underlying value of the option is determined by the volatility and the management's ability to act accordingly. To find the payoff of exercising the option, we use the approach developed by Copeland and Antikarov (2001). According to this, the exercise price of the abandonment option is equal to the liquidation value of the underlying project, which in this thesis is the UHE BU.

To determine the liquidation value of the UHE BU, we rely on the research conducted by Berger et al. (1996), who investigate the investor valuation of the abandonment option. Berger et al. (1996) use a sample of 1,043 firms to estimate, how many cents per dollar of book value each of the major asset types generates when liquidated. The studies find, that fixed assets are disposed for 53.5 cents on the dollar, inventory for 54.7 cents on the dollar and finally non-inventory assets are sold 71.5 cents on the dollar. Cash items and marketable securities are disposed at book value, and the same applies to the payables and debt (Berger et al., 1996) (analysis in appendix 8).

To verify the use of Berger et al.'s liquidation discounts (1996), a comparison and discussion of related research has been conducted in appendix 8. The discussion yields the conclusion, that since Berger et al.'s (1996) findings are based on a larger and more representative sample, we find it appropriate to apply these to the case of Maersk Drilling.

With the liquidation rates identified, the exercise prices can be estimated by multiplying this to the balance sheet of the UHE BU as shown in appendix 8a.

Below is the payoff tree presented, showing the liquidation values and payoffs that Maersk Drilling would get if exercising the option at various time horizons. It can be seen that if the intrinsic value increases over time the option payoff will decrease, or potentially be out of the money. Vice versa, if the intrinsic value decreases, the option payoff will increase and the option will be in the money.

Payoff Tree						
Period:	***31.01.2020***	***2020***	***2021***	***2022***	***2023***	***2024***
Payoff:	214	0	0	0	0	0
		370	156	0	0	0
			409	307	116	0
				429	369	262
					428	384
						413
Exercise price (liquidation value)	*546*	*529*	*486*	*466*	*446*	*421*

Table 55: Payoff Tree (Authors' analysis)

The value of the underlying option is naturally a product of the expected payoff in the future. So the value of the option today can easily be higher than the payoff today if the payoff is expected to be even higher in the future. This is the case, as can be seen in the table below.

Option Value Tree						
Period:	***31.01.2020***	***2020***	***2021***	***2022***	***2023***	***2024***
Put Value:	228,93	157	69	0	0	0
		276	209	108	0	0
			322	270	168	0
				363	334	262
					392	384
						413

Table 56: Option value tree (Authors' analysis)

Despite a payoff of USD214m on the 31 Jan 2020, the option should not be exercised, as the value of the option is USD229m. The suggestion is then to keep the option, as the future payoff is expected to be higher. In other words, now is not the time to liquidate the UHE BU. This thesis will not comment on the optimal time to exercise the option, as this is not relevant to the problem statement (Chapter 1.3).

8.6 Step 5: Estimate contingent NPV (Combined DCF and ROV estimate)

The fifth and final step of the ROV is to calculate the contingent NPV. This is the product of the DCF-model and the real option valuation. The value is decomposed and presented in the table below:

Contingent valuation	
Volatility:	**73%**
Firm value without flexibility:	2.120
Ultra-harsh segment without flexibility:	332
Ultra-harsh segment with flexibility:	561
Value of abandonment option:	229
Firm value with flexibility:	**2.349**
Increase in firm value due to flexibility:	**10,80%**
% of total value represented by flexibility:	**9,75%**

Table 57: Contingent valuation (Authors' analysis)

The total value of Maersk Drilling is based on the DCF valuation of the whole company, and the option value is based on the DCF valuation of the ultra-harsh business unit only. We can see that the managerial flexibility increases the value captured with 10.80%. This puts the total value of Maersk Drilling at USD2,349m on 31 Jan 2020. With ~42m shares outstanding this equals an increase in share price from USD51.04 (DKK345.10) to USD56.56 (DKK382.43). The implication of this increase in value is that the DCF-model undervalues Maersk Drilling, as it fails to consider the upside of volatility captured in the managerial flexibility.

Compared to the actual share price of Maersk Drilling on the 31 Jan 2020 of DKK 376.00, the combination of the DCF-model and ROV gives an estimate much closer to the actual price than the DCF-model as a stand-alone model. It must be noted that this only means that the combination of the DCF-model and ROV is more accurate if the market is assumed to function correctly.

8.6.1 Sensitivity analysis

To analyse the robustness of the valuation above, a sensitivity analysis has been conducted. The table below shows how the valuation would change if the volatility in the ultra-harsh jackup-segment change in intervals of 5%.

Sensitivity analysis					
Volatility:	**63%**	**68%**	**73%**	**78%**	**83%**
Firm value without flexibility:	2.120	2.120	2.120	2.120	2.120
Ultra-harsh segment without flexibility:	332	332	332	332	332
Ultra-harsh segment with flexibility:	537	549	561	572	582
Value of abandonment option:	205	217	229	240	250
Firm value with flexibility:	2.325	2.337	**2.349**	2.360	2.370
Increase in firm value due to flexibility:	9,68%	10,25%	**10,80%**	11,32%	11,80%
% of total value represented by flexibility:	8,83%	9,30%	**9,75%**	10,17%	10,56%
Share price (USD):	55,99	56,28	**56,56**	56,82	57,07
Share price (DKK):	378,56	380,54	**382,43**	384,21	385,90

Table 58:Sensitivity analysis of contingent valuation (Authors' analysis)

As the real option is only identified on one business segment and represents just 10.80% of the total value, naturally a slight change in volatility will not affect the valuation drastically. The sensitivity analysis above, suggests that the managerial flexibility will represent between 8.83% and 10.56% of the total valuation if the volatility is between 63% and 83%. The fair share price of Maersk Drilling will in line with this be between USD 55.99 (DKK 378.56) and USD 57.07 (DKK 385.90).

9. Discussion and conclusion

With the aim of identifying how ROV can overcome the shortcomings of the DCF-model to increase valuation accuracy of companies in ILC-transitions, this thesis makes a number of interesting findings.

This thesis finds that the combination of the DCF-model and ROV captures more value than the DCF-model on its own. While this is undeniable, it does not necessarily mean that it is more accurate.

The thesis concludes that the difference between the valuation estimates can be explained by the two models' ability to value volatility and uncertainty. Through the analysis of the ILC, it becomes clear that the volatility and uncertainty increase around ILC-transitions. This thesis examines the significance of the volatility and uncertainty which arises in the transition from maturity to decline. It is concluded that the DCF-model is particularly weak when estimating the value of companies that are operating in uncertain environments with high volatility. The root cause of this weakness is identified to be the way volatility is incorporated in the model. High volatility results in a high β, which effectively increases the WACC used to discount the future free cash flows. As a result, higher volatility will result in a lower valuation.

To improve the valuation accuracy of the DCF-model, this thesis finds that ROV can capture the upside of volatility while limiting the downside. By looking at the management's ability to navigate its environment, ROV can capture the value of flexibility in the shape of real options. As this is essentially what the DCF-model failed to do, this thesis concludes that by combining the two, the valuation should, in theory, be more accurate. This is especially true in ILC-transitions due to the importance of management's flexibility.

In summary, this thesis concludes that ROV can increase the valuation accuracy of companies in ILC-transitions by considering the upside of volatility through managerial flexibility. By doing so, ROV manages to quantify the value of uncertainty. The implication of this, is that the DCF-model on a stand-alone basis undervalues companies in environments with high uncertainty and volatility.

These implications are enhanced by the results of the conducted case study, in which the DCF-model on a stand-alone basis as well as in a combination with ROV are applied. On a stand-alone basis, the DCF-model yields an estimated fair share price of Maersk Drilling to be DKK 345.10. With the addition of ROV, the valuation increased with 10.8% to DKK 382.43.

Following the arguments of Flyvbjerg (2015) about generalisability, this thesis argues that the findings from the case study can be applied to other companies in similar ILC-transitions. The valuation of uncertainty and volatility is not specific to the offshore oil & gas drilling industry or Maersk Drilling. Rather it is specific to the uncertainty that is caused by ILC-transitions, why other industries are expected to experience similar characteristics.

10. Limitations and future research

Throughout this thesis, the strengths and weaknesses of the applied theories have been discussed. Selected theories have been compared to alternatives to ensure that we have used the most appropriate ones to answer our problem statement. Furthermore, the results have to a large degree been held against similar proxies or historical data to ensure their validity. However, despite the ongoing discussion throughout this thesis, some central points should be discussed further.

Both the DCF-model and ROV build on the ILC-assumption that the offshore drilling industry is in a transition to decline. The ILC-analysis builds on current information, which means that future developments could accelerate or postpone the transition. As a result, the forecast could turn out differently. The majority of the line items in the financial statements have been forecasted, which causes uncertainty in the accuracy of the FCFF estimates. In addition, the WACC, used to discount the FCFF, relies on numerous assumptions which causes even more uncertainty in our value estimate.

The ROV suffers from the same risks, since it builds on the DCF valuation. In addition the ROV is also exposed to computational risks because our estimates of volatility are the main driver used to develop scenarios of how the underlying asset value evolves. Furthermore, the payoffs in ROV is highly affected by the liquidation rate. The rates used in this thesis builds on an empirical study, but despite being the best estimate, it must be noted that this study focused on the liquidation of whole firms, not business units. Also, this thesis uses liquidation as a strategic move, where the sample mainly focused on liquidations caused by bankruptcies and fire sales. As a result, it is expected to differ from the actual rate Maersk Drilling liquidate at.

To compensate for the limitations and computational risks discussed above, this thesis conducted a sensitivity analysis of both the DCF-valuation and the ROV-valuation. This gives an indication of how much the results would change if the underlying variables differed from our estimates.

For an outsider to verify the conclusion on another case study, access to data on a business unit level is required. The ROV is best performed on a more granular level, as the theory looks at a company as a portfolio of real options. To separate volatility, exercise price and more, it is necessary to have data available for each real option. In practice, this is not the case, as many companies report across different business units. It must also be noted, that even if the company does provide granular data that allows analysis on a business unit level, it takes a significant amount of work to separate the business unit from the whole company, to conduct the DCF valuation on a single business unit. In the separation of the business unit, all line items of all three financial statements must be considered to get an accurate DCF valuation. The valuation of the business unit will play an important role in valuing the real option, so there are no short cuts. Furthermore, the management's incentive must be taken into consideration. In large conglomerates that work across different industries and have many business units, the management might not want to exercise an abandonment option, if the business unit is part of a diversification strategy. The same goes if the business unit is generating cross-sales in other business units. This loss of cross-sales activity in other business units will not be caught by the model. Furthermore, conglomerates often trade with a conglomerate discount, which should also be captured in the valuation. With this in mind, the ideal scenario for the implementation of such an approach would be to pure-play companies.

In continuation of the ROV, an interesting topic to further analyse would be the effects on the company if the real option is exercised. An analysis could focus on the challenges or benefits that the company might face post-exercise. Another interesting topic of analysis related to exercising a real option could be focused on agency problems and moral hazard. The question to be asked would, for instance, be, if the management would have any personal incentives to exercise or not, despite what is in the interest of the shareholders. An element of game theory could also be included. If the competition is aware of the real option, the value might change as information becomes available to more players.

Lastly, as this thesis finds that the DCF-model undervalues companies in ILC-transitions, it would be relevant to examine practical consequences this might have for companies and investors. As stated in the introduction, the DCF-model is the benchmark of valuation models and many investors rely on DCF estimates when making investment decisions. Consequently, transitioning industries might miss out on potential investments and investors might miss out on potential investment opportunities.

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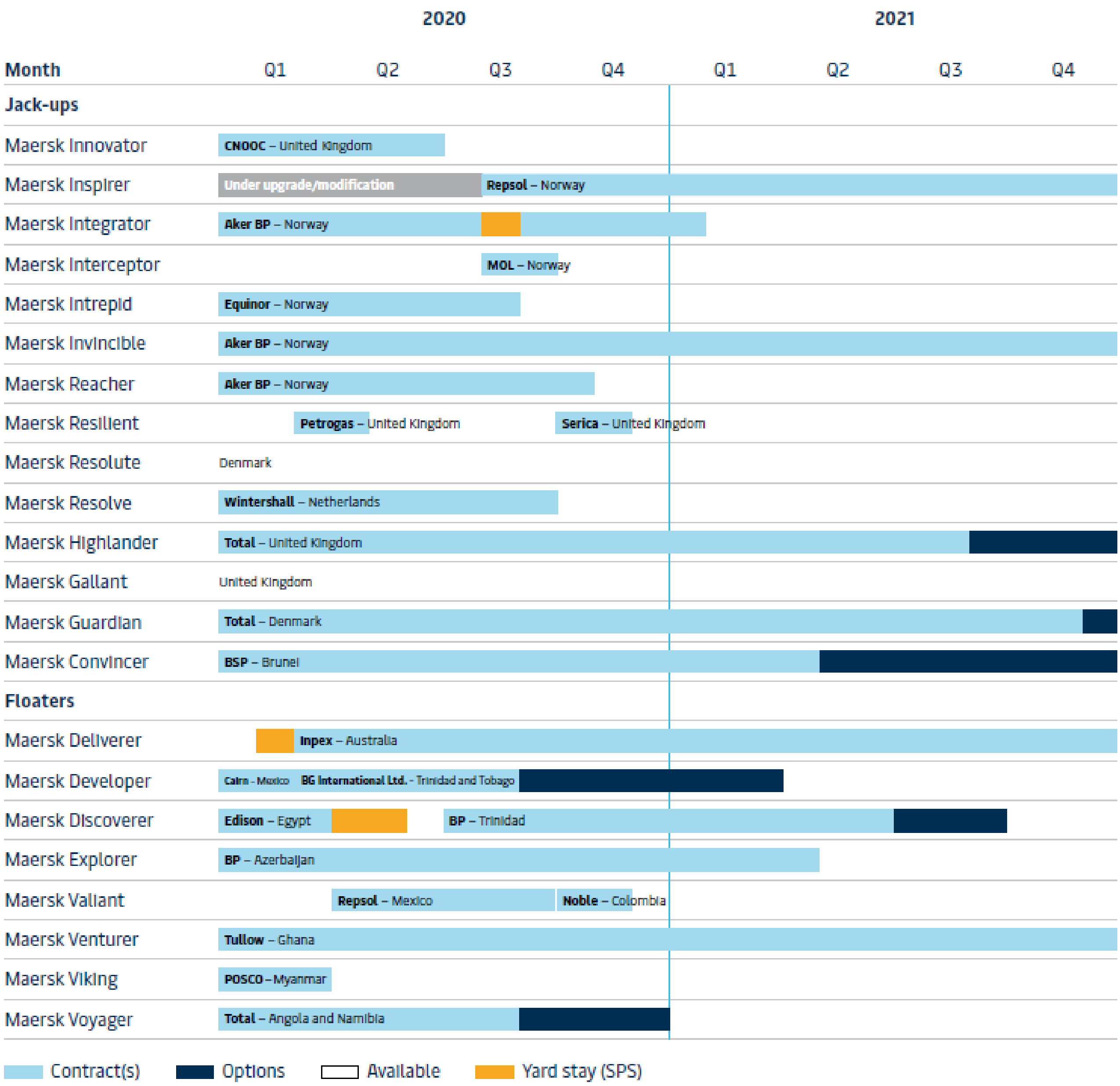
12. Appendix

Appendix 1: Fleet overview. Source: Maersk Drilling Annual Report (2019):



Appendix 2a: Segment definitions:

The 22 segments are constructed at a combination of a rig type and geographical area. The geographies are divided into regions or countries depending on their significance for Maersk Drilling. For instance, Norway represents one geographical area while the whole of South East Asia represents another. This is because Norway is generating significant revenue and has been doing so consistently, whereas Maersk Drilling's revenue from South East Asia consists of small amounts of several countries.

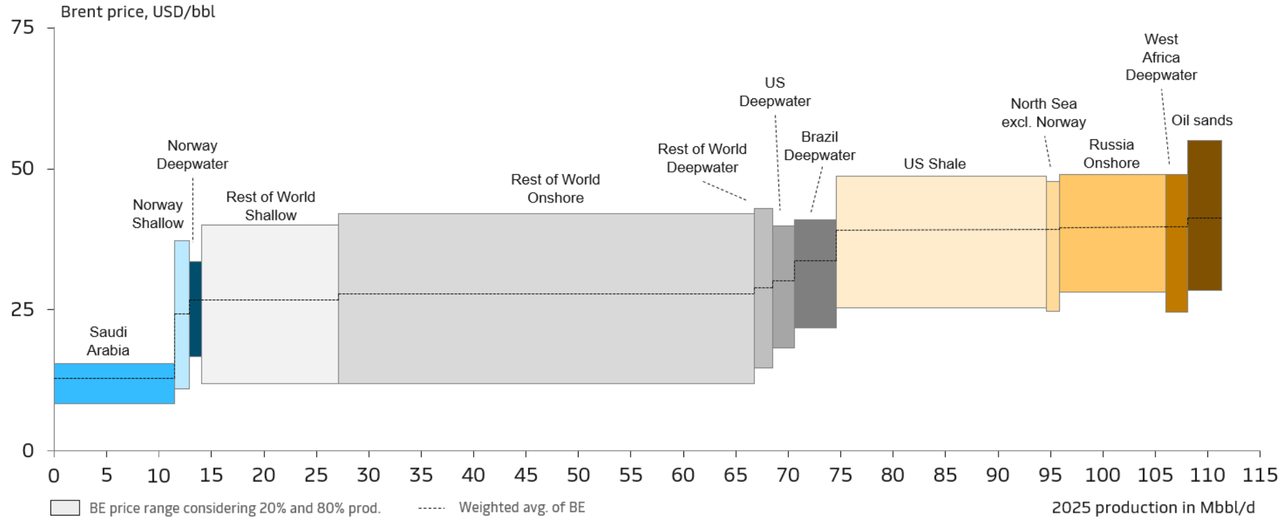
Furthermore, only segments where Maersk Drilling has been active within the last 5 years are included. The full list of segments is presented below (*Note that the full list is not mutually exclusive, but the 22 selected segments are*):

Rig type:	**Geography:**
Jackup	Global
Semisubmersible	Global
Drillship	Global
All rig types	Norway
All rig types	UK
All rig types	North Sea Excl. Norway & UK
All rig types	Mexico
All rig types	Middle East
All rig types	SE Asia
All rig types	Indian Ocean
All rig types	US GOM
All rig types	W Africa
All rig types	Far East
All rig types	Aus/NZ
All rig types	Med/Black Sea
All rig types	S America
All rig types	Caspian
All rig types	Russian Arctic
All rig types	C America
All rig types	Baltic
All rig types	Canada East
All rig types	US Alaska
Jackup	Norway
Jackup	UK
Jackup	North Sea Excl. Norway & UK
Jackup	Mexico
Jackup	Middle East
Jackup	SE Asia

Jackup	Indian Ocean
Jackup	US GOM
Jackup	W Africa
Jackup	Far East
Jackup	Aus/NZ
Jackup	Med/Black Sea
Jackup	S America
Jackup	Caspian
Jackup	Russian Arctic
Jackup	C America
Jackup	Baltic
Jackup	Canada East
Jackup	US Alaska
Semisubmersible	Norway
Semisubmersible	UK
Semisubmersible	North Sea Excl. Norway & UK
Semisubmersible	Mexico
Semisubmersible	Middle East
Semisubmersible	SE Asia
Semisubmersible	Indian Ocean
Semisubmersible	US GOM
Semisubmersible	W Africa
Semisubmersible	Far East
Semisubmersible	Aus/NZ
Semisubmersible	Med/Black Sea
Semisubmersible	S America
Semisubmersible	Caspian
Semisubmersible	Russian Arctic
Semisubmersible	C America
Semisubmersible	Baltic
Semisubmersible	Canada East
Semisubmersible	US Alaska
Drillship	Norway
Drillship	UK
Drillship	North Sea Excl. Norway & UK
Drillship	Mexico
Drillship	Middle East

Drillship	SE Asia
Drillship	Indian Ocean
Drillship	US GOM
Drillship	W Africa
Drillship	Far East
Drillship	Aus/NZ
Drillship	Med/Black Sea
Drillship	S America
Drillship	Caspian
Drillship	Russian Arctic
Drillship	C America
Drillship	Baltic
Drillship	Canada East
Drillship	US Alaska

Appendix 2b: Breakeven levels for different segments/regions



The cost of supply curve above shows the breakeven prices across selected regions deemed relevant for this thesis. The top of the bars show the 80th percentile most expensive barrel of oil, while the bottom of the bars show the 20th percentile. In other words the bars represent the breakeven price of the middle 60%. The dashed line shows the weighted average breakeven price.

Appendix 3a: Comments on the reformulated income statement:

Share of results in joint ventures/ Profit (loss) from unconsolidated subsidiaries: According to (Koller et al., 2015), investments in associates should be classified as operational, if the investment is regarded as part of the companies' core business. Consequently, recognised results in joint ventures or unconsolidated subsidiaries were examined thoroughly and classified following Koller et al. (2015).

Other operating income and expenses: Some of the companies within the offshore drilling industry, reported an item named other operating income and expenses. As the financial statements did not disclose the origins of the items, and the items were reoccurring, they were assumed being part of the reoccurring operations.

Impairment losses and reversals: As stated in the main part of the thesis, many of the companies within the offshore drilling recognised significant impairment losses and reversals during the period from FY15-FY19 due to challenging market conditions. As impairments are unrecognised losses or gains these are characterised as part of non-recurring operations (Koller et al., 2015)

Special items: The recognised special items of Maersk Drilling and its peers mainly relate to shipyard compensation, transaction costs, restructuring costs etc. These items are transitory and are therefore from ongoing operating expenses and classified as part of non-recurring operations (Koller et al., 2015).

Gain/loss on sales of non-current assets: Recognised gains or losses on sales of non-current assets were classified as part of non-recurring operations.

Operating leases: Before the implementation of IFRS 16 and ASC 842 (US GAAP) in FY19, operating lease agreements were an off-balance sheet item. To compare the reported numbers of FY19 with prior financial periods it is necessary to adjust for the operating leases. And as none of the companies within the offshore drilling industry have implemented IFRS 16 or ASC 842 under the full retrospective approach, all periods from FY15 to FY18 must be adjusted. The adjustment of operating leases was conducted following the method suggested by Damodaran (2002), where the operating leases were capitalised. The overall method is explained in detail below:

1) First, the historical data on operating lease expenses and payment schedules were collected using the annual reports. The data is displayed in appendix 10.

2) To estimate the present value of the operating lease agreements, it was necessary to estimate the historical cost of debt. The cost of debt for each company was estimated using the same approach as the one applied in the estimation of Maersk Drilling cost in the cost of capital. As Maersk Drilling among other peers is not rated by the Moodys, S&P etc. the credit spread was estimated using a synthetic bond rating. The same method was applied in the estimating of Maersk Drilling cost in the cost of capital estimation. To apply a consistent method, the ratings of the credit-rated companies[5] were substituted by the synthetic ratings. The estimated credit rating are displayed in appendix 10.

[5] Rated by Moodys, S&P etc.

3) The present value of the operating lease agreements was computed using the estimated cost of debt, and an asset life of 10.9 years. We used an asset lifetime of 10.9 because the companies did not disclose the lifetime of the lease agreements underlying assets. As a result, we turned to the literature, where (Koller et al., 2015) suggest using a lifetime of 10.9 years, as a comprehensive research paper (Lim et. al, 2003) examined the PP&E of 7,000 firms over 20 years and found a median asset life at 10.9 years. The present value computations are displayed in appendix 10.

4) The fourth step includes the calculation of depreciation and interest expenses. This is done under the simplifying assumption, that operating lease expenses are equal to the sum of depreciation and interest expenses. First, the interest expenses were computed by multiplying the estimated lease liability with the costs of debt. Second, the depreciation was computed as the difference between the reported lease expenses and the estimated interest expense. The calculations of depreciation and interest expenses are displayed in appendix 10.

5) Finally, the adjustments were incorporated into the financial statements. The estimated lease liability was recognised under net debt, and the corresponding leasing asset was recognised as part of PP&E. On the income statement, the originally recognised lease expenses were removed and instead replaced by the estimated depreciation and interest expenses.

Appendix 3b: Comments on the reformulated balance sheet:

Share of results in joint ventures/ Profit (loss) from unconsolidated subsidiaries: According to Petersen et al., (2017), investments in associates should be classified as operating assets, if the investment is regarded as part of the companies' core business. Consequently, reported shares in joint ventures or unconsolidated subsidiaries were examined thoroughly, and classified following Petersen et al., (2017)

Tax payables: The reported tax payable are treated as part of operating activities. This is under the assumption, that these do not carry interest. (Petersen et al., 2017).

Loans receivables: Petersen et al., (2017) state, that intercompany receivables often are interest-bearing, thus they should be included in the financing activities. However, if the receivables are a result of normal intercompany trading, they should be categorised as part of operating. Maersk Drilling has previously recognised intercompany receivables from A.P Moller Maersk and other subsidiaries. The origins of the receivables are not disclosed in the annual report; however, they are interest-bearing, thus we assume they are part of financing activities**.** The same approach is applied for the industry peers.

Operating leases: See method under income statement.

Operating cash: Cash and cash equivalents are usually considered as excess cash, which can be used to repay debt, pay dividends or buy shares back. However, some of the reported cash is also used for day-to-day operations, which means it ideally needs to be included in operating activities. The problem related to reclassifying some of the cash as operating is to decide which amount to include. Petersen et al., (2017) argue, that analysts should rely on own experience when assessing the reclassification. Sørensen (2017) argues, that 0.5%-1.5% of the reported cash should be reclassified as part of operating. As we have no prior experience with such reclassification, we use a conservative estimate of 0.5%.

Assets held for sale: are categorised as part of financing activities, as the sale will result in a reduction of net interest-bearing debt or increase in cash and cash equivalents (Petersen et al., 2017).

Deferred taxes: Deferred tax assets and liabilities are a result of temporary differences between the book value of an asset and its corresponding tax value. The items are non-interest bearing; hence they are classified as part of operations (Petersen et al., 2017).

Other current asset and liabilities: Other current receivables and payables often include a variety of accounting items, such as derivatives, tax receivables, VAT, duties etc. Not all of these items are part of a firms operating activities, thus they need to be reclassified as part of the financing. However, due to limited disclosure in the annual reports, not all line-items could be exactly classified. As a result, the items which had not been fully disclosed in the annual report were assumed being part of operating activities.

Appendix 3c: Maersk Drilling's analytical income statement:

Maersk Drilling (USD in millions)	FY14 Act	FY15 Act	FY16 Act	FY17 Act	FY18 Act	FY19 Act
Revenue	1,998	2,518	2,297	1,439	1,429	1,222
Operating costs	(1,095)	(1,112)	(816)	(681)	(714)	(710)
Gross profit	**903**	**1,406**	**1,481**	**758**	**715**	**512**
SG&A costs	-	-	(90)	(66)	(84)	(97)
Share of results in joint ventures	-	-	-	-	(1)	(2)
EBITDA	**903**	**1,406**	**1,391**	**692**	**630**	**413**
Depreciation and amortisation	(310)	(530)	(597)	(475)	(421)	(387)
EBIT	**593**	**876**	**794**	**217**	**209**	**26**
Special items	9	10	16	2	(16)	(8)
Impairment losses/reversals	(35)	(27)	(1,510)	(1,769)	810	(34)
Tax, operating activities	(131)	(175)	1	48	(49)	(6)
NOPAT	**436**	**684**	**(699)**	**(1,502)**	**954**	**(22)**
Net financial items	42	(104)	(91)	(21)	(14)	(68)
Tax, net financials items	(10)	21	0	1	1	(23)
Net financials, after tax	**32**	**(83)**	**(91)**	**(20)**	**(13)**	**(91)**
Net income	**468**	**601**	**(790)**	**(1,522)**	**941**	**(113)**
Effective tax rate	(23.2%)	(20.4%)	(0.1%)	(3.1%)	(4.9%)	34.5%
Danish corporate tax rate	25%	24%	22%	22%	22%	22%
Check to reported figures	-	-	-	-	-	-

Appendix 3d: Maersk Drilling's analytical balance sheet, FY14-19:

Maersk Drilling (USD in millions)	31 Dec 15 Act	31 Dec 16 Act	31 Dec 17 Act	31 Dec 18 Act	31 Dec 19 Act
Operating assets					
Intangible assets	36	109	85	56	31
PP&E	7,840	5,978	4,274	4,849	4,731
Right-of-use assets	60	55	36	40	31
Financial assets	43	31	2	3	5
Deferred tax assets	22	16	20	2	3
Total non-current assets	**8,001**	**6,189**	**4,417**	**4,950**	**4,801**
Trade receivables	434	288	297	339	264
Prepayments	126	101	79	58	41
Other receivables, operating	87	95	58	37	63
Operating cash	0	2	0	2	2
Total current assets	**647**	**486**	**434**	**436**	**370**
Total operating assets	**8,648**	**6,675**	**4,851**	**5,386**	**5,171**
Operating liabilities					
Provisions	(21)	(21)	(10)	(28)	(15)
Deferred tax	(182)	(108)	(68)	(60)	(47)
Trade payables	(219)	(148)	(163)	(196)	(180)
Other payables, operating	(42)	(62)	(53)	(66)	(61)
Deferred income	(147)	(57)	(48)	(39)	(32)
Tax payables	(97)	(70)	(41)	(40)	(69)
Total operating liabilities	**(708)**	**(466)**	**(383)**	**(429)**	**(404)**
Invested capital	**7,940**	**6,209**	**4,468**	**4,957**	**4,767**
Total equity	**8,316**	**8,761**	**6,213**	**3,814**	**3,680**
Borrowings, non-current	2,619	1,939	-	1,375	1,273
Leasing liabilities	60	55	36	40	-
Derivatives	-	-	-	-	22
Borrowings, current	356	14	1,632	95	136
Other payables, financial	29	33	28	5	2
Interest bearing liabilities	**3,064**	**2,041**	**1,696**	**1,515**	**1,433**
Cash and cash equivalents	(44)	(458)	(49)	(370)	(308)
Assets held for sale	-	-	-	-	(38)
Intercompany recievables	(3,395)	(4,134)	(3,390)	(2)	-
Other receivables, financial	(1)	(1)	(2)	-	-
Interest bearing assets	**(3,440)**	**(4,593)**	**(3,441)**	**(372)**	**(346)**
Net debt	**(376)**	**(2,552)**	**(1,745)**	**1,143**	**1,087**
Invested capital	**7,940**	**6,209**	**4,468**	**4,957**	**4,767**
Check to reported figures	-	-	-	-	-

Appendix 4a: Methodology of beta estimation:

In order to estimate the beta of Maersk Drilling, we used the method suggested by (Koller et al., 2015), where the equity beta for each industry peers was estimated by plotting 60 month stock returns against the MSCI World Index returns[6]. We use monthly returns as frequency measurement, since daily and weekly measurements result in systematic biases [7]. These systematic biases are due to stock illiquidity and bounces between the bid and ask price. The use of daily and weekly returns is problematic, when the stock is illiquid, since it leads to returns that are equal to zero. A return of zero is not due to a constant stock value, but wrather the fact that it have not been traded, thus only the last trade is recorded. Beta estimates based on illuquid stocsk are therefore downward biased, and by using longer-dated returns we reduce this issue (Koller et al., 2015).

In addition to the liqudity issue, high-frequency measurements also leads to the bid-ask bounce problem. The problem relates to periodic stock prices that are recorded at the last trade, and depends on whether the last trade was a purchase (ask) or sale (bid). A stock whose intrinsic value remain unchanged will as a result bounce between the bid and ask prices, which leads to a deceptive beta estimate. By using lower frequency measurements we reduce this distortion (Koller et al., 2015).

As stated above, we use the MSCI World Index as a proxy for the true market portfolio in CAPM. We use this, because it is an well-diversified index and because Maersk Drilling and its peers are listed on multiple exhanges, thus needing a world index. Furthermore, by not using local market indices we avoid the risk of measuring a firm's sensitivity to a specific industry instead of the market-wide systamtic risk. This is because most countries often are heavily weighted in a few number of industries (Koller et al., 2015).

Koller et al. (2015) suggest using a measurement period of 60 months, which is based on industry consensus as Morningstar and Thompson One. In addition, empirical testing of beta accuracy and estimation periods (Alexander & Chervany, 1980), have also shown that four and six-year estimation periods give the best result, but were stastistically indistinguishable thus five years are used. Conseqeuntly, we apply a five-year measurement period for the beta estimation.

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[6] Morgan Stanley Capital International

[7] "Consider two companies in the same industry competing for a large customer contract. Depending on which company wins the contract, one company's stock price will rise; the other company's stock price will fall. If the market rises during this period, the winning company will have a higher measured beta, and the losing company will have a lower measured beta, even though the decision had nothingto do with market performance. Using an industry beta to proxy for company risk lessens the effect of idiosyncratic shocks. on which company wins the contract, one company's stock price will rise; the other company's stock price will fall. If the market rises during this period, the winning company will have a higher measured beta, and the losing company will have a lower measured beta, even though the decision had nothing to do with market performance. Using an industry beta to proxy for company risk lessens the effect of idiosyncratic shocks." (Koller et al., 2015, p. 254),

Appendix 4b: Regression output, beta estimation:

Awilco Drilling PIC:

Regression Statistics	
Multiple R	0.3
R Square	0.1
Adjusted R Square	0.1
Standard Error	0.1
Observations	60.0

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0	0.1	0.1	4.9	0.0
Residual	58.0	1.3	0.0		
Total	59.0	1.4			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	(0.0)	0.0	(1.3)	0.2	(0.1)	0.0
Beta	**1.21**	0.5	2.2	0.0	0.1	2.3

Noble Corporation Plc:

Regression Statistics	
Multiple R	0.51
R Square	0.26
Adjusted R Square	0.25
Standard Error	0.16
Observations	60.00

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	0.52	0.52	20.32	0.00
Residual	58.00	1.48	0.03		
Total	59.00	2.00			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	(0.06)	0.02	(2.87)	0.01	(0.10)	(0.02)
Beta	**2.66**	0.59	4.51	0.00	1.48	3.83

Seadrill Limited:

Regression Statistics	
Multiple R	0.28
R Square	0.08
Adjusted R Square	0.06
Standard Error	0.35
Observations	60.00

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	0.61	0.61	5.07	0.03
Residual	58.00	7.03	0.12		
Total	59.00	7.64			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	(0.14)	0.05	(3.13)	0.00	(0.23)	(0.05)
Beta	**2.89**	1.28	2.25	0.03	0.32	5.46

Pacific Drilling S.A.

Regression Statistics	
Multiple R	0.08
R Square	0.01
Adjusted R Square	(0.01)
Standard Error	0.67
Observations	60.00

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	0.16	0.16	0.36	0.55
Residual	58.00	26.22	0.45		
Total	59.00	26.38			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	(0.05)	0.09	(0.61)	0.55	(0.23)	0.12
Beta	**1.49**	2.48	0.60	0.55	(3.47)	6.46

Transocean Limited

Regression Statistics	
Multiple R	0.56
R Square	0.32
Adjusted R Square	0.31
Standard Error	0.14
Observations	60.00

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	0.54	0.54	26.90	0.00
Residual	58.00	1.17	0.02		
Total	59.00	1.71			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	(0.03)	0.02	(1.84)	0.07	(0.07)	0.00
Beta	**2.71**	0.52	5.19	0.00	1.67	3.76

Valaris Plc

Regression Statistics	
Multiple R	0.56
R Square	0.32
Adjusted R Square	0.31
Standard Error	0.17
Observations	60.00

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	0.78	0.78	27.16	0.00
Residual	58.00	1.66	0.03		
Total	59.00	2.43			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	(0.06)	0.02	(2.92)	0.00	(0.11)	(0.02)
Beta	**3.25**	0.62	5.21	0.00	2.00	4.50

Diamond Offshore Drilling, Inc.

Regression Statistics	
Multiple R	0.55
R Square	0.30
Adjusted R Square	0.29
Standard Error	0.14
Observations	60.00

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	0.46	0.46	25.31	0.00
Residual	58.00	1.06	0.02		
Total	59.00	1.53			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	(0.05)	0.02	(2.62)	0.01	(0.08)	(0.01)
Beta	**2.51**	0.50	5.03	0.00	1.51	3.51

Maersk Drilling A/S

Regression Statistics	
Multiple R	0.89
R Square	0.79
Adjusted R Square	0.76
Standard Error	0.07
Observations	10.00

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	0.14	0.14	29.84	0.00
Residual	8.00	0.04	0.00		
Total	9.00	0.18			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	(0.05)	0.02	(2.25)	0.05	(0.10)	0.00
Beta	**2.74**	0.50	5.46	0.00	1.58	3.89

Appendix 5a: Budget for the Maersk Drilling Group:

Maersk Drilling, income statement *(in %)*	**FY16 Act**	**FY17 Act**	**FY18 Act**	**FY19 Act**	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
Revenue growth (YoY growth)	(8.8%)	(37.4%)	(0.7%)	(14.5%)	(21.8%)	34.9%	10.0%	(6.7%)	(4.8%)
Operating costs (as a % of revenue)	(35.5%)	(47.3%)	(50.0%)	(58.1%)	(60.3%)	(53.6%)	(49.6%)	(53.4%)	(53.8%)
Gross margin	**64.5%**	**52.7%**	**50.0%**	**41.9%**	**39.7%**	**46.4%**	**50.4%**	**46.6%**	**46.2%**
SG&A costs (as a % of revenue)	(3.9%)	(4.6%)	(5.9%)	(7.9%)	(7.9%)	(7.9%)	(7.9%)	(7.9%)	(7.9%)
Share of results in joint ventures (as a % of revenue)	0.0%	0.0%	(0.1%)	(0.2%)	(0.1%)	(0.1%)	(0.1%)	(0.1%)	(0.1%)
EBITDA margin	**60.6%**	**48.1%**	**44.1%**	**33.8%**	**31.7%**	**38.3%**	**42.4%**	**38.6%**	**38.2%**
Depreciation and amortisation (as a % of tangible & intangible assets)	(7.5%)	(7.7%)	(9.6%)	(7.8%)	(7.8%)	(7.8%)	(7.8%)	(7.8%)	(7.8%)
EBIT margin	**34.6%**	**15.0%**	**14.6%**	**2.1%**	**(7.6%)**	**10.5%**	**18.0%**	**13.5%**	**12.8%**
Tax rate	(0.1%)	(3.1%)	(4.9%)	34.5%	(22.0%)	(22.0%)	(22.0%)	(22.0%)	(22.0%)
NOPAT margin	**(30.4%)**	**(104.4%)**	**66.8%**	**(1.8%)**	**(5.9%)**	**8.2%**	**14.0%**	**10.5%**	**10.0%**

Maersk Drilling, balance sheet *(as a % of revenue)*	**31 Dec 16 Act**	**31 Dec 17 Act**	**31 Dec 18 Act**	**31 Dec 19 Act**	**31 Dec 20 Bud**	**31 Dec 21 Bud**	**31 Dec 22 Bud**	**31 Dec 23 Bud**	**31 Dec 24 Bud**
Operating assets									
Intangible & tangible assets	267.4%	305.4%	346.1%	392.2%	480.7%	342.2%	299.3%	309.3%	313.4%
Trade receivables	12.5%	20.6%	23.7%	21.6%	21.6%	21.6%	21.6%	21.6%	21.6%
Prepayments	4.4%	5.5%	4.1%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%
Other receivables	4.1%	4.0%	2.6%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%
Operating cash	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Total current assets	**21%**	**30%**	**31%**	**30%**	**30.2%**	**30.2%**	**30.2%**	**30.2%**	**30.2%**
Total operating assets	**289%**	**336%**	**377%**	**422%**	**511%**	**372%**	**330%**	**340%**	**344%**
Operating liabilities									
Trade payables	(6.4%)	(11.3%)	(13.7%)	(14.7%)	(14.7%)	(14.7%)	(14.7%)	(14.7%)	(14.7%)
Other payables	(2.7%)	(3.7%)	(4.6%)	(5.0%)	(5.0%)	(5.0%)	(5.0%)	(5.0%)	(5.0%)
Deferred income	(2.5%)	(3.3%)	(2.7%)	(2.6%)	(2.6%)	(2.6%)	(2.6%)	(2.6%)	(2.6%)
Tax payables	(3.0%)	(2.8%)	(2.8%)	(5.6%)	(5.6%)	(5.6%)	(5.6%)	(5.6%)	(5.6%)
Deferred tax	(4.7%)	(4.7%)	(4.2%)	(3.8%)	(3.8%)	(3.8%)	(3.8%)	(3.8%)	(3.8%)
Provisions	(0.9%)	(0.7%)	(2.0%)	(1.2%)	(1.2%)	(1.2%)	(1.2%)	(1.2%)	(1.2%)
Total operating liabilities	**(20%)**	**(27%)**	**(30%)**	**(33%)**	**(33%)**	**(33%)**	**(33%)**	**(33%)**	**(33%)**
Invested capital	**268%**	**309%**	**347%**	**389%**	**478%**	**339%**	**297%**	**306%**	**311%**
Net debt (as a % of Invested capital)	**(41.1%)**	**(39.0%)**	**23.1%**	**22.8%**	**22.8%**	**22.8%**	**22.8%**	**22.8%**	**22.8%**

Appendix 5b: Budget for the Maersk Drilling Group:

Maersk Drilling, income statement *(in USD millions)*	FY16 Act	FY17 Act	FY18 Act	FY19 Act	FY20 Bud	FY21 Bud	FY22 Bud	FY23 Bud	FY24 Bud
Revenue	2,297	**1,439**	**1,429**	**1,222**	**955**	**1,289**	**1,418**	**1,322**	**1,259**
Operating costs	(816)	(681)	(714)	(710)	(576)	(691)	(703)	(705)	(677)
Gross profit	**1,481**	**758**	**715**	**512**	**379**	**598**	**715**	**617**	**582**
SG&A costs	(90)	(66)	(84)	(97)	(76)	(102)	(113)	(105)	(100)
Share of results in joint ventures	-	-	(1)	(2)	(1)	(2)	(2)	(2)	(1)
EBITDA	**1,391**	**692**	**630**	**413**	**302**	**494**	**600**	**510**	**481**
Depreciation and amortisation	(597)	(475)	(421)	(387)	(375)	(359)	(345)	(332)	(320)
EBIT	**794**	**217**	**209**	**26**	**(73)**	**135**	**255**	**178**	**161**
Special items	16	2	(16)	(8)	-	-	-	-	-
Impairment losses and reversals	(1,510)	(1,769)	810	(34)	-	-	-	-	-
Tax, operating	1	48	(49)	(6)	16	(30)	(56)	(39)	(35)
NOPAT	**(699)**	**(1,502)**	**954**	**(22)**	**(57)**	**105**	**199**	**139**	**125**

Maersk Drilling, balance sheet *(in USD millions)*	31 Dec 16 Act	31 Dec 17 Act	31 Dec 18 Act	31 Dec 19 Act	31 Dec 20 Bud	31 Dec 21 Bud	31 Dec 22 Bud	31 Dec 23 Bud	31 Dec 24 Bud
Operating assets									
Intangible & tangible assets	**6142**	**4395**	**4945**	**4793**	**4,593**	**4,411**	**4,243**	**4,089**	**3,946**
Trade receivables	288	297	339	264	206	278	306	286	272
Prepayments	101	79	58	41	32	43	48	44	42
Other receivables	95	58	37	63	49	66	73	68	65
Operating cash	2	0	2	2	1	2	2	2	2
Total current assets	**486**	**434**	**436**	**370**	**289**	**390**	**429**	**400**	**381**
Total operating assets	**6,675**	**4,851**	**5,386**	**5,171**	**4,886**	**4,806**	**4,678**	**4,494**	**4,332**
Operating liabilities									
Trade payables	(148)	(163)	(196)	(180)	(141)	(190)	(209)	(195)	(185)
Other payables	(62)	(53)	(66)	(61)	(48)	(64)	(71)	(66)	(63)
Deferred income	(57)	(48)	(39)	(32)	(25)	(34)	(37)	(35)	(33)
Tax payables	(70)	(41)	(40)	(69)	(54)	(73)	(80)	(75)	(71)
Deferred tax	(108)	(68)	(60)	(47)	(37)	(50)	(55)	(51)	(48)
Provisions	(21)	(10)	(28)	(15)	(12)	(16)	(17)	(16)	(15)
Total operating liabilities	**(466)**	**(383)**	**(429)**	**(404)**	**(316)**	**(426)**	**(469)**	**(437)**	**(416)**
Invested capital	**6,209**	**4,468**	**4,957**	**4,767**	**4,570**	**4,380**	**4,209**	**4,057**	**3,916**
Net debt	**(2,552)**	**(1,745)**	**1,143**	**1,087**	**1,042**	**998**	**959**	**925**	**893**

Appendix 6a: Budget for the ultra-harsh environment business unit:

UHE Business unit, income statement *(in %)*	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
Revenue growth, Group (YoY growth)	(22%)	35%	10%	(7%)	(5%)
UHE % of Group revenue	38%	42%	31%	27%	29%
Revenue growth, UHE (YoY growth)	**(36%)**	**50%**	**(19%)**	**(17%)**	**2%**
Operating costs *(as a % of revenue)*	(60%)	(55%)	(68%)	(82%)	(82%)
Gross margin	**40%**	**45%**	**32%**	**18%**	**18%**
SG&A costs *(as a % of revenue)*	(7.9%)	(7.9%)	(7.9%)	(7.9%)	(7.9%)
EBITDA margin	**32%**	**37%**	**24%**	**10%**	**10%**
Depreciation and amortisation *(as a % of tangible & intangible assets)*	(7.8%)	(7.8%)	(7.8%)	(7.8%)	(7.8%)
EBIT margin	**(9%)**	**11%**	**(7%)**	**(26%)**	**(23%)**
Tax rate	(22%)	(22%)	(22%)	(22%)	(22%)
NOPAT margin	**(7%)**	**8%**	**(5%)**	**(20%)**	**(18%)**

UHE Business unit, balance sheet *(as a % of revenue)*	**31 Dec 20 Bud**	**31 Dec 21 Bud**	**31 Dec 22 Bud**	**31 Dec 23 Bud**	**31 Dec 24 Bud**
Operating assets					
Intangible & tangible assets	502%	316%	370%	425%	396%
Trade receivables	22%	22%	22%	22%	22%
Prepayments	3%	3%	3%	3%	3%
Other receivables	5%	5%	5%	5%	5%
Operating cash	0%	0%	0%	0%	0%
Total current assets	**30.2%**	**30%**	**30%**	**30%**	**30%**
Total operating assets	**532.2%**	**346.5%**	**400.5%**	**455.3%**	**426.7%**
Operating liabilities					
Trade payables	(15%)	(15%)	(15%)	(15%)	(15%)
Other payables	(5%)	(5%)	(5%)	(5%)	(5%)
Deferred income	(3%)	(3%)	(3%)	(3%)	(3%)
Tax payables	(6%)	(6%)	(6%)	(6%)	(6%)
Deferred tax	(4%)	(4%)	(4%)	(4%)	(4%)
Provisions	(1%)	(1%)	(1%)	(1%)	(1%)
Total operating liabilities	**(33%)**	**(33%)**	**(33%)**	**(33%)**	**(33%)**
Invested capital	**499%**	**313%**	**367%**	**422%**	**394%**
Net debt (as a % of Invested capital)	**22.8%**	**22.8%**	**22.8%**	**22.8%**	**22.8%**

Appendix 6b: Budget for the ultra-harsh environment business unit:

UHE Business unit, income statement *(in USD millions)*	**FY19 Act**	**FY20 Bud**	**FY21 Bud**	**FY22 Bud**	**FY23 Bud**	**FY24 Bud**
Revenue, Group	1,222	955	1,289	1,418	1,322	1,259
UHE % of Group revenue	46%	38%	42%	31%	27%	29%
Revenue	**559**	**360**	**539**	**436**	**360**	**367**
Operating costs, Group	(710)	(576)	(691)	(703)	(705)	(677)
UHE operating costs % of Group		37%	43%	42%	42%	45%
Operating costs	-	(215)	(297)	(297)	(297)	(302)
Gross profit	**-**	**145**	**242**	**139**	**63**	**65**
SG&A costs, Group	(710)	(76)	(102)	(113)	(105)	(100)
UHE SG&A costs % of Group		38%	42%	31%	27%	29%
SG&A costs	-	(29)	(43)	(35)	(29)	(29)
EBITDA	**-**	**116**	**200**	**104**	**34**	**36**
Depreciation and amortisation	-	(150)	(141)	(134)	(126)	(120)
EBIT	**-**	**(34)**	**58**	**(29)**	**(92)**	**(84)**
Tax		7	(13)	6	20	18
NOPAT	**-**	**(26)**	**45**	**(23)**	**(72)**	**(65)**

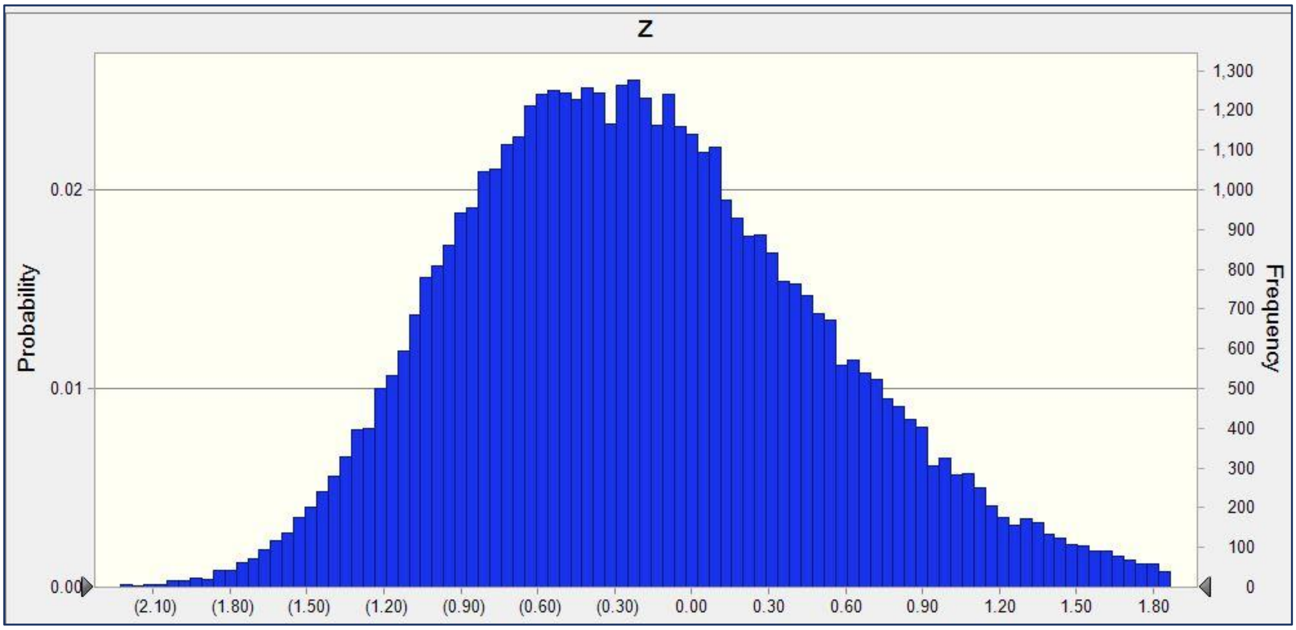
UHE Business unit, balance sheet *(in USD millions)*	**31 Dec 19 Est**	**31 Dec 20 Bud**	**31 Dec 21 Bud**	**31 Dec 22 Bud**	**31 Dec 23 Bud**	**31 Dec 24 Bud**
Operating assets						
Intangible & tangible assets	1912	1,805	1,706	1,615	1,531	1,454
Trade receivables	121	78	117	94	78	79
Prepayments	19	12	18	15	12	12
Other receivables	29	19	28	22	19	19
Operating cash	1	0	1	1	0	0
Total current assets	**169**	**109**	**163**	**132**	**109**	**111**
Total operating assets	**2,081**	**1,914**	**1,869**	**1,747**	**1,640**	**1,565**
Operating liabilities						
Trade payables	(82)	(53)	(79)	(64)	(53)	(54)
Other payables	(28)	(18)	(27)	(22)	(18)	(18)
Deferred income	(15)	(9)	(14)	(11)	(9)	(10)
Tax payables	(32)	(20)	(30)	(25)	(20)	(21)
Deferred tax	(22)	(14)	(21)	(17)	(14)	(14)
Provisions	(7)	(4)	(7)	(5)	(4)	(5)
Total operating liabilities	**(185)**	**(119)**	**(178)**	**(144)**	**(119)**	**(121)**
Invested capital	**1,896**	**1,795**	**1,691**	**1,603**	**1,521**	**1,444**
Net debt	**433**	**409**	**386**	**365**	**346**	**329**

Appendix 7: Output Monte Carlo simulations, @Crystall ball:

50,000 Trials

Statistic	Forecast values
Trials	50,000
Base Case	0.09
Mean	(0.18)
Median	(0.24)
Mode	---
Standard Deviation	0.73
Variance	0.53
Skewness	0.5171
Kurtosis	3.47
Coeff. of Variation	-4.05
Minimum	(2.72)
Maximum	3.57
Mean Std. Error	0.00

Estimated volatility of UHE BU.



Appendix 8a: Liquidation value of the ultra-harsh environment business unit:

Balance sheet, UHE BU *(In USD millions)*	**31 Dec 19 Est**	**31 Dec 20 Bud**	**31 Dec 21 Bud**	**31 Dec 22 Bud**	**31 Dec 23 Bud**	**31 Dec 24 Bud**
Operating assets						
Intangible & tangible assets	1,912	1,805	1,706	1,615	1,531	1,454
Trade receivables	121	78	117	94	78	79
Prepayments	19	12	18	15	12	12
Other receivables	29	19	28	22	19	19
Operating cash	1	0	1	1	0	0
Operating liabilities						
Trade payables	(82)	(53)	(79)	(64)	(53)	(54)
Other payables	(28)	(18)	(27)	(22)	(18)	(18)
Deferred income	(15)	(9)	(14)	(11)	(9)	(10)
Tax payables	(32)	(20)	(30)	(25)	(20)	(21)
Deferred tax	(22)	(14)	(21)	(17)	(14)	(14)
Provisions	(7)	(4)	(7)	(5)	(4)	(5)
Net debt	(433)	(409)	(386)	(365)	(346)	(329)

Liquidation discount factors *(Berger et al., 1996)*	**31 Dec 19 Est**	**31 Dec 20 Bud**	**31 Dec 21 Bud**	**31 Dec 22 Bud**	**31 Dec 23 Bud**	**31 Dec 24 Bud**
Intangible and tangible assets	0.54	0.54	0.54	0.54	0.54	0.54
Trade receivables	0.72	0.72	0.72	0.72	0.72	0.72
Prepayments	0.72	0.72	0.72	0.72	0.72	0.72
Other receivables	0.72	0.72	0.72	0.72	0.72	0.72
Operating cash	1.00	1.00	1.00	1.00	1.00	1.00
Trade payables	1.00	1.00	1.00	1.00	1.00	1.00
Other payables	1.00	1.00	1.00	1.00	1.00	1.00
Deferred income	1.00	1.00	1.00	1.00	1.00	1.00
Tax payables	1.00	1.00	1.00	1.00	1.00	1.00
Deferred tax	-	-	-	-	-	-
Provisions	1.00	1.00	1.00	1.00	1.00	1.00
Net debt	1.0	1.0	1.0	1.0	1.0	1.0

Liquidation value of UHE BU *(USD in millions)*	**31 Dec 19 Est**	**31 Dec 20 Bud**	**31 Dec 21 Bud**	**31 Dec 22 Bud**	**31 Dec 23 Bud**	**31 Dec 24 Bud**
Intangible and tangible assets	1,022.9	965.6	912.8	864.1	819.2	777.8
Trade receivables	86.3	55.5	83.3	67.4	55.6	56.6
Prepayments	13.4	8.6	12.9	10.5	8.6	8.8
Other receivables	20.6	13.3	19.9	16.1	13.3	13.5
Operating cash	0.7	0.5	0.7	0.6	0.5	0.5
Trade payables	(82.3)	(53.0)	(79.5)	(64.3)	(53.1)	(54.0)
Other payables	(27.9)	(17.9)	(26.9)	(21.8)	(18.0)	(18.3)
Deferred income	(14.6)	(9.4)	(14.1)	(11.4)	(9.4)	(9.6)
Tax payables	(31.6)	(20.3)	(30.5)	(24.6)	(20.3)	(20.7)
Deferred tax	-	-	-	-	-	-
Provisions	(6.9)	(4.4)	(6.6)	(5.4)	(4.4)	(4.5)
Net debt	(433.4)	(409.4)	(386.2)	(365.2)	(346.3)	(328.9)
Estimated liquidation value	**547.2**	**529.07**	**485.84**	**465.92**	**445.66**	**421.25**

Appendix 8b: Discussion of the liquidation discounts presented by Berger et al. (1996)

Other research related to the estimation of liquidation discounts, has been conducted by Kausar and Lennox (2017). Kausar and Lennox (2017) investigate the expected outcome of bankruptcy, and how the assets' liquidation values differ from the assets' reported at book value. Kausar and Lennox (2017) use a sample of 120 UK companies, which had filed for bankruptcy between 1994-2008, to estimate the realisation rates for five categories of non-cash assets. The result is summarised in the table below:

Table: Summary of Liquidation/realisation rates

Type of non-cash asset	Kausar and Lennox (2017) (cents per dollar)	Berger et al. (1996) (cents per dollar)
Intangible assets	**0.089**	**0.535**
Land	**0.884**	
Other fixed assets, excluding land	**0.451**	
Inventory	**0.477**	**0.547**
Other current assets	**0.572**	**0.715**

Compared to the findings of Berger et al., 1996, Kausar and Lennox provide a more asset-specific realisation rate, as they provide a breakdown of the non-current assets. Despite the more specific realisation rate provided by Kausar and Lennox (2017), the liquidation value of the UHE BU will be based on the realisation rates estimated by Berger et al., (1996). This decision is built on two aspects. First, the research conducted by Kausar and Lennox (2017), is founded on a sample only 120 firms, whereas the findings of Berger et al. (1996) is based on a sample of 1,043 entities, thus the estimates are more representative. Second, the re-alisation rate by Kausar and Lennox (2017), is derived using only companies, which had filed for bankruptcy. However, focusing on the liquidation of a BU instead of a firm, yields a strategic opportunity. As a result, the liquidation of a BU can be related to a strategic move, and not only due to bankruptcy. Berger et al. (1996) incorporate this in the estimated reali-sation rates, as they are based on observations that represent both the sales of the discon-tinued line of business and 'fire sale' liquidations of separate assets. Consequently, Berger et al's (1996) realisation rates are used in the calculation of the UHE liquidation value.

One issue related to the realisation rates of Berger et al. (1996) is their assumption, that payables are realised at book value. While this is a fair assumption for trade payables and other accrued expenses, it is not for deferred tax liabilities.

Deferred taxes are measured as the difference between the book value and tax value of the assets multiplied by the nominal tax rate. Berger et al's (1996) do not address the issue of estimating the deferred taxes when computing the liquidation value. Instead, they simply assume, that all payables are liquidated at book value. Under this assumption, the realisation rate indirectly assumes that the assets are liquidated at book value, as deferred taxes are paid only if the assets had been sold at book value (Petersen et al., 2017). To address this issue we assume, that the realisation rate of deferred tax liabilities is zero. This assumption is based on two aspects. First, we do not know the tax values of the liquidated assets. Second, Petersen et al., (2017) argue that the realisation rate of deferred tax liabilities typically is zero, since the low realisation rate of assets causes the liquidation value to be less than the tax value. As a result, the liquidation values of the deferred tax liabilities are assumed to be zero.

Appendix 9: Estimation of synthetic rating and cost of debt (Damadoran, 2020)

For developed market firms with market cap > $5 billion

If interest coverage ratio is			Spread 2014	Spread: 2015	Spread: 2016	Spread: 2017	Spread 2018	Spread 2019
>	≤ to	*Rating is*	*Spread is*	*Spread is*	*Spread is*	*Spread is*	*Spread is*	*Spread is*
(100,000)	0	D2/D	3.81%	12.00%	20.00%	14.50%	18.60%	28.34%
0	1	C2/C	3.47%	10.00%	16.00%	10.50%	13.95%	21.26%
1	1	Ca2/CC	3.17%	8.00%	12.00%	8.00%	10.63%	16.20%
1	1	Caa/CCC	2.87%	7.00%	9.00%	6.50%	8.64%	15.37%
1	1	B3/B-	2.52%	6.00%	7.50%	5.50%	4.37%	9.65%
2	2	B2/B	2.23%	5.00%	6.50%	4.50%	3.57%	7.90%
2	2	B1/B+	1.93%	4.00%	5.50%	3.75%	2.98%	6.58%
2	2	Ba2/BB	1.04%	3.25%	4.25%	3.00%	2.38%	4.50%
2	2	Ba1/BB+	0.65%	2.75%	3.25%	2.50%	1.98%	3.75%
3	3	Baa2/BBB	0.54%	1.75%	2.25%	1.60%	1.27%	3.13%
3	4	A3/A-	0.40%	1.20%	1.75%	1.25%	1.13%	2.44%
4	5	A2/A	0.29%	1.00%	1.25%	1.10%	0.99%	2.16%
6	6	A1/A+	0.23%	0.90%	1.10%	1.00%	0.90%	1.96%
7	8	Aa2/AA	0.13%	0.70%	1.00%	0.80%	0.72%	1.57%
8.50	100,000	Aaa/AAA	0.05%	0.40%	0.75%	0.60%	0.54%	1.26%

For all emerging market firms and developed market firms with market cap < $5 billion

If interest coverage ratio is			Spread 2014	Spread: 2015	Spread: 2016	Spread: 2017	Spread 2018	Spread 2019
greater than	≤ to	Rating is	*Spread is*	*Spread is*	*Spread is*	*Spread is*	*Spread is*	*Spread is*
(100,000)	0	D2/D	3.81%	12.00%	20.00%	14.50%	18.60%	28.34%
0.5	0.8	C2/C	3.47%	10.00%	16.00%	10.50%	13.95%	21.26%
0.8	1.2	Ca2/CC	3.17%	8.00%	12.00%	8.00%	10.63%	16.20%
1.3	1.5	Caa/CCC	2.87%	7.00%	9.00%	6.50%	8.64%	15.37%
1.5	2.0	B3/B-	2.52%	6.00%	7.50%	5.50%	4.37%	9.65%
2.0	2.5	B2/B	2.23%	5.00%	6.50%	4.50%	3.57%	7.90%
2.5	3.0	B1/B+	1.93%	4.00%	5.50%	3.75%	2.98%	6.58%
3.0	3.5	Ba2/BB	1.04%	3.25%	4.25%	3.00%	2.38%	4.50%
3.5	4.0	Ba1/BB+	0.65%	2.75%	3.25%	2.50%	1.98%	3.75%
4.0	4.5	Baa2/BBB	0.54%	1.75%	2.25%	1.60%	1.27%	3.13%
4.5	6.0	A3/A-	0.40%	1.20%	1.75%	1.25%	1.13%	2.44%
6.0	7.5	A2/A	0.29%	1.00%	1.25%	1.10%	0.99%	2.16%
7.5	9.5	A1/A+	0.23%	0.90%	1.10%	1.00%	0.90%	1.96%
9.5	12.5	Aa2/AA	0.13%	0.70%	1.00%	0.80%	0.72%	1.57%
13	100,000	Aaa/AAA	0.05%	0.40%	0.75%	0.60%	0.54%	1.26%

Appendix 10a: Reported operating lease expenses and payments schedules:

Reported operating lease expenses *USD in millions*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
Maersk Drilling A/S	n.a.	13	10	9	20
Awilco Drilling Plc.	0.3	0.48	0.36	0.32	0.34
Noble Corporation Plc.	18.0	8.7	7.8	8.3	7.5
Seadrill Ltd.	24.0	23.0	17.0	19.0	16.0
Pacific Drilling S.A.	4.5	3.0	2.5	2.4	1.6
Transocean Ltd.	95.0	72.0	45.0	52.0	35.0
Valaris Plc.	54.4	50.9	39.7	37.0	40.1
Diamond Offshore Drilling Inc.	10.6	7.8	5.5	3.9	3.1

Maersk Drilling A/S *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
0-1 years	n.a.	14	10	8	9
2-5 years	n.a.	33	31	23	27
After 5 years	n.a.	30	27	12	11
Carrying amount	n.a.	77	68	43	47
Credit rating	A2/A	Baa2/BBB	Aa2/AA	A1/A+	A1/A+
Interest rate	4.5%	5.6%	4.5%	4.2%	3.9%

Awilco Drilling Plc *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
0-1 years	0.47	0.45	0.40	0.34	0.32
2-5 years	1.56	1.48	1.45	1.35	1.27
After 5 years	3.32	3.24	0.53	0.58	0.23
Carrying amount	5.35	5.17	2.38	2.27	1.82
Credit rating	Aaa/AAA	Aaa/AAA	B1/B+	Aaa/AAA	Baa2/BBB
Interest rate	4.9%	4.9%	9.7%	4.6%	5.0%

Noble Corporation Plc. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
0-1 years	22.51	19.42	15.72	18.72	15.21
2-5 years	39.60	25.57	17.82	20.05	15.95
After 5 years	11.47	7.89	4.89	3.84	5.72
Carrying amount	73.58	52.87	38.42	42.61	36.89
Credit rating	A3/A-	A1/A+	A3/A-	B3/B-	Ca2/CC
Interest rate	4.7%	5.0%	5.6%	9.2%	14.2%

Seadrill Ltd. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
0-1 years	15.00	11.00	17.00	12.00	11.00
2-5 years	36.00	30.00	31.00	27.00	26.00
After 5 years	21.00	13.00	5.00	1.00	1.00
Carrying amount	72.00	54.00	53.00	40.00	38.00
Credit rating	A3/A-	Ba1/BB+	Baa2/BBB	Ba2/BB	Ca2/CC
Interest rate	5.2%	7.2%	6.5%	7.0%	14.4%

Pacific Drilling S.A. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
0-1 years	2.39	2.33	2.29	2.22	1.55
2-5 years	8.72	8.65	8.56	8.68	6.05
After 5 years	10.22	8.10	5.94	3.96	1.18
Carrying amount	21.33	19.08	16.79	14.86	8.78
Credit rating	Baa2/BBB	Ba1/BB+	B2/B	D2/D	D2/D
Interest rate	4.9%	6.9%	10.4%	18.2%	22.2%

Transocean Ltd. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
0-1 years	23.00	15.00	10.00	15.00	18.00
2-5 years	45.00	44.00	39.00	43.00	51.00
After 5 years	62.00	62.00	42.00	39.00	135.00
Carrying amount	130.00	121.00	91.00	97.00	204.00
Credit rating	Aa2/AA	Aa2/AA	A2/A	B1/B+	B3/B-
Interest rate	4.5%	4.8%	5.1%	7.4%	7.9%

Valaris Plc. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
0-1 years	77.30	45.30	32.70	22.60	32.30
2-5 years	68.80	51.00	62.30	48.30	48.70
After 5 years	55.00	53.40	37.40	24.60	15.20
Carrying amount	201.10	149.70	132.40	95.50	96.20
Credit rating	Aaa/AAA	Aa2/AA	A2/A	B2/B	Ca2/CC
Interest rate	4.4%	4.8%	5.1%	8.2%	14.2%

Diamond Offshore Drilling Inc. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
0-1 years	1.34	2.67	1.76	1.73	2.09
2-5 years	2.34	1.81	0.69	0.85	1.08
After 5 years	-	0.08	0.03	-	-
Carrying amount	3.68	4.57	2.48	2.59	3.17
Credit rating	Aaa/AAA	Aa2/AA	A2/A	Ba1/BB+	B2/B
Interest rate	4.4%	4.8%	5.1%	6.2%	7.1%

Appendix 10b: Estimated of risk-free rates used in the capitalization of operating lease agreements (Investing, 2020)

Goverment Bond 10Y *(20-year average interest rate)*	**31 Dec 2014**	**31 Dec 2015**	**31 Dec 2016**	**31 Dec 2017**	**31 Dec 2018**	**31 Dec 2019**	**31 Jan 2020**
US	4.3%	4.1%	3.9%	3.7%	3.6%	3.4%	3.4%
Denmark	4.2%	3.8%	3.5%	3.2%	3.0%	2.7%	2.69%
Norway	4.8%	4.5%	4.2%	4.0%	3.8%	3.6%	3.6%

Appendix 10c: Operating lease adjustments on income statement and balance sheet

Maersk Drilling A/S *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
Lease asset	n.a.	59.6	54.8	36.1	40.3
Lease liability	n.a.	59.6	54.8	36.1	40.3
Interest expense	n.a.	3.3	2.5	1.5	1.6
Depreciation	n.a.	9.7	7.5	7.5	18.4

Awilco Drilling Plc *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
Lease asset	4.0	3.9	1.7	1.9	1.5
Lease liability	4.0	3.9	1.7	1.9	1.5
Interest expense	0.2	0.2	0.2	0.1	0.1
Depreciation	0.1	0.3	0.2	0.2	0.3

Noble Corporation Plc. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
Lease asset	63.0	45.3	32.7	33.8	25.4
Lease liability	63.0	45.3	32.7	33.8	25.4
Interest expense	3.0	2.3	1.8	3.1	3.6
Depreciation	15.0	6.4	6.0	5.2	3.9

Seadrill Ltd. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
Lease asset	58.2	41.1	43.9	33.2	26.4
Lease liability	58.2	41.1	43.9	33.2	26.4
Interest expense	3.0	3.0	2.8	2.3	3.8
Depreciation	21.0	20.0	14.2	16.7	12.2

Pacific Drilling S.A. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
Lease asset	16.5	13.7	10.8	7.8	8.8
Lease liability	16.5	13.7	10.8	7.8	8.8
Interest expense	0.8	0.9	1.1	1.4	1.9
Depreciation	3.7	2.1	1.4	1.0	(0.3)

Transocean Ltd. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
Lease asset	103.6	93.4	69.8	68.9	127.1
Lease liability	103.6	93.4	69.8	68.9	127.1
Interest expense	4.6	4.5	3.6	5.1	10.1
Depreciation	90.4	67.5	41.4	46.9	24.9

Valaris Plc. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
Lease asset	171.6	122.5	108.0	70.4	64.3
Lease liability	171.6	122.5	108.0	70.4	64.3
Interest expense	7.5	5.9	5.5	5.8	9.1
Depreciation	46.9	45.0	34.2	31.2	31.0

Diamond Offshore Drilling Inc. *(USDm)*	**FY14 Act**	**FY15 Act**	**FY16 Act**	**FY17 Act**	**FY18 Act**
Lease asset	3.3	4.1	2.3	2.3	2.8
Lease liability	3.3	4.1	2.3	2.3	2.8
Interest expense	0.1	0.2	0.1	0.1	0.2
Depreciation	10.5	7.6	5.4	3.8	2.9

Appendix 11a: Awilco Drilling PLC's analytical financial statements, FY15-FY19

Awilco Drilling PLC (USD in millions)	FY15 Act	FY16 Act	FY17 Act	FY18 Act	FY19 Act
Revenue	247.0	72.5	131.7	56.5	38.1
Operating costs	(87.8)	(36.6)	(27.8)	(27.3)	(24.8)
Gross profit	**159.3**	**35.9**	**103.9**	**29.3**	**13.4**
SG&A costs	(8.6)	(8.9)	(8.8)	(8.8)	(9.2)
EBITDA	**151**	**27**	**95**	**20**	**4**
Depreciation and amortisation	(18.3)	(15.8)	(15.9)	(13.7)	(11.6)
EBIT	**132**	**11**	**79**	**7**	**(7)**
Impairment losses/reversals	(30)	-	(90)	(25)	(23)
Tax, operating activities	(10)	5	0	(1)	(0)
NOPAT	**92**	**17**	**(11)**	**(20)**	**(31)**
Net financials	21	(10)	40	(3)	0
Tax, net financials	(2)	(5)	(1)	(0)	0
Net financials, after tax	**19**	**(14)**	**39**	**(3)**	**0**
Net income	**111.0**	**2.3**	**28.2**	**(22.9)**	**(30.6)**
Effective tax rate	**(10%)**	**48%**	**(2%)**	**8%**	**1%**
Check to reported figures	**-**	**0.000**	**-**	**-**	**-**

Awilco Drilling PLC (USD in millions)	31 Dec 15 Act	31 Dec 16 Act	31 Dec 17 Act	31 Dec 18 Act	31 Dec 19 Act
Operating assets					
PP&E	234	239	179	187	203
Right-of-use assets	4	4	2	2	-
Deferred tax	2	3	1	0	0
Inventories	5	5	5	5	5
Operating cash	1	0	1	0	0
Current tax	69	22	4	0	-
Trade receiavbles	10	24	24	12	9
Total operating assets	**325**	**298**	**215**	**207**	**218**
Operating liabilities					
Deferred taxes	-	(1)	-	-	-
Accounts payable	(6)	(1)	(1)	(6)	(1)
Other current liabilities, operating	(94)	(33)	(8)	(0)	(7)
Total operating liabilities	**(100)**	**(35)**	**(9)**	**(6)**	**(8)**
Invested capital	**225**	**263**	**206**	**200**	**210**
Total equity	**244**	**227**	**231**	**261**	**251**
Long term debt	100	90	80	-	-
Lease liabilities	4	4	2	2	-
Other long-term liabilities, financing	-	-	0	0	-
Short term debt	10	10	10	-	-
Other current liabilities, financing	2	2	1	-	-
Interest bearing liabilities	**116**	**105**	**93**	**2**	**-**
Cash and cash equivalents	(135)	(70)	(119)	(64)	(41)
Interest bearing assets	**(135)**	**(70)**	**(119)**	**(64)**	**(41)**
Net debt	**(19)**	**36**	**(25)**	**(61)**	**(41)**
Invested capital	**225**	**263**	**206**	**200**	**210**
Check to reported figures	**-**	**-**	**-**	**-**	**-**

Appendix 11b: Noble Corporation Ltd.'s analytical financial statements, FY15-FY19

Noble Corporation Ltd. (USD in millions)	FY15 Act	FY16 Act	FY17 Act	FY18 Act	FY19 Act
Revenue	3,352	2,302	1,237	1,083	1,305
Operating costs	(1,294)	(915)	(653)	(660)	(747)
Gross profit	**2,058**	**1,387**	**584**	**423**	**558**
SG&A costs	(77)	(69)	(72)	(73)	(169)
EBITDA	**1,981**	**1,317**	**512**	**350**	**389**
Depreciation and Amortisation	(641)	(617)	(553)	(490)	(440)
EBIT	**1,341**	**700**	**(41)**	**(140)**	**(51)**
Impairment losses/reversals	(418)	(1,459)	(122)	(802)	(615)
Tax, operating activities	(198)	86	(16)	81	25
NOPAT	**724**	**(673)**	**(179)**	**(861)**	**(641)**
Net financials	(180)	(209)	(287)	(295)	(243)
Tax, net financials	39	24	(28)	25	9
Net financials, after tax	**(141.3)**	**(185.1)**	**(315.4)**	**(269.3)**	**(233.5)**
Minority interest	**(72.2)**	**(71.7)**	**(22.6)**	**245.5**	**173.8**
Net income	**511.0**	**(929.6)**	**(516.5)**	**(885.1)**	**(700.6)**
Effective tax rate	**(21%)**	**(11%)**	**10%**	**(9%)**	**(4%)**
Check to reported figures	**-**	**-**	**-**	**-**	**-**

Noble Corporation Ltd. (USD in millions)	31 Dec 15 Act	31 Dec 16 Act	31 Dec 17 Act	31 Dec 18 Act	31 Dec 19 Act
Operating assets					
PP&E	11,484	10,062	9,489	8,481	7,767
Right-of-use assets	45	33	34	25	-
Other non-current assets	141	186	266	125	85
Trade receivables	499	319	205	201	280
Operating cash	3	4	3	2	1
Tax receivable	56	55	105	20	-
Other current assets, operating	174	92	66	63	36
Total operating assets	**12,401**	**10,751**	**10,169**	**8,917**	**8,170**
Operating liabilities					
Deferred taxes	(93)	(2)	(165)	(92)	(68)
Deferred income	-	-	-	-	(31)
Tax payable	(88)	(47)	(34)	(29)	(31)
Accrued expenses	(81)	(48)	(55)	(50)	(56)
Accounts payable	(223)	(108)	(84)	(126)	(108)
Other current liabilities, operating	(98)	(69)	(72)	(60)	(171)
Total operating liabilities	**(583)**	**(274)**	**(410)**	**(357)**	**(465)**
Invested capital	**11,818**	**10,477**	**9,759**	**8,560**	**7,704**
Total equity	**7,422**	**6,467**	**5,951**	**4,655**	**3,659**
Long term debt	4,163	4,040	3,796	3,877	3,779
Lease liabilities	45	33	34	25	-
Other long-term liabilities, financing	324	297	290	276	230
Short-term debt	300	300	250	-	63
Other current liabilities, financing	73	61	98	100	88
Interest bearing liabilities	**4,905**	**4,731**	**4,468**	**4,279**	**4,160**
Cash and cash equivalents	(510)	(722)	(660)	(373)	(105)
Intercompany receivables	-	-	-	-	(10)
Interest bearing assets	**(510)**	**(722)**	**(660)**	**(373)**	**(115)**
Net debt	**4,396**	**4,009**	**3,808**	**3,905**	**4,045**
Invested capital	**11,818**	**10,477**	**9,759**	**8,560**	**7,704**
Check to reported figures	**-**	**-**	**-**	**-**	**-**

Appendix 11c: Seadrill Ltd.'s analytical financial statements, FY15-FY19

Seadrill Ltd. **(USD in millions)**	**FY15** **Act**	**FY16** **Act**	**FY17** **Act**	**FY18** **Act**	**FY19** **Act**
Revenue	4,335	3,169	2,088	1,253	1,388
Operating costs	(1,687)	(1,059)	(808)	(792)	(1,032)
Gross profit	**2,648**	**2,110**	**1,280**	**461**	**356**
SG&A costs	(248)	(234)	(277)	(162)	(130)
Other operating income (expense)	47	21	27	28	39
Profit (loss) from unconsolidated subsidiaries	192	283	174	59	(115)
EBITDA	**2,639**	**2,180**	**1,204**	**386**	**150**
Depreciation and Amortisation	(799)	(824)	(815)	(697)	(560)
EBIT	**1,840**	**1,356**	**389**	**(311)**	**(410)**
Restructuring costs	-	-	(1,337)	(3,374)	-
Gain/loss on disposal of assets	(41)	-	(245)	-	-
Impairment losses/reversals	(1,848)	(939)	(1,537)	(414)	(302)
Tax, operating activities	(24)	(1,885)	(59)	(35)	22
NOPAT	**(73)**	**(1,468)**	**(2,789)**	**(4,134)**	**(690)**
Net financials	(378)	(373)	(306)	(353)	(549)
Tax, net financials	(184)	1,686	(7)	(3)	17
Net financials, after tax	**(562.1)**	**1,313.4**	**(313.0)**	**(355.8)**	**(532.0)**
Minority interest	**1.0**	**(26.0)**	**129.0**	**7.0**	**3.0**
Net income	**(634.0)**	**(181.0)**	**(2,973.0)**	**(4,483.0)**	**(1,219.0)**
Effective tax rate	**49%**	**(452%)**	**2%**	**1%**	**(3%)**
Check to reported figures	**-**	**-**	**-**	**-**	**-**

Seadrill Ltd. **(USD in millions)**	**31 Dec 15** **Act**	**31 Dec 16** **Act**	**31 Dec 17** **Act**	**31 Dec 18** **Act**	**31 Dec 19** **Act**
Operating assets					
PP&E	16,455	15,848	13,493	6,688	6,424
Right-of-use assets	41	44	33	26	-
Subsidiaries	2,592	2,168	1,473	800	389
Deferred taxes	81	96	85	18	4
Other non-current assets	331	145	132	36	59
Operating cash	8	8	7	10	6
Trade receivables	718	462	295	208	173
Other current assets, operating	395	495	233	272	158
Total operating assets	**20,621**	**19,266**	**15,752**	**8,059**	**7,213**
Operating liabilities					
Deferred taxes	(136)	(112)	(107)	(87)	(12)
Accounts payable	(141)	(93)	(72)	(82)	(86)
Other current liabilities, operating	(1,560)	(1,352)	(268)	(310)	(322)
Total operating liabilities	**(1,837)**	**(1,557)**	**(447)**	**(479)**	**(420)**
Invested capital	**18,784.0**	**17,708.7**	**15,304.6**	**7,579.7**	**6,793.3**
Total equity	**10,068**	**10,063**	**6,959**	**3,073**	**1,850**
Long term debt	9,054	6,319	485	6,881	6,280
Intercompany debt	590	413	324	261	258
Lease liabilities	41	44	33	26	-
Liabilitites subject to compromise	-	-	9,191	-	-
Other long-term liabilities, financing	401	119	67	121	128
Short-term debt	1,489	3,195	509	33	343
Interest bearing liabilities	**11,575**	**10,090**	**10,609**	**7,322**	**7,009**
Cash and cash equivalents	(1,575)	(1,545)	(1,476)	(2,050)	(1,255)
Assets held for sale	(128)	-	-	-	-
Other current assets, financing	-	-	(24)	(50)	-
Intercompany receivables	(1,156)	(899)	(764)	(716)	(811)
Interest bearing assets	**(2,859)**	**(2,444)**	**(2,264)**	**(2,816)**	**(2,066)**
Net debt	**8,716**	**7,646**	**8,346**	**4,507**	**4,943**
Invested capital	**18,784**	**17,709**	**15,305**	**7,580**	**6,793**
Check to reported figures	**-**	**-**	**-**	**-**	**-**

Appendix 11d: Pacific Drilling Ltd.'s analytical financial statements, FY15-FY19

Pacific Drilling Ltd. (USD in millions)	FY15 Act	FY16 Act	FY17 Act	FY18 Act	FY19 Act
Revenue	1,085	769	320	265	230
Operating costs	(402)	(274)	(230)	(194)	(226)
Gross profit	**683**	**496**	**90**	**71**	**3**
SG&A costs	(56)	(63)	(87)	(55)	(38)
Other operating income (expense)	(43)	(2)	(36)	(3)	(1)
Profit (loss) from unconsolidated subsidiaries	-	-	-	0	(220)
EBITDA	**584**	**430**	**(34)**	**14**	**(256)**
Depreciation and amortisation	(271)	(291)	(292)	(289)	(195)
EBIT	**312.4**	**138.9**	**(325.4)**	**(275.1)**	**(450.7)**
Restructuring costs	-	-	(6)	(1,801)	(2)
Tax, operating activities	(58)	204	(8)	9	(10)
NOPAT	**254**	**343**	**(340)**	**(2,068)**	**(463)**
Net financials	(157)	(154)	(180)	(115)	(91)
Tax, net financials	29	(226)	(5)	0	(2)
Net financials, after tax	**(186.2)**	**(176.0)**	**(199.7)**	**(1,907.2)**	**(105.8)**
Net income	**126.2**	**(37.2)**	**(525.2)**	**(2,182.4)**	**(556.5)**
Effective tax rate	**(19%)**	**147%**	**3%**	**(0%)**	**2%**
Check to reported figures	**-**	**0.0000**	**-**	**-**	**-**

Pacific Drilling Ltd. (USD in millions)	31 Dec 15 Act	31 Dec 16 Act	31 Dec 17 Act	31 Dec 18 Act	31 Dec 19 Act
Operating assets					
Intangible assets	-	-	-	85	-
Tangible assets	5,157	4,921	4,660	1,924	1,843
Subsidaries	-	-	-	12	-
Other non-current assets, operating	39	45	33	24	23
Trade receivables	168	95	41	41	29
Operating cash	1	3	2	2	1
Inventories	98	96	87	40	44
Other current assets, operating	25	24	30	37	33
Total operating assets	**5,488**	**5,183**	**4,852**	**2,165**	**1,973**
Operating liabilities					
Deferred revenue	(61)	(32)	(13)	-	-
Accounts payable	(44)	(18)	(12)	(15)	(24)
Other current liabilities, operating	(101)	(92)	(60)	(26)	(35)
Total operating liabilities	**(206)**	**(142)**	**(85)**	**(41)**	**(60)**
Invested capital	**5,282.6**	**5,041.6**	**4,767.3**	**2,124.4**	**1,913.6**
Total equity	**2,692.1**	**2,666.2**	**2,151.8**	**1,619.0**	**1,068.8**
Long term debt	2,769	2,649	-	1,039	1,074
Lease liabilities	14	11	8	9	-
Intercompany debt	-	-	-	4	-
Liabilities subject to compromise	-	-	3,088	-	-
Other long term liabilitites, financing	33	31	32	28	39
Short term debt	77	497	-	-	-
Accrued interest	16	14	6	17	16
Interest bearing liabilities	**2,909**	**3,201**	**3,134**	**1,097**	**1,128**
Cash and cash equivalents	(115)	(623)	(316)	(387)	(283)
Intercompany receivables	(203)	(203)	(203)	(205)	-
Interest bearing assets	**(318)**	**(826)**	**(518)**	**(592)**	**(283)**
Net debt	**2,591**	**2,375**	**2,615**	**505**	**845**
Invested capital	**5,282.6**	**5,041.6**	**4,767.3**	**2,124.4**	**1,913.6**
Check to reported figures	**-**	**-**	**-**	**-**	**-**

Appendix 11e: Transocean Ltd.'s analytical financial statements, FY15-FY19

Transocean Ltd. (USD in millions)	FY15 Act	FY16 Act	FY17 Act	FY18 Act	FY19 Act
Revenue	7,386	4,161	2,973	3,018	3,088
Operating costs	(2,883)	(1,830)	(1,336)	(1,764)	(1,953)
Gross profit	**4,503**	**2,331**	**1,637**	**1,254**	**1,135**
SG&A costs	(192)	(172)	(156)	(188)	(193)
EBITDA	**4,311.0**	**2,159.0**	**1,481.0**	**1,066.0**	**942.0**
Depreciation and amortisation	(1,030)	(934)	(879)	(843)	(1,042)
EBIT	**3,280.5**	**1,224.6**	**602.1**	**223.1**	**(100.0)**
Gain/loss on disposal of assets	(36)	4	(1,603)	-	(12)
Impairment losses/reversals	(1,875)	(93)	(1,498)	(1,464)	(609)
Tax, operating activities	(162)	(130)	(78)	(159)	(36)
NOPAT	**1,208**	**1,005**	**(2,577)**	**(1,400)**	**(757)**
Net financials	(355)	(202)	(504)	(534)	(477)
Tax, net financials	42	23	(16)	(69)	(23)
Net financials, after tax	**(312.6)**	**(178.5)**	**(519.9)**	**(602.7)**	**(500.5)**
Minority interest	(35)	(49)	(30)	7	2
Net income	**860.0**	**778.0**	**(3,127.0)**	**(1,996.0)**	**(1,255.0)**
Effective tax rate	**(12%)**	**(11%)**	**3%**	**13%**	**5%**
Check to reported figures	-	-	-	-	-

Transocean Ltd. (USD in millions)	31 Dec 15 Act	31 Dec 16 Act	31 Dec 17 Act	31 Dec 18 Act	31 Dec 19 Act
Operating assets					
Intangible Assets	-	-	-	795	608
Tangible assets	20,818	21,093	17,402	20,408	18,847
Right-of-use assets	93	70	69	127	-
Other tangible assets, operating	410	400	355	448	990
Deferred taxes	316	298	47	66	20
Trade receivables	1,379	898	641	604	654
Operating cash	13	18	17	14	12
Inventories	635	561	418	474	479
Other current assets, operating	92	121	112	159	158
Total operating assets	**23,757**	**23,458**	**19,061**	**23,095**	**21,768**
Operating liabilities					
Deferred taxes	(339)	(178)	(44)	(64)	(266)
Deferred income	(161)	(390)	(422)	(531)	(429)
Accounts payable	(448)	(206)	(201)	(269)	(311)
Accrued income taxes	(82)	(95)	(79)	(70)	(64)
Other current liabilities, operating	(608)	(625)	(536)	(380)	(405)
Total operating liabilities	**(1,638)**	**(1,494)**	**(1,282)**	**(1,314)**	**(1,475)**
Invested capital	**22,118.8**	**21,964.4**	**17,779.1**	**21,780.6**	**20,292.7**
Total equity	**14,816.0**	**15,833.0**	**12,769.0**	**13,114.0**	**11,867.0**
Long term debt	7,397	7,740	7,146	9,605	9,137
Lease liabilities	93	70	69	127	-
Pension obligations	379	370	353	355	346
Other liabilities, financing	568	393	307	538	336
Short term debt	1,093	724	250	373	568
Other current liabilities, financing	438	335	303	366	376
Interest bearing liabilities	**9,968**	**9,632**	**8,428**	**11,364**	**10,763**
Cash and cash equivalents	(2,666)	(3,500)	(3,418)	(2,697)	(2,337)
Interest bearing assets	**(2,666)**	**(3,500)**	**(3,418)**	**(2,697)**	**(2,337)**
Net debt	**7,303**	**6,131**	**5,010**	**8,667**	**8,426**
Invested capital	**22,118.8**	**21,964.4**	**17,779.1**	**21,780.6**	**20,292.7**
Check to reported figures	-	-	-	-	-

Appendix 11f: Valaris PLC's analytical financial statements, FY15-FY19:

Valaris PLC (USD in millions)	FY15 Act	FY16 Act	FY17 Act	FY18 Act	FY19 Act
Revenue	4,063	2,776	1,843	1,705	2,053
Operating costs	(1,819)	(1,261)	(1,153)	(1,279)	(1,806)
Gross profit	**2,245**	**1,515**	**691**	**426**	**247**
SG&A costs	(118)	(101)	(158)	(103)	(189)
Share of results in joint ventures	-	-	-	-	(13)
EBITDA	**2,126.3**	**1,414.3**	**532.7**	**323.4**	**45.7**
Depreciation and amortisation	(617)	(479)	(476)	(510)	(610)
EBIT	**1,508.8**	**934.8**	**56.7**	**(186.5)**	**(564.0)**
Impairment losses/reversals	(2,746)	-	(183)	(40)	(104)
Special items	-	-	-	-	-
Tax, operating activities	12	(102)	(70)	(38)	(1,344)
NOPAT	**(1,226)**	**833**	**(197)**	**(264)**	**(2,012)**
Net financials	(234)	63	(70)	(312)	604
Tax, net financials	2	(7)	(39)	(52)	1,216
Net financials, after tax	**(231.4)**	**55.8**	**(108.6)**	**(364.0)**	**1,820.2**
Minority interest	(9)	(7)	1	(3)	(6)
Net income	**(1,466.1)**	**882.1**	**(304.7)**	**(631.6)**	**(198.0)**
Effective tax rate	**(1%)**	**(11%)**	**56%**	**17%**	**201%**
Check to reported figures	**-**	**-**	**-**	**-**	**-**

Valaris PLC (USD in millions)	31 Dec 15 Act	31 Dec 16 Act	31 Dec 17 Act	31 Dec 18 Act	31 Dec 19 Act
Operating assets					
PP&E	11088	10919	12874	12616	15097
Right-of-use assets	122	108	70.43	64.27	0.00
Investment in joint venture	-	-	-	-	317
Other non-current assets, operating	238	176	140	98	-
Inventories	235	225	279	268	340
Trade receivables	582	361	345	349	524
Operating cash	7	13	4	3	1
Prepaid expenses	94	39	58	50	50
Other current assets, operating	69	48	38	38	48
Total operating assets	**12,435**	**11,889**	**13,809**	**13,486**	**16,376**
Operating liabilities					
Accounts payable	(225)	(146)	(433)	(211)	(288)
Accrued payroll	(140)	(111)	(112)	(72)	(134)
Income taxes payable	(88)	(41)	(46)	(37)	(61)
Other current liabilities, operating	(301)	(212)	(168)	(199)	(222)
Other long-term liabilities, operating	(300)	(181)	(209)	(219)	(867)
Total operating liabilities	**(1,053)**	**(690)**	**(967)**	**(737)**	**(1,573)**
Invested capital	**11,381.6**	**11,198.8**	**12,841.8**	**12,749.7**	**14,802.8**
Total equity	**6,517.2**	**8,255.0**	**8,730.0**	**8,088.8**	**9,309.6**
Long term debt	5,869	4,943	4,751	5,010	5,924
Lease liabilities	122	108	70	64	-
Other long-term liabilities, financing	150	142	178	177	-
Short term debt	-	332	-	-	125
Other current liabilties, financing	22	13	0	11	-
Interest bearing liabilities	**6,162**	**5,537**	**5,000**	**5,263**	**6,048**
Cash and cash equivalents	(1,298)	(2,593)	(888)	(602)	(102)
Intercompany receivables	-	-	-	-	(453)
Interest bearing assets	**(1,298)**	**(2,593)**	**(888)**	**(602)**	**(555)**
Net debt	**4,864**	**2,944**	**4,112**	**4,661**	**5,493**
Invested capital	**11,381.6**	**11,198.8**	**12,841.8**	**12,749.7**	**14,802.8**
Check to reported figures	**-**	**-**	**-**	**-**	**-**

Appendix 11g: Diamond Offshore's analytical financial statements, FY15-FY19:

Diamond Offshore Drilling (USD in millions)	FY15 Act	FY16 Act	FY17 Act	FY18 Act	FY19 Act
Revenue	2,419	1,600	1,486	1,083	981
Operating costs	(1,345)	(888)	(906)	(828)	(906)
Gross profit	**1,075**	**712**	**579**	**255**	**74**
SG&A costs	-	-	-	-	-
EBITDA	**1,074.8**	**712.3**	**579.4**	**255.2**	**74.3**
Depreciation and amortisation	(501)	(387)	(352)	(335)	(356)
EBIT	**574.1**	**325.2**	**227.0**	**(79.5)**	**(281.3)**
Gain/loss on disposal of assets	2	(4)	11	(0)	(1)
Impairment losses/reversals	(860)	(678)	(99)	(27)	-
Special items	(10)	-	(14)	(5)	-
Tax, operating activities	83	73	(230)	23	31
NOPAT	**(211)**	**(284)**	**(106)**	**(89)**	**(251)**
Net financials	(87)	(112)	(145)	(115)	(120)
Tax, net financials	25	23	270	23	13
Net financials, after tax	**(62.9)**	**(88.7)**	**124.5**	**(91.2)**	**(106.3)**
Net income	**(274.3)**	**(372.5)**	**18.3**	**(180.3)**	**(357.2)**
Effective tax rate	**(28%)**	**(20%)**	**(186%)**	**(20%)**	**(11%)**
Check to reported figures	**-**	**-**	**0.000**	**-**	**-**

Diamond Offshore Drilling (USD in millions)	31 Dec 15 Act	31 Dec 16 Act	31 Dec 17 Act	31 Dec 18 Act	31 Dec 19 Act
Operating assets					
Tangible assets	6,379	5,727	5,262	5,184	5,153
Right-of-use assets	4	2	2	3	-
Other non-current assets, operating	101	139	102	66	204
Operating cash	1	1	2	2	1
Trade receivables	405	247	257	169	251
Prepaid expenses	119	102	158	163	69
Total operating assets	**7,010**	**6,218**	**5,782**	**5,587**	**5,678**
Operating liabilities					
Deferred taxes	(277)	(197)	(167)	(104)	(48)
Accounts payable	(70)	(30)	(39)	(44)	(69)
Income taxes payable	(15)	(24)	(30)	(21)	(23)
Accrued liabilities	(235)	(164)	(126)	(144)	(183)
Other liabilities, operating	(155)	(103)	(113)	(136)	(276)
Total operating liabilities	**(752)**	**(518)**	**(476)**	**(449)**	**(598)**
Invested capital	**6,257.6**	**5,700.0**	**5,306.6**	**5,138.0**	**5,079.7**
Total equity	**4,112.8**	**3,750.1**	**3,774.3**	**3,584.7**	**3,232.2**
Long term debt	1,980	1,981	1,972	1,974	1,976
Lease liabilities	4	2	2	3	
Short term debt	287	104	-	-	-
Other Liabilities, financing	18	18	28	28	28
Interest bearing liabilities	**2,289**	**2,106**	**2,003**	**2,005**	**2,004**
Cash and cash equivalents	(130)	(155)	(374)	(452)	(155)
Assets held for sale	(14)	(0)	(96)	-	(1)
Interest bearing assets	**(144)**	**(156)**	**(470)**	**(452)**	**(156)**
Net debt	**2,145**	**1,950**	**1,532**	**1,553**	**1,847**
Invested capital	**6,257.6**	**5,700.0**	**5,306.6**	**5,138.0**	**5,079.7**
Check to reported figures	**-**	**-**	**-**	**-**	**-**

Appendix 12a: Correlation

Cross-correlation is often just referred to as correlation, and it measures the degree to which two variables move in relation to each other. Serial-correlation, on the other hand, is often referred to as autocorrelation, and it measures the degree of similarity between a given time series and a lagged version of itself over previous time intervals (Newbold et al., 2013). Ignoring the effect of serial or cross-correlation may result in a deceptive volatility estimate, which later causes the ROV to be under or overvalued. This issue is also addressed by Copeland and Antikarov (2001), who highlights the importance of incorporating the correlation between the uncertain variables into the simulated volatility estimate. Further investigation has been conducted by Cobb and Charnes (2004), who examines the effect of serial and cross-correlation on the simulated volatility. The results show, that positive serial correlations will increase the volatility and thus the project value, while negative serial correlations tend to decrease the volatility and decrease the project value. Intuitively, this transpires since large deviations from the expected level tend to be followed by large deviations in the same direction. For negative serial correlations, the adjustment will be towards the expected level, thus leading to more stable cashflows.

For cross-correlation Cobb and Charnes (2004) examines the price-demand correlation coefficient, which is highly relevant to the case of this thesis, since the identified key risk drivers comprise of price (day rate) and demand (utilisation). Cobb and Charnes (2004) find that larger negative correlation coefficients lead to stable cash flows and thereby less volatility. For larger positive correlation coefficients, volatility will increase, but the outturn on cash flow will depend on the configuration of prices and demand. If prices increase and demand is high the cash flow will increase tremendously, but if prices decrease and demand is low, the cash flow will decrease dramatically. Correlation coefficients close to zero represent a demand, which is inelastic (Cobb and Charnes, 2004)

Now that we've established the need and relevance for incorporating correlation into the simulated volatility estimate, we must determine the cross and serial-correlation for the identified key risk drivers. This is done in the next part.

Appendix 12b: Cross and serial-correlation:

The cross-correlation between the forecasted day rates and demand is estimated using the Pearson *r* correlation (Newbold, 2013, p. 84).

$$r_{xy} = \frac{Cov(x,y)}{\sigma_x * \sigma_y} = \frac{-0.03}{0.04 * 1.07} = -0.603$$

Using the formula above, the correlation coefficient amounts to -0.637, which indicates a clear negative correlation between the historical day rates and demand. The negative relationship between price and demand indicates, that the demand is elastic, thus an increase in day rates will lead to less demand. To test the significance of the estimated correlation coefficient, we conduct a two-tailed t-test using a 5%-significance level (Barrow, 2013, p. 255)

$$t = \frac{r_{xy}\sqrt{n-2}}{\sqrt{1-r_{xy}^2}} = \frac{-0.6\sqrt{5-2}}{\sqrt{1-0.6^2}} = -1.31$$

The test yields a p-value and critical value of 28% and -1.31, respectively. As a result, the null hypothesis cannot be rejected, and the estimated correlation coefficient is therefore not statically significant. Consequently, the correlation between the forecasted day rates and demand will not be incorporated in the simulated volatility estimate.

As previously stated, the simulated volatility estimate must not only be adjusted for cross-correlation but also serial-correlation. To determine the serial-correlation of both the day rates and demand, we use the following formula (Barrow, 2013, p. 434):

$$r_{xx} = \frac{Cov(x_t, x_{t+1})}{\sigma_{x_t}}$$

Applying this formula to the forecasted day rates and demand of the UHE, yields serial correlations of 0.75 and 0.02 respectively. To test the significance of the serial-correlation, we use a Durbin-Watson (DW) statistic with a 5%-significance level. The DW statistic is a one-tail test of the null hypothesis of no serial-correlation against the alternative of positive and negative serial correlation. The test statistic is determined using the formula below (Barrow, 2013, p. 434):

$$DW = \frac{\sum_{t=2}^{n}(e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$$

The DW test statistics amounted to 2.58 and 1.94 for the day rate and demand, respectively. Based on the upper and lower limit, the serial-correlation of both variables were statistically insignificant. Based on these findings, the serial-correlation of either variable will be incorporated in the simulated volatility estimate. The table below displays the summary of the DW test statistic:

Variables	Covariance	Variance	Serial Correlation	Durbin-Watson	Lower limit	Upper limit	4-Lower limit	4-Upper limit	Results
Day rate, UHE	0.001	0.002	0.75	2.58	0.39	1.14	2.86	3.61	Insignificant
Demand, UHE	0.025	1.143	0.02	1.94	0.39	1.14	2.86	3.61	Insignificant