Hanne Hegard and Kristine Lerberg Nystad

Optimal WACC calculation for Kongsberg Gruppen ASA

Systematic review of Kongsberg Gruppen ASA`s WACC calculation

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ABSTRACT

The purpose of the thesis is to obtain the best possible estimate of the Weighted Average Cost of Capital (WACC) for Kongsberg Gruppen ASA. The desired outcome is an estimate that is as reliable as possible, future-oriented, but is also a practically applicable estimate. The thesis addresses and sheds light on the underlying factors that have an impact on the calculation.

The main topic is how to calculate the Cost of Equity for Kongsberg Gruppen ASA. The following factor models were examined: CAPM, Fama-French Three-Factor model, Carhart Four Factor model, and Fama-French Five-Factor model.

We recommend Kongsberg Gruppen ASA to use CAPM as their method for calculating the Cost of Equity. Within the CAPM we propose using Damodaran's Bottom-up beta. The Risk-free rate should be the Yield to Maturity calculated based on Norwegian Government Bonds, and for the Equity Risk Premium, we recommend calculating the Implied Equity Premium. In the Cost of Debt part in our WACC calculation, we recommend Kongsberg Gruppen ASA to continue using 3-month NIBOR + 10-year credit spread as their pre-tax Cost of Debt. Our conclusion is quite similar to Kongsberg Gruppen ASA calculation methods. However, we believe we managed to further develop these calculations and adjusted them to produce more forward-looking and precise estimates. Using these calculations, Kongsberg Gruppen ASA's WACC for 2021 is 5,80%.

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CHAPTER ONE – INTRODUCTION

In this chapter, we give a short introduction to the WACC and Kongsberg Gruppen ASA.

1.1 SHORT INTRODUCTION

WACC has been told to be the most used and criticized finance measure of all time. Over the years academics have tried to revolutionize WACC with their calculation methods, and yet there is no overall agreement on the right calculation method surrounding WACC. The methods promise better results and estimates than the previous methods, still, they all seem to come with their disadvantages. Despite the arrival of new methods, companies seem reluctant to toss the good old method CAPM. Notwithstanding, companies such as Kongsberg Gruppen ASA are still dedicated to discovering new developments in WACC. This shaped our research question to the following:

"Consider the use of different calculation methods for WACC, and their weaknesses/strengths to obtain the best possible estimate for Kongsberg Gruppen ASA"

Kongsberg Gruppen ASA's WACC calculation was already highly updated with the academic theory and customized to practice, as they have used the calculation methods of Aswath Damodaran. He is a central academic in corporate finance and valuation and gave WACC its nickname "The swiss army knife of finance", due to its many uses. We have also used Aswath Damodaran as our main source throughout this thesis Damodaran (2002), (2016), (2019), (2020) as he is an academic that is highly updated within the field, and regularly updates his methods and estimates.

Some methods and approaches struggle with their backward-looking estimate by using historical data. We try to change the historical approached to get a more forward-looking estimate. This is done by assessing CAPM with Time-series, different Fama-French Factor-Models, and changing the different components in the WACC formula with more updated methods. This thesis is written for Kongsberg Gruppen ASA and has a practical approach with their wishes and needs in mind. Due to the practical nature of this thesis, we were not able to examine each topic in depth. Instead, we present an overall insight into how the Kongsberg Group ASA can calculate their optimal WACC.

1.2 SHORT INTRODUCTION OF KONGSBERG GRUPPEN ASA

Kongsberg Gruppen ASA is a leading global technology corporation delivering mission-critical solutions with extreme performance for customers that operate under extremely challenging conditions. They work across several sectors: deep-sea, digital, defence, merchant marine, oil and gas, fisheries, aerospace and space industry. Kongsberg Gruppen ASA operate in three divisions: Kongsberg Maritime, Kongsberg Defence & Aerospace and Kongsberg Digital. Kongsberg Gruppen ASA was listed on the Oslo Stock Exchange in 1993. The Norwegian Government owns 50,001% of the shares, Folketrygdfondet owns 7,37%, and the rest is privately owned (Kongsberg Gruppen ASA, 2021).

1.3 STRUCTURE

The remaining of the thesis is as follows:

CHAPTER TWO – LITERATURE REVIEW

This chapter introduces the relevant theory. The sections in this chapter consist of Cost of Equity, Cost of Debt and Capital Structure. You will find the different approaches to calculate Cost of Equity and Cost of Debt under these sections.

CHAPTER THREE – KONGSBERG GRUPPEN ASA'S WACC

Chapter three review Kongsberg Gruppen ASA's WACC calculation.

CHAPTER FOUR – WACC CALCULATIONS

In chapter four, the implementation of the different calculation methods for the Cost of Equity and the Cost of Debt will be presented.

CHAPTER FIVE – EMPIRICAL ANALYSIS

This chapter focus on testing and interpretating the empirical results of Bottom-up beta, Time-series beta and the Factor Models.

CHAPTER SIX – DISCUSSION

In this chapter, the complete WACC calculation will be presented and compared with Kongsberg Gruppen ASA. The recommendation of the optimal WACC calculation, based upon results and best practice, are introduced.

CHAPTER SEVEN – CONCLUSION

Chapter seven conclude with the recommendation for the optimal WACC calculation for Kongsberg Gruppen ASA.

CHAPTER TWO – LITERATURE REVIEW

This chapter presents the relevant theory for this thesis. The main sections are the Cost of Equity, Cost of Debt and Capital Structure. The Cost of Equity addresses CAPM and different factor models. In the Cost of Debt and Capital Structure section we review their relevant theory.

2.1 WACC

The WACC formula goes as follows:

$$WACC = Cost\ of\ equity * \frac{Equity}{Equity + Debt} + Cost\ of\ debt * (1 - t)\ \frac{Debt}{Debt\ +\ Equity}$$

Formula 1 – WACC

WACC is used in corporate finance, as a hurdle rate on investments, an optimizing tool for capital structure, and divination for dividends. In valuation, it is used as a discount rate in discounted cash flow valuation and as a control variable when we are pricing an asset. While the calculation is widely used, there is still no definitive answer on how to calculate WACC.

2.2 COST OF EQUITY

There are various ways to calculate the Cost of Equity. Kongsberg Gruppen ASA uses the most popular choice which is The Capital Asset Pricing Model (CAPM). However, there are other models out there like; Fama-French Three-Factor Model, Carhart Four-Factor Model and Fama-French Five-Factor Model. Moving on we will discuss these models, their advantages and disadvantages, their different approaches, and try to find the "best practice" for Kongsberg Gruppen ASA.

2.2.1 THE CAPITAL ASSET PRICING MODEL (CAPM)

The Capital Asset Pricing Model was constructed through numerous papers by William Sharpe, John Litner, Jan Mossin, and Jack Treynor in the 1960s. Using CAPM to estimate the Cost of Equity is a well-known practice. In fact, according to a survey performed by Brotherson, Eades, Harris, and Higgins (2015), only 1 of the 309 respondents used a different model than CAPM. It seems like many companies use CAPM due to the simplicity of the model, which is an advantage in practice. The model has been with us for decades, and over time has become a "habit" to use for companies.

Graham & Harvey (2001) performed a similar survey as Brotherson, Eades, Harris and, Higgins (2015), where they discussed why CFOs used a 50-year-old model. They figured there must be more to the choice since more complex and sophisticated models had surfaced by 2001. Why would highly experience individuals in finance still use the much-criticized CAPM? Explanations might be amongst the line that the CAPM is easy to use, and/or the CFOs might not believe that other, more sophisticated models, perform better than the CAPM.

Even though CAPM is considered a simple calculation at first sight, the approach is widely discussed and criticized. Even though CAPM produces relatively high R^2, its underlying assumptions question the validity of the model. It is questioned to which extent these assumptions meet the reality of the real world. The eight underlying assumptions go as following according to Pratt & Grabowski (2008, pp. 86-87):

1. Investors are risk-averse.
2. Rational investors seek to hold an efficient portfolio (fully diversified).

3. All investors have an identical investment horizon (expected holding period).
4. All investors have identical expectations about such variables as expected rates of return and how capitalization rates are generated.
5. There is no transaction cost.
6. There are no investment-related taxes.
7. The rate received from lending money is the same as the cost of borrowing money.
8. The market has perfect divisibility and liquidity.

One can for example question the underlying assumption that rational investors seek to hold efficient portfolios (fully diversified), while in reality, we see a tendency of investors exhibiting home bias (Tesar & Werner, 1995). But the criticism does not stop here, the model includes input variables such as beta, risk-free rate, and equity risk premium, which all come with their advantages and disadvantages.

2.2.1.1 Beta

Beta is used as a measure of risk. Damodaran (2002) explains that there are two components that are similar for all betas in finance; the first is that beta or betas do not measure total risk, but the risk added to a diversified portfolio. The second is that all beta`s are standardized around 1 which represents the market, and they measure the relative risk of an asset.

Estimating beta might sound simple when we first hear of it; just run a regression of the returns on any asset against returns on an index representing the market. The slope of this regression is beta. This estimate covers the two components mentioned earlier because; it detects the risk (the investment) added to a diversified portfolio (the index), and the beta is standardized because the weighted average of the slope coefficients will always be one.

But in practice, it is not this simple. First of all, beta is not always standardized around one, and despite it being widely used, the beta has caused CAPM criticism. Pratt & Grabowski (2008) argue that beta is not a very reliable estimate of risk and may cause CAPM's underlying assumptions not to hold in practice. This emphasizes the importance of understanding beta in its entirety when it is useful and when it is inadequate.

There are different methods to measure beta, and all of them come with some advantages and disadvantages.

Consider running a regression of the returns on any asset against returns on an index representing the market. The advantage is that it is a fairly simple task to do, and the information is easy to access. However, this regression beta is a statistical measure. When we evaluate, interpret, and criticize this beta, we are evaluating, interpreting, and criticizing a statistical measurement. The statistical measurement can pass every test which makes it a good measurement, but it tells us little about the economic situation in practice. A regression beta is also easy to manipulate based on what impression you want to give. By mixing around with the choice of the market index, time period, and return interval, one can lower the standard error and make a regression that looks very good. However, this estimate will not reflect the truth, and on top of that, a regression beta is based upon historical data. This will present the average past of a company, not paint a picture of the company as it is today (Damodaran, 2002).

Fortunately, there are alternative ways to measure betas to fix the regression beta problem. According to Damodaran (2002), there are three methods:

1. Modified regression beta: We can modify the regression beta by changing the index used to estimate the beta and adjust the beta estimate. The choice of index is not based upon the hunt for the best statistical tests, but a more company-specified beta by finding information about the fundamentals of the company. The modified regression beta can still get you high standard errors, and it will neither reflect the current firm`s business mix nor the current leverage.
2. Relative risk measures: Make a measure of the relative risk without using historical prices on the stock and the index, but by making assumptions about the nature of risk, and from there calculating relative volatility or use accounting betas.
3. Estimate Bottom-up betas: Bottom-up betas are forward-looking and do not use just one single regression to come up with a beta. The advantages of doing so are that the standard error in a Bottom-up beta will be significantly lower than a single regression beta. Bottom-up betas can be adjusted to reflect the firm’s business mix and financial leverage.

Damodaran describes Bottom-up beta as the most promising method to estimate beta. This is also the method used by Kongsberg Gruppen ASA. When estimating the Bottom-up beta one takes three variables into account. The first is what kind of business the firm is in, the second is the degree of operating leverage, and at last, we have the firm's financial leverage. Below you will find a figure describing the three variables:

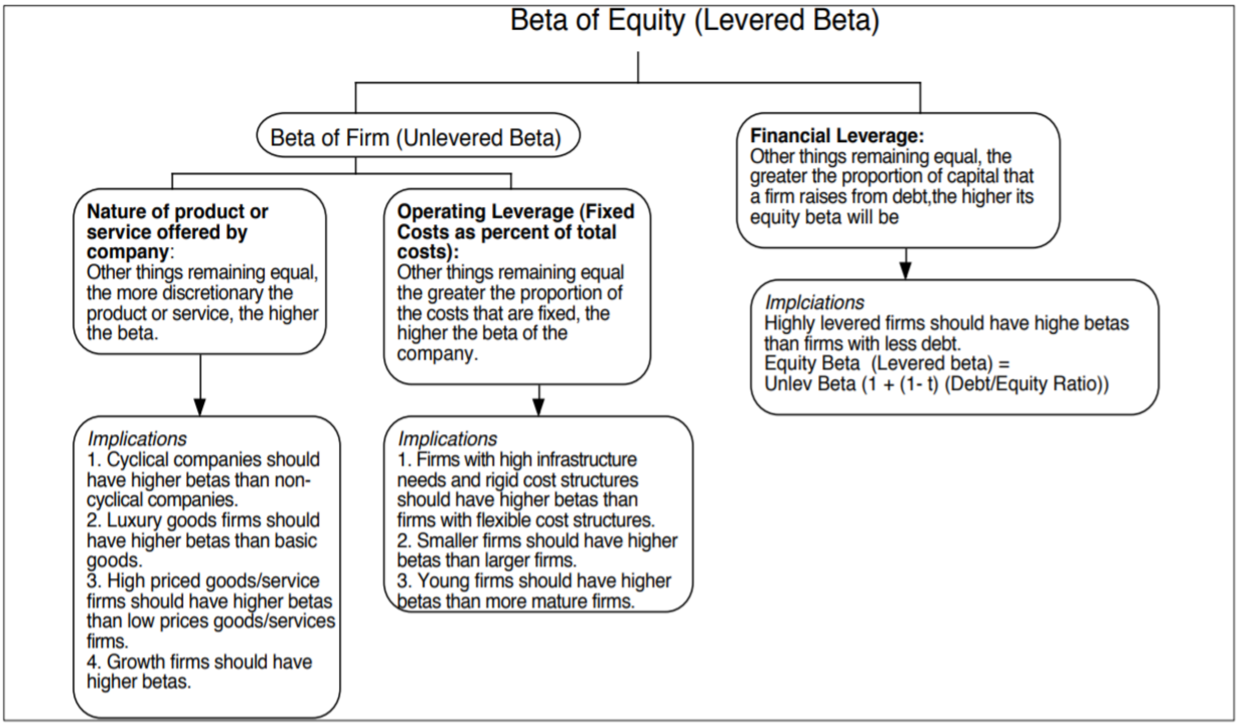

Figure 1 – Beta of equity (Levered Beta)

Figure 1 shows that Damodaran operates with the term "Levered beta" and "Unlevered beta". This is because Damodaran's Bottom-up beta excludes debt, and then includes it again. The unlevered beta is the average of all the companies' betas excluded from the individual debt or leverage. It is necessary to account for the companies' different capital and debt structures. To get a levered beta, the average of the unlevered betas is used to calculate the levered beta for Kongsberg Gruppen ASA. The formula is:

$$Levered\ Beta = Unlevered\ Beta(1 + (1 - Tax\ Rate)(Debt/Equity\ Ratio))$$

Formula 2 – Levered Beta

To measure error and "fit" for Bottom-up beta, one can use standard error. Damodaran (2020) present an easy formula to calculate the standard error for Bottom-up betas:

$$\frac{Average\ Standard\ Error\ across\ Company\ Betas}{\sqrt{Number\ of\ comapnies\ in\ sample}}$$

Formula 3 – Standard Error for Bottom-up beta

WACC calculation offers many approaches, but the approaches cannot guarantee a correct answer. The goal is to obtain an estimate that is as accurate as possible. One can for example use beta adjustment to secure a higher possibility of reaching the most accurate beta. Kongsberg Gruppen ASA uses an adjusted beta method called the Merrill Lynch approach or Blume approach, which originates from and is similar to the Bayesian-Vasicek adjusted beta. The Blume approach for adjusted betas was developed by Marshall E. Blume in his papers from 1971 and 1975.

The formula to adjusted beta goes as follows:

$$Adjusted\ Beta = \hat{a} + \hat{b}\hat{\beta}$$

Formula 4 – Blume's Adjusted Beta

According to Martin Lally (1998), $\hat{a}$ and $\hat{b}$ in the Blume approach are the coefficients from cross-sectionally regressing betas. These are estimated from one period against those estimated from a prior period. Both Blume and Merrill Lynch used fixed parameters of $\hat{a} = 0{,}33\ or\ \frac{1}{3}$ and $\hat{b} = 0{,}67\ or\ \frac{2}{3}$.

The adjusted beta formula is therefore as follow:

$$\beta_{adjusted} = \frac{2}{3}\beta_{estimated} + \frac{1}{3}\beta_{market}$$

Formula 5 – Blume's Adjusted Beta with fixed parameters

While $\hat{b} = 0{,}67\ or\ \frac{2}{3}$ is multiplied with the estimated company beta, $\hat{a} = 0{,}33\ or\ \frac{1}{3}$ is multiplied with the market beta, cause both Merrill Lynch and Blume conclude that betas will converge towards the market beta with the value 1 over time. Lally (1998) argues that Blume (1975) himself has provided evidence to support this convergence, and academics such as Dimson & Marsh (1983) and Francis (1979) have also given support to Blume`s evidence. The Blume approach adjusts the company beta by correcting for the tendency to converge towards the market beta which is 1. Since Blume proclaim that betas tend to converge towards

1 in the future, he argues that this adjustment will give a more robust estimate, as well as a more forward-looking beta.

2.2.1.2 Time-series beta approach

When estimating beta for Kongsberg Gruppen ASA, we are interested in an estimate that tells us something about the future. It is therefore an advantage to evaluate a method that takes temporal effects into account in the best way possible, and this is where Time-series comes in.

Time-series might not be as widely used as the traditional CAPM beta (cross-sectional historical beta) or multifactor model. The approach presents an interesting way of forecasting future betas based upon historical data, which cross-sectional historic betas do not. Even though Time-series beta uses historical data, the approach differentiates itself from cross-sectional betas in different ways. The cross-sectional analysis process data over a single period in time, while Time-series analysis process data over some time.

Time-series is a broad concept in statistics, and one must know a lot to be able to understand what you are actually doing with it. There is no overall agreement on how the method should be calculated, which makes this method challenging. Time series are also associated with several weaknesses. Wayne F. Velicer & Brett A. Plummer (1998) presents three of these; generalization problems, the challenge in acquiring appropriate measures, and the challenge to identify the best model to represent the data.

The error measures used to evaluate the prediction power of our Time-series forecast, are the Mean Absolute Deviation (MAD), Mean Square Error (MSE), Root of the Mean Square Error (RMSE), and Mean Absolute Percentage Error (MAPE). The MAD tells us how spread out the beta values in our data are. The MSE is supposed to tell us how far our forecasted estimates are from the actual beta values. The RMSE is telling us about how concentrated the actual beta values are around our estimated beta values. MAPE is the most used error measure in forecasting, it is telling us how accurate the prediction is by measuring the relative size of the error. The lower MAD, MSE, RMSE, and MAPE estimates are, the better.

Dawn Wright (2017) informs us that even though MAD, MSE, RMSE, and MAPE seem to come hand in hand in forecasting measures, certain conditions need to be known or in place before evaluating them. MAD, MSE and RMSE are all scale-dependent, by that we mean the size of the errors are related to the units or the forecast values. If we were to compare forecasts with different units, such as one with units in 1000s and the other in 100s, or in different currencies, one should be careful with the comparison. In our forecast for Kongsberg Gruppen ASA, are dealing with the same beta units calculated on the same data across forecasts. However, one needs to be aware of outliers, as they increase all the error measures. MSE and RMSE are especially sensitive to outliers, and one should therefore use MAD and MAPE instead if one observes outliers.

Even though MAPE is considered the most used forecasting error measure, it may not be as applicable in our forecasts. As MAPE involves a deviation, it should only be used on data that is measured on a ratio scale. A ratio scale is a scale that has a real zero, if the data is based on interval data one should look away from the MAPE. While it is highly unlikely to obtain a negative beta, it is possible. One should therefore be cautious with using MAPE as a measure for the beta forecast.

2.2.1.3 Risk-free rate

According to Robert Bruner, Kenneth M. Eades, Robert S. Harris & Robert F. Higgins (1998), most firms use a historical long-term Treasury bond yield with a maturity of ten or more years as risk-free rate. This is a backward-looking estimate. Some companies borrow short-term and argue that they borrow money cheaper this way. It would not be a good idea to lower the cost of capital because of this. The cost of capital is not supposed to reward companies for borrowing in short term. Over 20 years have passed since Bruner, et al (1998) discovered that most firms use historical long-term risk-free rates, and they still do. The same goes for Mukherji's (2011) statement, that treasury securities normally have been used as the closet proxy for a risk-free rate, because of very little default risk. But how do we know that a government bond is default-free? We do not. Some say that the government can print more money to secure against default. This will cause an increase in inflation and is something we try to avoid. According to Damodaran (2016), government bonds are considered default-free if bond rating agencies say so. This can be seen as a weak defence, due to a AAA rating meaning low default risk, there will still be some risk involved and is therefore not risk-free.

Instead of using historical long-term Treasury bond yield, the risk-free rate can also be calculated using Yield to Maturity (YTM). One advantage of using YTM is that it gives the investors the ability to compare between securities and the return they can get. You can also get a more up-to-date estimate using this method of calculating risk-free rate, and so the method is considered forward-looking.

Formula for YTM:

$$Bond\ price = \frac{Coupon\ 1}{(1+YTM)^1} + \frac{Coupon\ 2}{(1+YTM)^2} + \cdots + \frac{Coupon\ n}{(1+YTM)^n} + \frac{Face\ value}{(1+YTM)^n}$$

Formula 6 – Yield to Maturity

2.2.1.4 Equity risk premium

In an unrealistic world where investors are risk natural, an asset`s value would be the present value of expected cash flows, discounted back at a risk-free rate. However, this is not the world we live in. Here investors are risk-averse. They will not pay as much for a risky cash flow, as for a riskless cash flow that has the same expected value.

Risk premiums addresses how much a risk averse investor should charge to take on risk. What price to give the amount of risk taken? “Given its importance, it is surprising how haphazard the estimation of equity risk premiums remains in practice” (Damodaran, 2019, p. 2). As investors become more risk-averse, equity risk premiums will rise, and if risk aversion decline, premiums will fall.

Unfortunately, there is no well-established recipe that all academics agree upon when calculating equity risk premium. All the methods seem to come with advantages and disadvantages. In general, one can find three methods to calculate equity risk premiums in the literature. Damodaran (2020) discusses the three basic approaches to estimate equity risk premium in his paper “Equity Risk Premiums (ERP): Determinants, Estimation and Implications – The 2020 Edition”. The three methods are the historical return approach, the survey approach, and the implied approach. In short:

The historical return approach is based on past returns and is widely used and criticized throughout the years. It faces limitations due to its backward-looking approach, large standard errors, and it might fail to detect crisis, among other things. Its defence is that “The underlying theory is that the past provides a reasonable indicator of how the market will behave in the future and investors' expectations are influenced by the historical performance of this market" (Pratt & Grabowski, 2008, p. 93). But the estimation seems to produce extensively different results, based on how you "play around" with the historical data.

The survey approach uses the information gathered from investors and/or managers when asked about future equity risk premiums. The result of this estimation seems to depend on the frame of your survey, who you are asking, and what you are asking them. The challenge is often to find a selection of investors that best reflects the overall market. There will be a risk of unreasonable risk premiums, that are very volatile and only provides information of short periods.

The implied approach where one uses future cash flows or observed bond default spreads to calculate the ERP. Unlike the historical premium, which is a backward-looking approach, the implied approach focuses on the future, which makes more sense, considering that equity risk premium is a forward-looking estimate. It has the advantages of not needing historical data and it is reflecting current market perceptions. This estimate heavily depends on the model you use and your assumption about the future. When using this approach, it is important to have the right discounted cash flow model to value the index, and that the dividends and growth rate are correct. It also assumes that the market is correctly valued. The implied equity premium can be calculated using three different approaches: DCF Model-based Premiums, Default Spread Based Equity Premiums, and Options Pricing Model-based Equity Risk Premium.

The approach used in our master thesis is the DCF approach. The DCF model uses future cash flow to arrive at a present value. One pitfall by using the DCF model is that it is very sensitive to assumptions related to constant growth and discount rate. Minor adjustments to the model, will lead it to fluctuate widely, and the value generated would not be accurate.

Damodaran (2020) proceeds to discuss why the estimates vary across approaches, and how to choose the "best" approach. We are of course most interested in how to choose the best approach, due to the practical path of this thesis. To do this, one needs to ask the following questions:

1. Predictive power: which approach gives the best prediction of the future? By looking at the correlation between the estimates and the actual future return, Damodaran show`s that it is implied equity premium that has the best predictive power.
2. Beliefs about markets: Use implied equity premium if you believe that the market is effective and/or that you cannot forecast the direction of the futures market. This is because this approach uses the current level of an index to estimate the market in the future.
   Use historical equity premium over a longer period if you think that the market can be over-or undervalued. And use a survey equity premium if you do not believe in the markets.
3. Purpose of analysis: If you need to calculate the equity risk premium for acquisition valuations and equity research, one should use the current implied premium, to make oneself market natural. When we need the equity risk premium for corporate finance, to calculate the Cost of Capital, one should choose a long-term average, historical, or implied premium.

The previous questions point towards implied equity risk premium when we are calculating the Cost of Capital for a company like Kongsberg Gruppen ASA. This approach gives us the highest predictive power when we believe that we cannot forecast the direction of the futures market, and our purpose of the analysis is to calculate the Cost of Capital.

2.2.1.5 Country risk

Companies that do a lot of business around the world are globalized, and when being an investor, you must deal with the risks that these countries have. The risk referred to is country risk. Doing investments in countries that are exposed to a different amount of risk will require higher returns in some countries. Country risk can come from many different sources, it can occur from political risk, legal risk, and economic structure.

To estimate country risk, there are three approaches to use: default spread, relative equity market standard deviation, or default spread plus relative standard deviation. We will not go deeper into this, as Kongsberg Gruppen ASA operates most of their business in Norway with a Norwegian government bond with an AAA rating. There is therefore very little risk associated with doing business in Norway.

2.2.2 THE FACTOR MODELS

Having explored the relevant literature behind CAPM, we are moving forward to examining the three different factor models as a way of calculating the Cost of Equity. The factor models presented in this thesis are called Three-Factor Model, Carhart-Four Factor model, and Five-Factor Model. These are financial models that address factors to determine market equilibrium and uses them to find out what the required rate of return is.

To evaluate the factor models we are examining the p-value, R^2, and Adjusted R^2. The p-value is the probability of the null hypothesis being correct given the sample observations. It is also an easy error measure to retrieve, as regression models calculate them for you. The significance level used for this thesis is 0,05. Just as p-value, R^2, and Adjusted R^2 are easily retrievable as the regression models calculate them for us. R^2 is telling us how close the data is to the fitted regression line. Adjusted R^2 also indicates the same as R^2, but it adjusts for the number of factors in our model.

2.2.2.1 The Fama-French Three-Factor Model

The Fama-French Three-Factor Model was developed by Eugene Fama and Kenneth French (1992). In their paper, they found variables that could explain equity return better than the single-factor model, CAPM, and therefor came up with the Fama-French Three-Factor Model. Although the Fama-French Three-Factor Model is based upon the CAPM, the approach includes two new beta coefficients, in addition to the one beta value from CAPM. The additional two variables are the size of the company (SMB), which means “Small Minus Big” and a value factor (HML) which means “High Minus Low”. “High” refers to high book-to-market equity ratio and “Low” stands for low book-to-market ratio.

They argue that average return is negatively correlated with the size, and that stocks with higher book-to-Market equity ratio (BE/ME) have higher average return. The Fama-French Three-Factor Model is supposed to give a better representation of the risk a company faces, because it explains the non-diversified risk in stocks better than the CAPM, well at least according to the authors. Although Fama and French have not really answered to why these factors work, they continue to present papers to show how their model outperforms the CAPM.

The Fama-French Three-Factor Model does not escape criticism, as academics express their concerns regarding the Book-to-Market effect. Josef Lakonishok (1994) and Porta (1996) argue that the Book-to-Market Effect is a consequence of investors believing that past portfolio performance will describe the performance too far into the future. This would cause value stocks to be under-priced and growth stocks to be overpriced, instead of compensating for the risk bearing investors (Nartea, Ward, & Djajadikerta, 2009).

It is important to be aware that the Three-Factor model by Eugene F. Fama & Kenneth R. French (1993), was developed and tested on US data, which can lead to the results only being relevant to markets with a particular set of characteristics like the US's.

The model addresses three factors:

1. The first factor of the Three-Factor Model describes how the asset correspond to the market portfolio. This is the same factor as used in CAPM.
2. Factor two captures the size of the company and is called SMB (Small market capitalization Minus Big market capitalization). The factor measures the historical excess return of companies with a small market capitalization over companies with large market capitalization.
3. Factor three captures the company's Book-to-Market ratio and is called HML (High book-to-market ratio Minus Low book-to-market ratio). The factor measures the historical excess returns of stocks that are considered to be trading below their worth (value stocks), over stocks that are considered to have the ability to outperform the overall market (growth stocks).

The formula for the Three-Factor Model is:

$$Cost\ of\ equity = r_f + (\beta_{Mkt-rf} * (Mkt - rf)) + (\beta_{SMB} * SMB) + (\beta_{HML} * HML)$$

Formula 7 – Three-Factor Model

Where:

E(ri) = The expected return on asset

r_f *= Risk-free rate*

β_i, s_i, h_i= *Betas*

SMB= *The return of a portfolio of small stocks in excess of the return on a portfolio of large stocks*

HML = *The return of a portfolio of stocks with a high book- to- market ratio in excess of the return on a portfolio of stocks with a low book- to- market ratio.*

According to Fama & French (1993), the SMB factor will divide the data of the stocks into two groups, one with small size stocks and the other with big size stocks. While SMB does it this way, the HML factor will divide stocks into three groups, which are low, medium, and high. From their paper from 1993, they found out that the variable BE/ME had a higher expressiveness than what stock size had. That is the reason why Fama & French divided HML into three groups.

Chen & Bassett (2014) explains how we can interperate the value of the factors. When making a regression out of the Three-Factor Model, we would either get positive or negative factors. A positive SMB factor indicates that the portfolio is weighted towards small-sized companies. If the SMB is negative, it would indicate the portfolio is weighted towards large companies, said in other words the portfolio is negatively exposed to the size factor. A positive HML factor will indicate that the excess return comes from a company's high Book-to-Market equity, and vice versa if the HML factor is negative.

2.2.2.2 Carhart Four-Factor Model

The Carhart Four-Factor model was developed by Mark M. Carhart (1997), through a paper he wrote as a tool for valuating mutual funds' behaviour. In this paper, he builds his work upon Fama & French (1993) and Narasimhan Jegadeesh & Sheridan Titman (1993). In the paper by Jegadeesh and Titman they discovered a trend for good and bad performances of stocks to continue over numerous months, they discovered a momentum effect (Bodie, Kane, & Marcus, 2014, pp. 432-433). Based upon these two articles, Carhart developed the Four-Factor Model by building on the Three-Factor model from Fama and French. His contribution was to include the fourth factor called momentum (MOM), which is also called WML (Winners Minus Losers) (Bodie, Kane, & Marcus, 2014). MOM is a factor that tells the difference between the average return on the winner and loser portfolios. The MOM estimate is calculated by taking the Winners Minus the Losers, calculated from data collected over twelve months. The winners are considered the stocks that belong to the top 30% of the data, and the losers are considered the stocks that belong to the bottom 30% of data (Czapkiewicz & Wójtowicz, 2014).

The Four-Factor Model by Carhart 1997:

$$Cost\ of\ equity = r_f + (\beta_{Mkt-rf} * (Mkt - rf)) + (\beta_{SMB} * SMB) + (\beta_{HML} * HML) + (\beta_{MOM} * MOM)$$

Formula 8 – Carhart Four-Factor Model

Where:

E(ri) = The expected return on asset

r_f *= Risk-free rate*

α *= Intercept of the regression line*

β_i, s_i, h_i, w_i *= Betas*

SMB *= The return of a portfolio of small stocks in excess of the return on a portfolio of large stocks*

HML *= The return of a portfolio of stocks with a high book- to- market ratio in excess of the return on a portfolio of stocks with a low book- to- market ratio.*

MOM *= The return of a portfolio of stocks with winners minus losers*

The momentum factor added by Carhart (1997) is supposed to give a substantially higher explanation power of the model. Tomasz Wójtowicz & Anna Czapkiewicz (2014) point out that the momentum factor might be a well-constructed factor and applicable in asset pricing, as momentum has shown positive results when implemented in different ways in many markets. Wójtowicz & Czapkiewicz (2014) substantiate this statement by referring to Geert K. Rouwenhorst (1998) who profitably applied the momentum strategies on 12 European stock markets. Griffin, Ji & Martin (2003) confirm that the occurrence of momentum exists in countries worldwide, and Chui, Wei & Titman (2002), found that momentum had an effect on the Asian Stock markets except for Japan and South Korea.

Fama & French (2012) point out that the Carhart Four-Factor Model is far from perfect when explaining the average returns, even though size and value patterns are better captured than in the Capital Asset Pricing Model. Avramov & Chordia (2006) agree with Fama & French (2012) and point out that the Four-Factor Model fails to address all the momentum in U.S. average stock returns. One might argue that the momentum factor is contradicting to the market efficiency, because unlike the factors in the Three-Factor Model, MOM has no risk-based explanation. The factor does however behave as a risk factor, as negative returns relative to the markets followed by a momentum-driven strategy have been observed.

The MOM factor has a simple theory. Winners tend to win, and losers tend to lose. If a stock produces profitable returns, it tends to continue doing so. Vice versa if the stock shows a negative return. The higher positive value in the MOM factor indicates a more well-performed stock, compared to the market.

2.2.2.3 Fama-French Five-Factor Model

In 2015, Fama-French Five-Factor Model was developed. This model was developed by augmenting the Fama-French Three-Factor Model with the profitability (RMW) and investment (CMA) factors that would capture the return premiums better. On Kenneth R. French`s own website, he explains the two new factors as following: "*RMA (Robust Minus Weak) is the average return on the two robust operating profitability portfolios minus the average return on the two weak operating profitability portfolios"* and that "*CMA (Conservative Minus Aggressive) is the average return on the two conservative investment portfolios minus the average return on the two aggressive investment portfolios*" (French, 2020).

There have been some challenges with the Fama-French Three-Factor Model to identify representatives for expected earnings and investments, that the Five-Factor Model claims to fix. Aharoni, Grundy & Zeng (2012) found that the Three-Factor Model has a weak statistically valid connection with investments and average return. Fama & French (2015) tested this model on the U.S market with data from July 1963 to December 2013. From this test, they found that Fama-French Five-Factor Model with profitability and investment factors performs better than the Three-Factor Model.

The formula for Five-Factor Model is:

$$Cost\ of\ Equity = r_f + (\beta_{Mkt-rf} * (Mkt - rf)) + (\beta_{SMB} * SMB) + (\beta_{HML} * HML) + (\beta_{RMW} * RMW) + (\beta_{CMA} * CMA)$$

Formula 9 – Five-Factor Model

Where:

E(ri) = The expected return on asset

r_f *= Risk-free rate*

α *= Intercept of the regression line*

$\beta_i, s_i, h_i, r_i, c_i$*= Betas*

SMB*= The return of a portfolio of small stocks in excess of the return on a portfolio of large stocks*

HML *= The return of a portfolio of stocks with a high book- to- market ratio in excess of the return on a portfolio of stocks with a low book- to- market ratio.*

RMW*= Difference between the return on diversified portfolio of stocks with robust and weak profitability*

CMA*= Difference between the return on diversified portfolios of the stock of low and high investments firms*

According to Blitz, Hanauer, Vidojevic & Vliet (2018) there are some concerns regarding the Five-Factor Model. They do not understand why Fama & French exclude the momentum factor, when this is a factor accepted by many. It is also said that Fama & French were too quick when adding two new factors, since the research on these are limited and they have not been tested in different markets and time periods. In the paper by Asness, Frazzini & Pedersen (2018) they address twenty factors, but out of these Fama and French only choose two. Why did they choose these two? What makes these factors better than the others? There are many questions that have not been answered, and not enough research has been done. Blitz, et al. (2018) believes there are not just bad things about the Five-Factor Model, and with more research we can understand the model better.

What the variables will tell us is that a positive value in the RMW factor indicates that a company has a higher probability and can earn better results, and vice versa, if it is negative the companies have low probability and harder to get good results. A positive CMA indicates that a company invest conservatively and are negative if a company invest aggressively.

2.3 COST OF DEBT

The second component in the WACC formula is Cost of Debt. This part of the formula will reflect the default risk that lenders perceive from the investment. The Cost of Debt is the rate at which the company can borrow long term today, it is the interest on new debt, not debt that is outstanding.
According to Damodaran (2016), the trick to the Cost of Debt is to keep it current. Reflect on the company's current default risk now standing, rather than the one it had when the company borrowed money. You should also stay currency consistent. If your company is borrowing money in different currencies, you need to decide on which currency you should estimate the Cost of Debt in.

When estimating the pre-tax Cost of Debt, two approaches are used the most:

1. The first and easiest approach is to look up the yield to maturity on a straight long-term bond outstanding from the firm. Damodaran (2018) points out that this is a “dangerous” method because you are assuming that the default risk in a bond and the default risk in the company match up. That is not always true, as risky companies can issue safe bonds. There are also very few companies that have long-term straight bonds that are liquid and widely traded, which can make the estimate inaccurate.
2. The second is to look up the companies rating and estimate a default spread based upon the rating the company has. Damodaran has made it easy, to use his estimated default spread based upon your company rating.

2.4 CAPITAL STRUCTURE

The weights on equity and debt can highly influence the Cost of Capital. Yet again, the calculation of weights presents issues. On Damodaran's website (2005), he explains how to proceed. The first is to decide whether to use the book value of equity and debt as weights or to use market values. Book values are being said to be irrelevant for the Cost of Capital because book values may paint a wrong picture of the company's borrowing capacity. Some companies may have a significantly greater capacity to borrow than their book values indicate.

It seems like most academics agree that market value is the way to go. However, we are confronted with challenges here as well. The market value of equity is easy to find for publicly traded companies, by taking the share price times the number of outstanding shares. The market value of debt, however, is another story. This is because det largest part of debt for some is bank loans and bond issues, which makes you choose between two ways of calculating this. The first one is to assume that the book value of debt is the same as market value. Still, this is only a good assumption if your company has newly issued debt or if the Cost of Debt has not changed much since the company issued new debt. Alternatively, you can calculate the market value with expected interest payments, face value and maturity of the debt (Damodaran, 2016).

CHAPTER THREE – KONGSBERG GRUPPEN ASA'S WACC

Chapter two introduced the relevant theory, which is necessary for further understanding of the methods in question. This chapter contains a review of Kongsberg Gruppen ASA's WACC calculation.

3.1 WACC

Kongsberg Gruppen ASA's Weighted Average Cost of Capital (WACC) for the 2021 budget was determined in October 2020 and is based on the prevailing market prices at the time. Kongsberg Gruppen ASA's Treasury Group updates the WACC once a year, as part of the budget process. The source we use for this section is the information we have gotten from Kongsberg Gruppen ASA (2021) themselves.

The WACC has been determined through weighting the market value of equity (E) and debt (D):

$$WACC = \frac{E}{D+E} * \overbrace{(r_f + \beta_L * (r_m - r_f))}^{CAPM} + \frac{D}{D+E} * r_D * (1 - T_c)$$

Formula 10 – Kongsberg Gruppen ASA's WACC formula

We will now consider the various variables that are included in the calculation of Kongsberg Gruppen ASA's WACC.

3.2 COST OF EQUITY

The Cost of Equity has been determined through the Capital Asset Pricing Model (CAPM). The model considers the sensitivity of an asset to non-diversifiable risk and is used to determine this asset's theoretically appropriate required return.

The Cost of Equity has been calculated through multiple steps. First, Kongsberg Gruppen ASA estimates their beta, which undergoes a calculation in line with Damodaran's (2016) theory. Kongsberg Gruppen ASA's beta represents the correlation coefficient through linear regression analysis between the development in the share price for Kongsberg Gruppen ASA and the MSCI World Index. The MSCI World Index was chosen due to Kongsberg Gruppen ASA's exposure to the global market and the company's high export ratio.

When using linear regression analysis, Kongsberg Gruppen ASA uses historical data to calculate WACC. However, they are aware that it does not seem fair to assume that investing in Kongsberg Gruppen ASA in the past, is the same as investing in Kongsberg Gruppen ASA in the future. First of all, Kongsberg Gruppen ASA has invested more in the Maritime Industry, due to the acquisition of Rolls Royce Commercial Marine (RRCM). This increases their exposure towards the Maritime Industry, which has a higher systematic risk than the defence sector. Secondly, one could argue that the dependence on large individual projects within defence would increase the risk of the Kongsberg Gruppen ASA share. These arguments show that Kongsberg Gruppen ASA is not the same in the future, as it was in the past. To compromise for using historical data, and estimate an appropriate beta, Kongsberg Gruppen ASA follow Damodaran's Bottom-up approach. The approach uses comparable companies to calculate beta for Kongsberg Gruppen ASA. Due to the maritime industry initially weighing 2/3 of the business, Kongsberg Gruppen ASA chose to use the betas within the maritime industry to represent their beta.

The betas for the comparable companies were calculated based on the following steps: First, the raw levered betas were determined. This was done through a simple linear regression analysis. They used 10-year monthly data to reach a substantial number of observations, which reduces the noise from potential outliers in the data set. Kongsberg Gruppen ASA kept an adjustment method used by Ernst & Young, from when they outsourced this task. They call this method the Bayesian approach. The raw levered beta (1,19) was adjusted towards the market beta (1,00) through weighting the raw levered beta 2/3 and the market beta 1/3. They did this to obtain a more robust beta that is more forward-looking, in consideration to the convergence tendency towards the market beta.

$$\beta_{adjusted} = \frac{2}{3} * 1{,}19 + \frac{1}{3} * 1{,}00 = 1{,}13$$

Calculation 1 – Kongsberg Gruppen ASA's Adjusted Beta

Thirdly, equity risk increases with higher leverage; higher leverage also increases the expected return on equity. Thus, the unlevered betas (adjusted for cash) for the respective peers were determined, through the following equation:

$$\beta_u = \frac{\beta_L}{1 + \frac{NIBD}{E}}$$

Formula 11 – Unlevering Levered Beta

Where:

β_L = *Levered beta*

NIBD = Net Interest-Bearing Debt

E = Equity

Using the numbers from table 1 further bellow:

$$\beta_u = \frac{1{,}13}{1 + \frac{11{,}6\%}{88{,}4\%}} \approx 1{,}00$$

Calculation 2 – Unlevered Beta

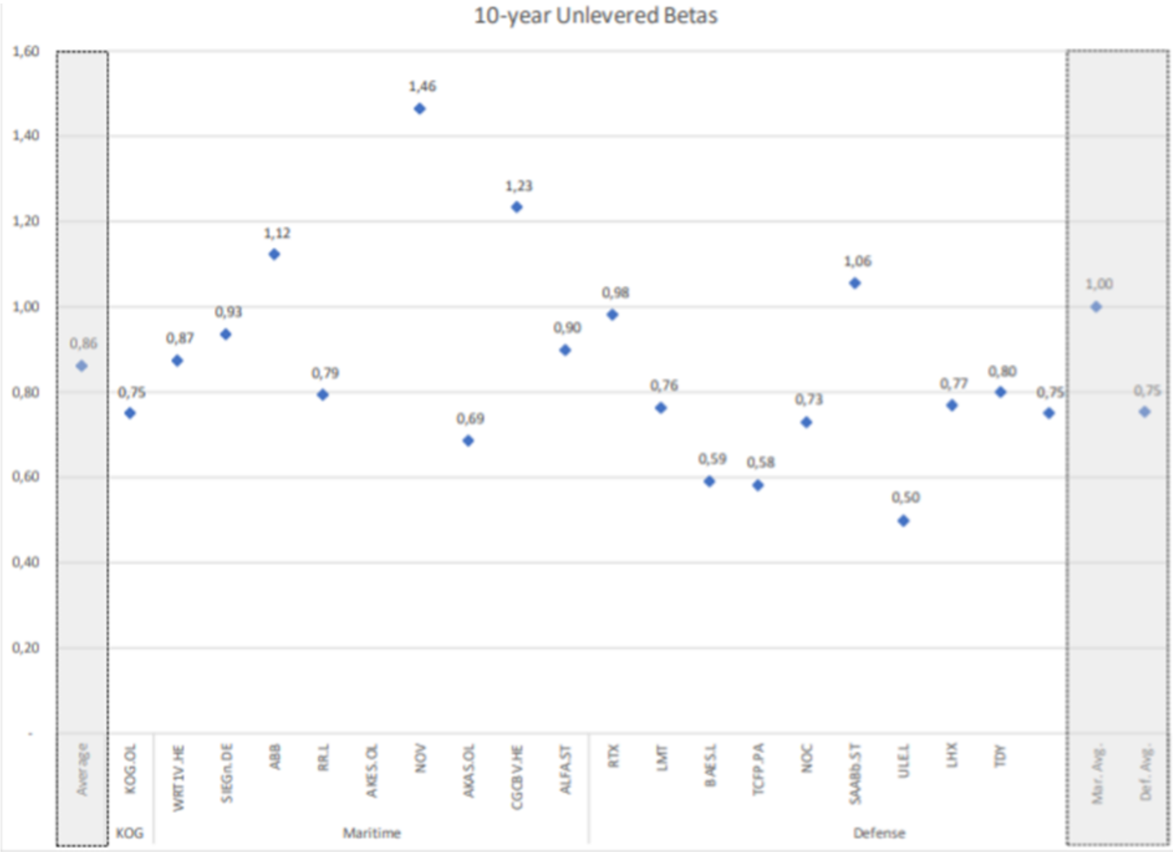

Figure 2 – 10-year Unlevered Betas

These unlevered betas are often said to be the Pure Play Betas. The average Pure Play Betas for the list of comparable companies are then calculated and made into an average beta for the Maritime industry (β_u=1,00), given the current exposure to the maritime industry post the Commercial Marine acquisition. In the last step, the beta (β_L) is levered considering the expected future leverage ratio for Kongsberg Gruppen ASA, through modifying formula 11 and basing this on a NIBD/E of approximately 13%, yielding a levered beta of 1.13.

$$\beta_L = \beta_u * (1 + \frac{NIBD}{E})$$

Formula 12 – Levered Beta

$$\beta_L = 1{,}00 * (1 + \frac{11{,}6\%}{88{,}4\%}) \approx 1{,}13$$

Calculation 3 – Levered Beta

In chapter two the levered beta formula is shown with taxation, but Kongsberg Gruppen ASA excludes this when calculating their levered beta. Kongsberg Gruppen ASA explains their unwillingness to a drastic decrease in WACC. By excluding the tax effect from the beta, it prevents a significant decline in WACC from 2019 to 2020.

We use standard error when measuring the error and "fit" for Kongsberg Gruppen ASAs Bottom-up beta. This error measure will be applied later in chapter six when comparing Kongsberg ASA's calculation to our calculations. We plot our estimates into the formula presented by Damodaran:

$$Standard\ Error\ for\ Bottom-up\ Beta = \frac{0{,}1593}{\sqrt{19}} = 0{,}0365$$

Calculation 4 – Standard Error for Bottom-up beta

The risk-free rate (r_f) is based upon the yield to maturity on a 10-year bond issued by the Kingdom of Norway with a bond rating of AAA. It should be a fair representation of the risk-free rate, as there is virtually no default risk in the government bond by the Kingdom of Norway, and the reinvestment risk is low given the long tenure of the bonds. To calculate the market risk premium $(r_m - r_f)$ Kongsberg Gruppen ASA used Damodaran's (2020) Excel file "Country Risk Premium 2020". Kongsberg Gruppen ASA uses the pre-calculated Country Equity Risk Premium for Developed Markets. It was calculated by Damodaran to be 5,2% and is based on the S&P 500 index.

3.3 COST OF DEBT

Kongsberg Gruppen ASA's bonds are traded on Oslo Stock Exchange; however, these are seldom traded. Given the low liquidity, the presented market price may differ from the actual market value. When the WACC calculation was carried out in October 2020, the current market value of Kongsberg Gruppen ASA was NOK 3.541 million, compared to a book value of NOK 3.450 million. The Yield to Maturity on Kongsberg Gruppen ASA's bonds is approximately 1,4%, and the weighted average tenor is three years. Since the WACC should reflect a long-term funding cost, the expected cost for a 10-year Kongsberg Gruppen ASA bond has been used as a basis for the WACC. A 10-year floating-rate bond based on 3-month NIBOR rate of 0,27%, plus the then-current expected 10-year credit spread for Kongsberg Gruppen ASA of 180 basis points due to a BBB rating on the company, has been swapped into a 10-year fixed-rate bond, yielding an estimated pre-tax Cost of Debt of 2,67%. After taking the tax shield into account (TC =22%), the Cost of Debt (rD) comes out to 2,08%.

3.4 WEIGHTED AVERAGE COST OF CAPITAL

The WACC is calculated based on the current market value of debt and equity. When putting all the numbers into the WACC formula Kongsberg Gruppen ASA gets a WACC after-tax of 6,09%.

$$WACC_{After-Tax} = \frac{27,0}{30,5} * \overbrace{(0,73\% + 1,13 * 5,2\%}^{CAPM} + \frac{3,5}{30,5} * 2,67\% * (1 - 22\%) = 6,09\%$$

Calculation 5 – WACC After-Tax

Kongsberg Gruppen ASA has also calculated WACC Pre-Tax: 7,80%.

$$WACC_{Pre-Tax} = \frac{WACC_{After-Tax}}{(1 - T_c)} = \frac{6,09\%}{(1 - 22\%)} = 7,80\%$$

Calculation 6 – WACC Pre-Tax

Below you will find a summary of the numbers used in Kongsberg Gruppen ASA's calculation and a comparison from their previous calculated WACC.

WACC Calculation	Current WACC 2020	Previous WACC 2019	Change
Unlevered Beta	1,00	1,02	-1,60 ppt.
Other Input Variables			
Risk Free Rate	0,73 %	1,25 %	-0,52 ppt.
Market Risk Premium	5,20 %	5,96 %	-0,76 ppt.
Pre-Tax Cost of Debt	2,67 %	3,18 %	-0,51 ppt.
Interst Rate New Debt	0,00 %	0,00 %	
Tax Rate	22,00 %	22,00 %	0,00 ppt.
Capital Structure			
Equity	88,40 %	85,03 %	3,38 ppt.
Debt	11,60 %	14,97 %	-3,38 ppt.
Levered Beta	1,13	1,20	-6,38 ppt.
Cost of Capital			
Cost of Equity	6,61 %	8,37 %	-1,76 ppt.
Cost of Debt	2,08 %	2,48 %	-0,40 ppt.
WACC (after tax)	**6,09 %**	**7,49 %**	**-1,40 ppt.**
WACC (pre-tax)	7,80 %	9,60 %	-1,8 ppt.

Table 1 – WACC Calculation Summary 2020-2019

As seen in Table 1, there are changes from the previous WACC calculation to the WACC calculation in 2020. We see a decrease in WACC, which indicates that if these WACC estimates for 2019 and 2020 is true to the market, Kongsberg Gruppen ASA got a higher market value in 2020 opposed to 2019, assuming the same expected cash flows. Kongsberg Gruppen ASA presents a figure that shows the input variables that have caused the WACC to decrease from 2019 to 2020. Figure 3 show that it is the risk-free rate and market return that have contributed the most to the change in WACC.

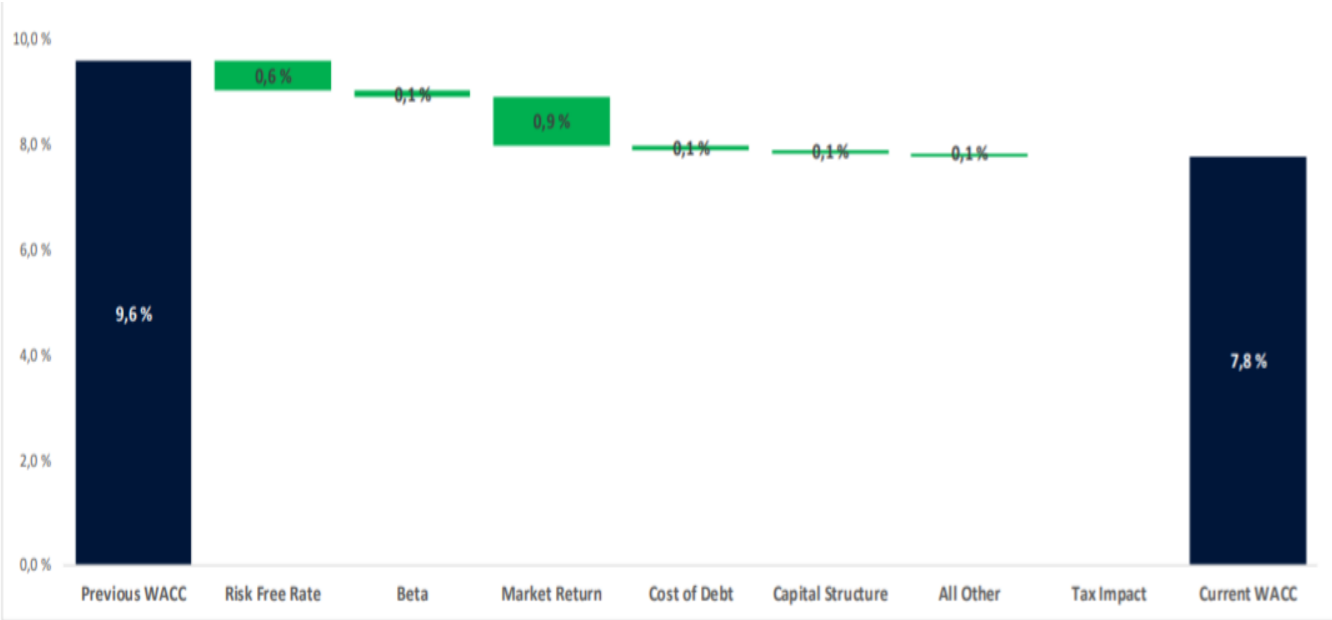

Figure 3 – Input change in WACC 2020-2019

CHAPTER FOUR – WACC CALCULATIONS

Earlier chapters reviewed relevant theory and Kongsberg Gruppen ASA's WACC calculation. In chapter four, the implementation of the different calculation methods for Cost of Equity and Cost of Debt will be presented.

4.1 COST OF EQUITY

In the Cost of Equity part, we chose to go in two directions, reviewing the Capital Asset Pricing Model (CAPM) and the factor models. Both directions divide into several paths with different viewing angles and calculation methods. The factor models present three different Models, Fama-French Three-Factor Model, Carhart Four-Factor Model, and Fama-French Five-Factor Model, while CAPM offers various calculations of the inputs.

While the Cost of Equity is the main attraction in the WACC discussion, the Cost of Debt seems to be a more one-way street. While there are different approaches to reach the Cost of Debt, the information available may choose the path for you. We have only used one approach to calculate the Cost of Debt. Following the guidelines of Damodaran, the inputs in the Cost of Debt differs from Kongsberg Gruppen ASA's calculation, but the principle is the same.

4.2 FACTOR MODEL – CAPM

The Capital Asset Pricing Model requires us to calculate beta, equity risk premium and risk-free rate. Beta and equity risk premium are well discussed and debated amongst academics. As we find ourselves surrounded by a sea of different methods and approaches, we choose to calculate Bottom-up beta, Time-series beta, risk-free rate and Implied Equity Risk Premium.

4.2.1 BOTTOM-UP BETA

A quick online search on Bottom-up beta will lure you with the promise of a better measure of the market risk associated with the business industry. We have chosen to use this method as Damodaran appoints Bottom-up beta to be the best.

Kongsberg Gruppen ASA also use Damodaran's Bottom-up beta. Our calculations will therefore be performed similarly. Kongsberg Gruppen ASA chooses to only utilize the beta calculated with comparable Maritime companies. We will include both Maritime and Defence companies, to achieve a beta that addresses large parts of the company risk.

Taking Kongsberg Gruppen ASA`s selected competitors, we use their 10-year monthly historical stock prices from Eikon to construct a linear regression. Doing this will give us a significant number of observations and reducing the noise from potential outliers in the data set. From this, we get the raw levered beta 1,058. Unlike Kongsberg Gruppen ASA we do not adjust our raw levered beta with the Bayesian correction, as this is not a part of Damodaran's calculations. Damodaran's Bottom-up method then dictates us to unlever our raw levered beta before again levering it with Kongsberg Gruppen ASA's Debt-to-Equity ratio. Kongsberg Gruppen ASA probably has a different policy on how much debt to use than the other companies in the sample. The raw levered betas are levered betas, but they reflect the average financial leverage of the companies in our sample, and not Kongsberg Gruppen ASA's. That is why we unlever the beta by dividing the raw levered beta of 1,058 by the tax rate of 22% and the average Debt-to-Equity ratio of 16% for all the firms in our sample.

To calculate our unlevered beta, we used the following formula:

$$\beta_u = \frac{\beta_{RL}}{1 + (1 - Tc) * \frac{D}{E}}$$

Formula 13 – Damodaran's Unlevered Beta

Where:

β_{RL} = *Raw Levered beta*

T_C = *Tax rate*

$Business\ \frac{D}{E}$ = *Average Debt-to-Equity ratio across compatible firms*

Our calculation then suggest that we have an unlevered business beta of 0,94.

$$\beta_u = \frac{1{,}058}{1 + (1 - 22\%) * 16\%} = 0{,}94$$

Calculation 7 – Damodaran's Unlevered Beta

While Kongsberg Gruppen ASA also bases their beta estimation on Damodaran's Bottom-up beta, the last part of our calculation is one of the parts that separate this method from theirs. Kongsberg Gruppen ASA calculates its beta without considering taxes, even though they are aware that tax should be considered from a theoretical perspective. We follow Damodaran's method, so tax is included in the last step of our calculation.

To calculate our levered and final beta we used the following formula:

$$\beta_L = \beta_u * (1 + (1 - T_C) * \frac{D}{E})$$

Formula 14 – Damodaran's Levered Beta

Where:

β_u = *Unlevered beta*

T_C = *Tax rate*

$\frac{D}{E}$ = *Kongsberg Gruppen ASA's Debt-to-Equity ratio*

Now that the comparable firms Debt-to-Equity ratio is excluded from the beta, we end up with an unlevered beta of 0,94. By multiplying the unlevered beta with taxes of 22% and Kongsberg Gruppen ASA's own Debt-to-Equity ratio of 6,15%, we are left with Kongsberg Gruppen ASA's levered beta of 0,99.

$$\beta_L = 0,94 * (1 + (1 - 22\%) * 6,15\%) = 0,99$$

Calculation 8 – Damodaran's Levered beta

4.2.2 TIME-SERIES BETA

The Time-series approach enables you to mix between different periods and lengths. Some might argue that this will manipulate the data to arrive at the desired estimate, but we believe that the Time-series approach can capture the forward-looking view we want. We collected 5-year weekly historical stock prices from Eikon for Kongsberg Gruppen ASA and MSCI World index and calculated return and excess return for both Kongsberg Gruppen ASA and MSCI World index. Using 1 year of excess returns, we constructed betas with the Excel function "Slope". We would then move "the window" 1 week at a time, still using 1-year of excess return. This approach will give us updated estimates continuously, using the newest information available.

When choosing the data period, we looked at Kongsberg Gruppen ASA's 1-year betas for five years. We saw a somewhat fluctuating chart, but an overall pattern appeared from 2018. Except for a high in 2019 and a low in 2020, the pattern seems to point towards a beta of 0,8.

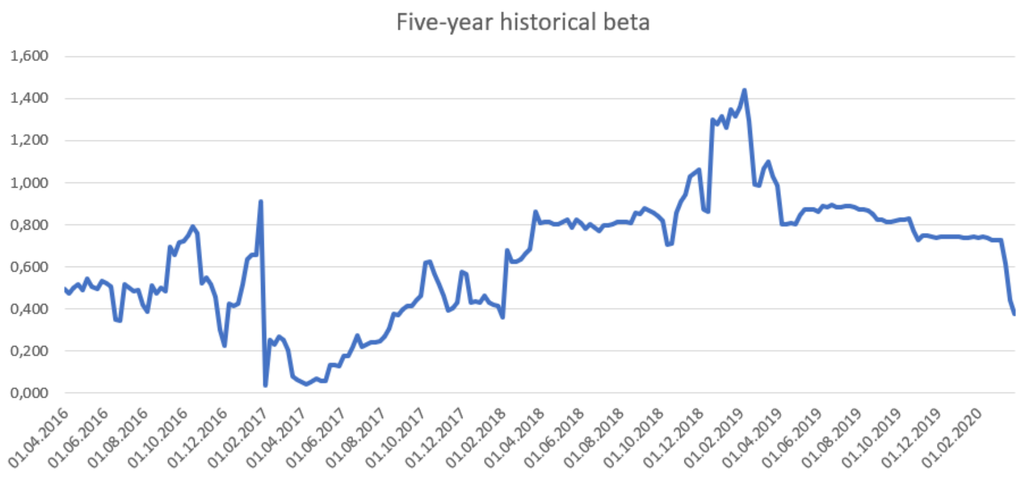

Figure 4 – Five-years historical beta

We limited the data period to 23.03.2018 – 16.04.2021 to isolate what we believe is a pattern. This 3-year historical beta period look like this:

Figure 5 – 3-year historical beta

We believe that the exception in 2020 that leads to a big downfall in beta is associated with the corona pandemic and is considered an extreme outlier. As we can see in figure 5 the beta is on its way up again. Due to the unusual situation, the corona pandemic brought, we want to exclude this decline from our model. The incline in 2019 will remain in our data set as it includes the whole year of 2019. The new 3-year historical beta looks like:

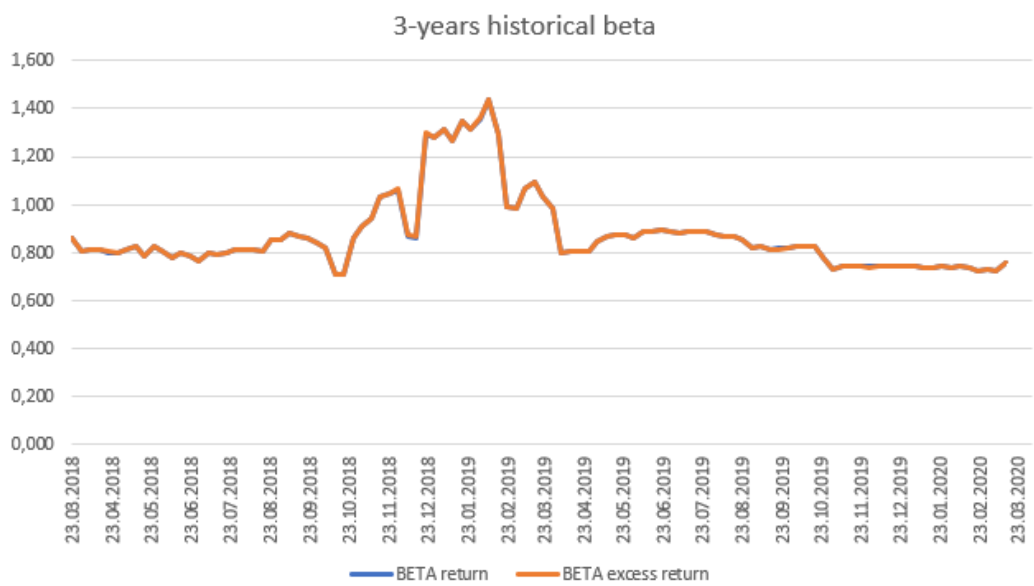

Figure 6 – 3-year historical beta excluding outliers

We want to use these betas to construct formulas that will give us updated forward-looking betas. By using different input and forecast lengths in the Excel function "Linest" we construct a slope and intercept based on these betas. These formulas were constructed with different input lengths of 1, 2, 3, 6, 9 months, and 1 year worth of betas. So, for example, by using 1-year betas, we are constructing a formula that will give us a future beta estimate, based on the betas for the last year. After constructing the formulas, we can forecast a beta for any desired period, by plotting in the desired future period, that can be 1 year into the future, or it can be 4 weeks.

$$Forward - looking\ beta = Slope * time + intercept$$

Formula 15 – Time-series Forward-looking beta

Calculating with 1-year (52 weeks) beta input to forecast two months (8 weeks) into the future, we get the following formula:

$$Time - Series\ Beta\ estimate = -0{,}0082 * (52 + 8) + 1{,}10 = 0{,}61$$

Calculation 9 – Time-series beta estimation

It is the beta 0,61 from the 1-year worth of betas as formula input to calculate a forecast two months' ahead, that will be represented as our Time-series estimate for the rest of this thesis. Chapter five will provide the evidence to why this is the best forecast.

4.2.3 RISK-FREE RATE

In chapter two, we have mentioned two methods to find out what the risk-free rate should be. The first method is about taking the risk-free rate from a Norwegian government bond with an AAA rating meaning low default risk. Norges Bank (2020) states that government bonds have an annual average of 0,82%. This represents a risk-free rate that is backward-looking.

Even though most firms use a historical long-term risk-free rate of 10 or more years, we found the idea of using historical estimates backward-looking, which works against the concept of a forward-looking estimate as WACC. To get a more updated estimate, we used a Norwegian Government bond (NO0010875230) (Den Norske Stat, 2020). We used this bond to calculate a Yield to Maturity rate. From this bond, we found the value of the coupon, the clean price, and what time it expires. We put these numbers into the following formula:

$$Bond\ price = \frac{Coupon\ 1}{(1+YTM)^1} + \frac{Coupon\ 2}{(1+YTM)^2} + \frac{Coupon\ 3}{(1+YTM)^3} + \frac{Coupon\ 4}{(1+YTM)^4} + \frac{Coupon\ 5}{(1+YTM)^5} + \frac{Coupon\ 6}{(1+YTM)^6} + \frac{Coupon\ 7}{(1+YTM)^7} + \frac{Coupon\ 8}{(1+YTM)^8} + \frac{Coupon\ 9}{(1+YTM)^9} + \frac{Face\ value}{(1+YTM)^{10}}$$

Formula 16 – Bond price

$$\frac{1{,}375}{(1+YTM)^{0{,}73151}} + \frac{1{,}375}{(1+YTM)^{1{,}73151}} + \frac{1{,}375}{(1+YTM)^{2{,}73151}} + \frac{1{,}375}{(1+YTM)^{3{,}73425}} + \frac{1{,}375}{(1+YTM)^{4{,}73425}} + \frac{1{,}375}{(1+YTM)^{5{,}73425}} + \frac{1{,}375}{(1+YTM)^{6{,}37425}} + \frac{1{,}375}{(1+YTM)^{7{,}73699}} + \frac{1{,}375}{(1+YTM)^{8{,}73699}} + \frac{100}{(1+YTM)^{9{,}73699}}$$

Calculation 10 – Bond price

We have one unknown variable that is Yield to Maturity. We found this by calculating the dirty price. We used the following formula:

$$Clean\ price +\ Accurate\ Interes = Dirtyprice$$

Formula 17 – Dirty price

The clean price for the Norwegian Government bond (NO0010875230) was retrieved from live.euronext.com on the 25th of November 2020, as this being the newest price available. Putting in the numbers we got a dirty price of 105,394.

$$105{,}025 + (1 + 0{,}73151) * 1{,}375 =\ 105{,}394$$

Calculation 11 – Dirty price

To find the Yield to Maturity we use the “goal seek” function in Excel and solving for YTM. We calculated the YTM estimate to be 0,70%.

4.2.4 IMPLIED EQUITY RISK PREMIUM

When calculating Equity Risk Premium, Kongsberg Gruppen ASA has chosen to use Damodaran’s pre-calculated estimate, which consists of his estimation on country risk + the current risk premium for a mature equity market. We want to use Damodaran’s Implied

Equity Risk Premium, which uses a chosen index and its inputs: "Dividend and stock buybacks", "Expected growth in earnings" and "Current Index price".

As we discussed earlier in chapter two, the choice of Equity Risk approach became obvious. The Implied Equity Risk approach focuses on the future. It has the advantage of not needing historical data, and it is reflecting current market perceptions. Asking ourselves Damodaran's questions on which approach to use, we found that the Implied Equity Approach gives us the highest predictive power. We believe that we cannot forecast the direction of the futures market, and our purpose of the analysis is to calculate the Cost of Capital. We use the DCF model to calculate the implied equity. The main reason for choosing this method is because it does not require us to find comparable companies and includes future expectations about the business (Corporate Finance Institute, n.d.).

Kongsberg Gruppen ASA has previously used MSCI World Index as their reference index when calculating beta because Kongsberg Gruppen ASA is an international company, and the index covers their market. We were unable to retrieve the necessary information from the index that is needed in the Implied Equity Risk Premium. So, we needed to find a different index that would represent Kongsberg Gruppen ASA's market and give us the necessary information. The American index S&P 500 might be a good alternative because MSCI World Index consists of over 50% American companies, and many of Kongsberg Gruppen ASA's competitors are American companies.

On April 30, 2021, the S&P500 Index closed at 4181,17, and the dividend and buybacks yield was 4,68%. The growth in earnings for the index, which is estimated by Bloomberg and an external analyst from InvestorsFriend Inc (Investorfriend Inc., 2021), is estimated to be approximately 4% for the next 5 years. This growth rate cannot be sustained forever, the growth is therefore continued at 4% for the next 5 years, and then lowered to the risk-free rate of 0,70%. If we assume that these are reasonable estimates of the expected dividends, expected growth and that the index is correctly priced, the value can be written as follows:

$$Index\ price\ 30.04.2021 = \frac{CF_1}{1+r} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \cdots + \frac{CF_n * (1+rf)}{(r-rf)*(1+r)^n}$$

Formula 18 – Current Index Price

$$\frac{203{,}51}{1+r}+\frac{211{,}65}{(1+r)^2}+\frac{220{,}11}{(1+r)^3}+\frac{228{,}92}{(1+r)^4}+\frac{238{,}07}{(1+r)^5}+\frac{238{,}07*(1+0{,}70)}{(r-0{,}70)*(1+r)^5}=4181{,}17$$

Calculation 12 – S&P 500 Current Index Price

Solving for r, we will get r = 6,14%

$$Equity\ risk\ premium = r - rf$$

Formula 19 – Implied Equity Risk Premium

$$6{,}14\% - 0{,}70\% = 5{,}44\%$$

Calculation 13 – MSCI Implied Equity Risk Premium

4.3 FACTOR MODELS – FAMA & FRENCH AND CARHART

We choose to use the Fama-French Factor Models and Carhart Four-Factor Model because they claim to explain equity return better than the single-factor model, CAPM. In chapter two we briefly went through how to calculate the factors in the factor models, however, one of the advantages of using factor models is that the factor returns are precalculated on the Kenneth R. French website. This makes the method easy and quick to use. We see this as a positive aspect as the Kongsberg Gruppen ASA, like all other companies, wants a simple practical method that provides good estimates. The data from Kenneth R. French website are based on the US market. We have not calculated the factor returns ourselves and will not go into detail on how to do so. The factor models involve some easy steps. All we need is Kongsberg Gruppen ASA`s daily historical stock prices from Eikon, and the daily value of the factor returns from Kenneth R. French home page for the same period. From there on we constructed a linear regression, from the daily factor returns referred to as β in the formulas below. We also calculate the average of the daily factor returns; this will be the risk premiums. The coefficients from the linear regression are multiplied with the risk premiums called (Mkt-rf), SMB, HML, MOM, RMW and CMA, see formulas and calculations bellow:

4.3.1 Three-Factor model

The formula for Fama- French Three-Factor model is:

$$Cost\ of\ equity = r_f + (\beta_{Mkt-rf} * (Mkt - rf)) + (\beta_{SMB} * SMB) + (\beta_{HML} * HML)$$

$$0{,}0000 + (0{,}6679 * 0{,}0004) + (0{,}3108 * -0{,}0001) + (0{,}2122 * -0{,}0002) = 0{,}02\%$$

Calculation 14 – Three-Factor Model

To get a Cost of Equity for one year we multiply our estimate by 252 days. The Three-Factor Model gives us a Cost of Equity of 5,46%.

$$Cost\ of\ Equity\ one\ year\ =\ 0{,}02\% * 252 = 5{,}46\%$$

4.3.2 Carhart Four-Factor model

$$Cost\ of\ equity = r_f + (\beta_{Mkt-rf} * (Mkt - rf)) + (\beta_{SMB} * SMB) + (\beta_{HML} * HML) + (\beta_{MOM} * MOM)$$

$$= 0{,}0000 + (0{,}6494 * 0{,}0003) + (0{,}2999 * -0{,}0000) + (0{,}0039 * -0{,}0001) + (-0{,}2048 * 0{,}0002) = 0{,}021\%$$

Calculation 15 – Carhart Four-Factor Model

To get a Cost of Equity for one year we multiply our estimate by 252 days. The Carhart-Four Factor Model gives us a Cost of Equity of 5,22%.

$$Cost\ of\ Equity\ one\ year = 0{,}021\% * 252 = 5{,}22\%$$

4.3.3 Five-Factor model

$$Cost\ of\ equity = r_f + (\beta_{Mkt-rf} * (Mkt - rf)) + (\beta_{SMB} * SMB) + (\beta_{HML} * HML) + (\beta_{RMW} * RMW) + (\beta_{CMA} * CMA)$$

$$= 0{,}000 + (0{,}6562 * 0{,}0004) + (0{,}3041 * -0{,}0001) + (0{,}2808 * -0{,}0002) + (0{,}0533 * 0{,}0002) + (-0{,}2275 * -0{,}0001) = 0{,}02\%$$

Calculation 16 – Five-Factor Model

To get a Cost of Equity for one year we multiply our estimate by 252 days. The Fama-French Five Factor Model gives us a Cost of Equity of 5,49%.

$$Cost\ of\ Equity\ one\ year = 0{,}02\% * 252 = 5{,}49\%$$

4.4 COST OF DEBT

To calculate the cost of debt for Kongsberg Gruppen ASA we used the inputs debt, total debt plus equity, pre-tax Cost of Debt, and tax rate. Understanding Kongsberg Gruppen ASA's capital structure is therefore essential. Kongsberg Gruppen ASA is a successful company that has survived uncertain times and markets. An important priority for Kongsberg Gruppen ASA is to have a healthy balance, and one can examine the company's capital structure to witness the company's success.

Kongsberg Gruppen ASA net interest-bearing debt is MNOK 3,949. The long-term interest-bearing debt consists of three long-term bonds that have a total of MNOK 1,950. They also have two short-term interest-bearing bonds, one that expires in June 2021 with a value of MNOK 1,000, and the second expires in December 2021 with a value of MNOK 500. Kongsberg Gruppen ASA has an equity-to-asset ratio of 33,9%, which tells us that Kongsberg Gruppen ASA owns 1/3 of its assets. The remaining 2/3 is primarily attributable to the shareholders of Kongsberg Gruppen ASA. They have a market value of debt of MNOK 2.014 and a market value of equity of MNOK 32.758.

To calculate the Cost of Debt we looked up Kongsberg Gruppen ASA`s rating. We found out that Kongsberg Gruppen ASA is A- (Nordic Credit Rating , 2021), and used Damodaran`s (2021) calculated default spreads related to ratings. The credit spread is 133 basis points and a default spread of 1,33% for Kongsberg Gruppen ASA. Together with 3-months NIBOR rate of 0,39% (Norske Finansielle Referanser AS, 2021), we can calculate Kongsberg Gruppen ASA's pre-tax Cost of Debt.

$$Pre - tax\ Cost\ of\ Debt = credit\ spread + 3M\ NIBOR$$

Formula 20 – Pre-tax Cost of Debt

To arrive at Kongsberg Gruppen ASA's market value of long-term debt, we took the issued amount and value for their three outstanding long-term bonds and multiplied them. The market value of debt ended up being 20.13.680.000, -. Kongsberg Gruppen ASA`s equity we calculated to be 32.758.191.839, -.

$$Pre - tax\ Cost\ of\ Debt = 1{,}33\% + 0{,}45\% = 1{,}78\%$$

Calculation 17 – Pre-tax Cost of Debt

When calculating the Cost of Debt for WACC we use the after-tax Cost of Debt. With all the necessary inputs, we use the following formula to calculate the Cost of Debt for Kongsberg Gruppen ASA:

$$Cost\ of\ Debt\ = \frac{D}{D+E} * r_d\ * (1 - tax\ rate)$$

Formula 21 – Cost of Debt

$r_d = Pre - tax\ cost\ of\ debt$

$$Cost\ of\ Debt\ = \frac{2013680000}{2013680000 + 32758191839} * 1{,}78\%\ * (1 - 22\%) = 0{,}08\%$$

Calculation 18 – Cost of Debt

Kongsberg Gruppen ASA's Cost of Debt are calculated to be 0,08%

CHAPTER FIVE – EMPIRICAL ANALYSIS

This chapter focus on testing and interpretating the empirical results of Bottom-up beta, Time-series beta and the Factor Models.

5.1 EMPIRICAL ANALYSIS BOTTOM-UP BETA

From chapter four, we calculated a Bottom-up beta of 0,99. To measure error and "fit" for Bottom-up beta, we use the standard error. We plot our estimates into the formula presented by Damodaran:

$$Standard\ Error\ for\ Bottom - up\ beta = \frac{0{,}1614}{\sqrt{19}} = 0{,}0370$$

Calculation 19 – Standard Error for Bottom-up beta

Damodaran (2020) states that the standard error for a Bottom-up beta will be significantly lower and more precise than in a single regression beta because the Bottom-up beta is averaging across the regression betas. It might introduce potential bias, as we may risk comparing Kongsberg Gruppen ASA to companies that might be too unlike themselves.

To compare if there is a significant difference in standard error between Bottom-up and a single regression beta, we have performed a single regression of Kongsberg Gruppen ASA's historical data to calculate the standard error:

Regression statestics	
Multiple R	0,4517
R-square	0,2041
Adjusted R- square	0,1973
Std error	0,0604
Observations	120

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,1104	0,1104	30,2546	0,0000
Residual	118	0,4306	0,0036		
Total	119	0,5410			

	Coefficients	*Standard Error*	*t-Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0,000721	0,005599	0,128776	0,897754	-0,010366	0,011808
Reference index	0,752279	0,136768	5,500417	0,000000	0,481442	1,023116

Table 2 – Single regression of Kongsberg Gruppen ASA

$$\frac{Bottom-up\ Beta\quad VS.\quad Single\ Regression\ Beta}{0{,}0370 < 0{,}1368}$$

The standard error for a single regression beta is 0,1368, and just as Damodaran stated; significantly higher than our standard error for the Bottom-up beta of 0,0370.

Using Bottom-up beta leaves us with the following inputs to Kongsberg Gruppen ASA's WACC formula:

WACC - Bottom-up Beta	
Cost of Equity - CAPM	**6,08 %**
Risk-free rate	0,70 %
Beta	0,99
Risk premium	5,44 %
Equity	32 758 191 830
Cost of Debt	**1,34 %**
Pre-tax Cost of Debt	1,72 %
Tax rate	22,0 %
Debt	2 013 680 000
Total E+D	34 771 871 830
WACC	**5,80 %**

Table 3 – WACC - Bottom-up

By using Bottom-up beta with our other estimates, in Kongsberg Gruppen ASA's WACC calculation, we are left with this WACC:

$$WACC = 5{,}72\% * \frac{32.758\ MNOK}{34.772\ MNOK} + 1{,}72\% * (1 - 22\%) \frac{2.014\ MNOK}{34.772\ MNOK} = 5{,}80\%$$

Calculation 20 – WACC with Bottom-up beta

5.2 EMPIRICAL ANALYSIS OF TIME-SERIES BETA

Time-series offer us the chance to obtain forward-looking estimates by forecasting betas based upon chosen data periods, data lengths and forecast length. This gives us many combinations and options. Choosing which combination that gives us the best forecast, we have tested how well they predict. By moving back in time and predicting already known betas, we can compare the predicted beta with the actual beta for that period. The measures we are using are Mean Absolute Deviation (MAD), Mean Square Error (MSE), Root of the Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE). We are choosing the model which presents the lowest error measures.

By forecasting two months ahead, the error measures are as follows:

Forecast with 1 month beta data			Forecast with 2 month beta data			Forecast with 3 month beta data		
MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE
0,22	0,16	24,08 %	0,18	0,08	19,01 %	0,19	0,09	20,84 %
	0,394			0,281			0,298	

Forecast with 6 month beta data			Forecast with 9 month beta data			Forecast with 1 year beta data		
MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE
0,23	0,09	24,50 %	0,18	0,06	20,33 %	0,17	0,04	20,85 %
	0,301			0,250			0,199	

By forecasting six months ahead, the error measures are as follows:

Forecast with 1 month beta data			Forecast with 2 month beta data			Forecast with 3 month beta data		
MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE
0,81	1,60	92,95 %	0,73	0,86	81,28 %	0,65	0,68	72,90 %
	1,267			0,925			0,826	

Forecast with 6 month beta data			Forecast with 9 month beta data			Forecast with 1 year beta data		
MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE
0,42	0,30	51,20 %	0,41	0,23	50,74 %	0,37	0,17	48,85 %
	0,551			0,480			0,413	

By forecasting 1 year ahead, the error measures are as follows:

Forecast with 1 month beta data			Forecast with 2 month beta data			Forecast with 3 month beta data		
MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE
1,77	7,96	234,42 %	1,14	2,69	151,23 %	0,95	1,88	126,56 %
	2,821			1,640			1,372	

Forecast with 6 month beta data			Forecast with 9 month beta data			Forecast with 1 year beta data		
MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE	MAD	MSE/RMSE	MAPE
0,86	1,22	116,51 %	0,98	1,08	133,47 %	0,93	0,86	122,79 %
	1,104			1,037			0,927	

From chapter four we emphasized the importance of being careful when using MSE and MAPE, due to outliers and that betas do not have a true zero. We can see these effects in our data; when we are using 1 months' worth of betas as formula input to calculate a forecast 1 year ahead, we get an MSE value of 7,96. This value is significantly higher than any of our other MSE values, and this is due to extreme outliers in this forecast. We can also see a MAPE value of 234,42%, as this forecast includes extreme negative and positive estimates. This proves to us that we need to look at our results with practical eyes, but also examine some of the results manually.

We have identified 1 years' worth of betas as formula input to calculate a forecast two months ahead as the best forecast.

Forecast with 1 year beta data		
MAD	MSE/RMSE	MAPE
0,17	0,04	20,85 %
	0,199	

Not only does it produce the lowest estimate MAD, MSE, and RMSE amongst all the different forecast combinations, but it also produces one on the lowest MAPE. Using this forecast combination, we get beta:

$$Time - Series\ Beta\ estimate = -0{,}0039 * 60 + 0{,}91 = 0{,}61$$

Calculation 21 – Time-series beta estimation

It is therefore the beta 0,61 from the 1-year worth of betas as formula input to calculate a forecast 2 months' ahead, that will be represented as the Time-series estimate for the rest of this thesis and compared to the other models.

Using Time-series beta leaves us with the following inputs to Kongsberg Gruppen ASA's WACC formula:

WACC - Time Series	
Cost of Equity - CAPM	**4,02 %**
Risk-free rate	0,70 %
Beta	0,61
Risk premium	5,44 %
Equity	32 758 191 830
Cost of Debt	**1,34 %**
Pre-tax Cost of Debt	1,72 %
Tax rate	22,00 %
Debt	2 013 680 000
Total E+D	34 771 871 830
WACC	**3,86 %**

Table 4 – WACC - Time-series

By using Time-series beta with our other estimates, in Kongsberg Gruppen ASA's WACC calculation, we are left with this WACC:

$$WACC = 3{,}79\% * \frac{32.758\ MNOK}{34.772\ MNOK} + 1{,}72\% * (1 - 22\%)\frac{2.014\ MNOK}{34.772\ MNOK} = 3{,}86\%$$

Calculation 22 – WACC with Time-series beta

5.3 EMPIRICAL ANALYSIS OF THE FACTOR MODELS

We calculated the Three, Four, and Five-factor models with daily 2-, 5- and 10-years of data. The daily 2-years data seem to produce the most reliable betas amongst the chosen period when looking at R^2 and adjusted R^2. Despite this, we choose 10-year daily data as our data input. There are multiple reasons for this decision; first, as we see in table 7, 2-years data input produces unusually high Cost of Equity estimates, which seem unreasonable to us and give poor estimates in practice.

Secondly, even though we observe a higher R^2 for 2-years data, we believe this is caused by unusually high returns in the markets that period. In practice, when there are few data points, the regression line will adapt so that the coefficients partly will capture random variation, and therefore R^2 tends to increase with more observations. But this effect is not seen in our model. What we see is a problem that the coefficients estimated are hardly constant over time. Thus, the model will not fit well with data for a long time period as for a short time period. In addition, the volatility of securities is not constant and therefore implies heteroskedasticity. The long period may capture extraordinary volatility which will give a lower R^2, even if the coefficients were constant, because the risk factors explain a smaller share of total risk.

Long data series give low standard errors for the coefficients, but if the coefficients are not constant, we get inaccuracy because we have many data points far back in history. It also means that R^2 is not decisive for the assessment of models in this context. We, therefore, choose 10-years of data as our data input based on the practical reasons presented.

R-Squared	Three-Factor	Carhart Four-Factor	Five-Factor
2-years	0,2076	0,2104	0,2097
5-years	0,0889	0,0893	0,0924
10-years	0,1011	0,1037	0,1015

Table 5 – R-Squared Factor Models

Adjusted R-Squared	Three-Factor	Carhart Four-Factor	Five-Factor
2-years	0,2028	0,2041	0,2017
5-years	0,0867	0,0864	0,0888
10-years	0,1000	0,1022	0,0997

Table 6 – Adjusted R-Squared Factor Models

Cost of Equity	Three-Factor	Carhart Four-Factor	Five-Factor
2-years	12,69 %	16,54 %	13,57 %
5-years	6,36 %	6,77 %	7,34 %
10-years	5,46 %	5,22 %	5,49 %

Table 7 – Cost of Equity Factor models

The factors in the factor models with 10-years data input will also be individually examined with p-value. Our null hypothesis for our analysis is that the coefficient is 0 and that the coefficient has no effect on our model.

$$H0: \beta_n = 0, no\ effect$$

$$H1: \beta_n > 0, effect$$

We will use a confidence level of 95% in our analysis. In other words, we will reject the null hypothesis if we observe a p-value under 0,05.

Regression statestics	
Multiple R	0,3087
R-square	0,0953
Adjusted R- square	0,0949
Std error	0,0178
Observations	2471

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0,0827	0,0827	260,0852	0,0000
Residual	2469	0,7852	0,0003		
Total	2470	0,8679			

	Coefficients	Standard Error	t-Stat	P-value	Lower 95%	Upper 95%
Intercept	0,0001	0,0004	0,1582	0,8743	-0,0006	0,0008
Mkt-RF	0,6228	0,0386	16,1272	0,0000	0,5470	0,6985

Table 8 – Regression CAPM

From table 8 we can see the results from a regression we did with the market factor. We find that the market factor (Mkt- RF) is statistically significant at the 95% confidence level.

Regression statestics	
Multiple R	0,3180
R-square	0,1011
Adjusted R- square	0,1000
Std error	0,0178
Observations	2471

ANOVA

	df	SS	MS	F	Significance F
Regression	3	0,0878	0,0293	92,5230	0,0000
Residual	2467	0,7802	0,0003		
Total	2470	0,8679			

	Coefficients	Standard Error	t-Stat	P-value	Lower 95%	Upper 95%
Intercept	0,0001	0,0004	0,2759	0,7826	-0,0006	0,0008
Mkt-RF	0,6679	0,0433	15,4206	0,0000	0,5830	0,7528
SMB	0,3108	0,1033	3,0077	0,0027	0,1082	0,5134
HML	0,2122	0,0835	2,5419	0,0111	0,0485	0,3759

Table 9 – Regression Three-Factor Model

Table 9 show the results from the Three-Factor Model regression. Mkt-RF, SMB, and HML are all statistically significant at a 5% level, indicating that they all have an effect on our model. We can also see that the SMB and HML factors are both positive, which indicates that that the Three-Factor model is the only model with substantial exposure to value and size.

Regression statestics	
Multiple R	0,3219
R-square	0,1037
Adjusted R- square	0,1022
Std error	0,0178
Observations	2471

ANOVA

	df	SS	MS	F	Significance F
Regression	4	0,0900	0,0225	71,2899	0,0000
Residual	2466	0,7780	0,0003		
Total	2470	0,8679			

	Coefficients	Standard Error	t-Stat	P-value	Lower 95%	Upper 95%
Intercept	0,0001	0,0004	0,3026	0,7622	-0,0006	0,0008
Mkt-RF	0,6494	0,0438	14,8179	0,0000	0,5635	0,7354
SMB	0,3000	0,1033	2,9042	0,0037	0,0974	0,5025
HML	0,0039	0,1150	0,0341	0,9728	-0,2215	0,2293
MOM	-0,2049	0,0779	-2,6314	0,0086	-0,3576	-0,0522

Table 10 – Regression Four-Factor Model

From table 10 we get the results for the Four- Factor Model. Mkt-RF, SMB and MOM are statistically significant at a 5% level, indicating that they all have an effect on our model. When introduction MOM into the model it made HML insignificant. Concluding that HML do not influence this model.

Regression statestics	
Multiple R	0,3186
R-square	0,1015
Adjusted R- square	0,0997
Std error	0,0178
Observations	2471

ANOVA

	df	SS	MS	F	Significance F
Regression	5	0,0881	0,0176	55,6982	0,0000
Residual	2465	0,7798	0,0003		
Total	2470	0,8679			

	Coefficients	Standard Error	t-Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Intercept	0,0001	0,0004	0,2715	0,7861	-0,0006	0,0008	-0,0006074	0,00080258
Mkt-RF	0,6562	0,0481	13,6308	0,0000	0,5618	0,7506	0,56181465	0,7506217
SMB	0,3041	0,1055	2,8823	0,0040	0,0972	0,5110	0,09720607	0,51098449
HML	0,2808	0,1362	2,0618	0,0393	0,0137	0,5479	0,01373701	0,54791171
RMW	0,0533	0,1848	0,2886	0,7729	-0,3090	0,4157	-0,3090418	0,41570133
CMA	-0,2275	0,2281	-0,9975	0,3186	-0,6748	0,2198	-0,6748407	0,21976301

Table 11 – Regression Five-Factor Model

Table 11 show the results from the Five-Factor Model regression. Here we can see that the only factors that are significant are Mkt-RF, SMB and HML. They are statistically significant at a 5% level, indicating that they all have an effect on our model. RMW and CMA are insignificant, which tells us they do not have an impact on our model. A negative CMA indicates that companies invest aggressively.

Out of the factor models, Three-Factor Model, Carhart`s Four-Factor Model, and the Five-Factor model, it is the Three-Factor Model that performs the best. This is because all its coefficients; Mkt-RF, HML, and SMB are statistically significant at 5% level. It is therefore the Three-Factor Model that will be compared to the other models. Even though the results indicate all statistically significant coefficients, the low R^2 and Adjusted R^2 weakens the model.

Using Fama-French Three-Factor Model inputs into Kongsberg Gruppen ASA's WACC formula, we get:

WACC - Three-Factor Model	
Cost of Equity - Three-Factor model	**5,46 %**
Equity	32 758 191 830
Cost of Debt	**1,34 %**
Pre-tax cost of debt	1,72 %
Tax rate	22,00 %
Debt	2 013 680 000
Total E+D	34 771 871 830
WACC	**5,22 %**

Table 12 – WACC - Three-Factor Model

Using the Cost of Equity calculated with the Three-Factor model in Kongsberg Gruppen ASA's WACC calculation, we get the following WACC:

$$WACC = 5,46\% \frac{32.758\ MNOK}{34.772\ MNOK} + 1,72\% * (1 - 22\%) \frac{2.014\ MNOK}{34.772\ MNOK} = 5,22\%$$

Calculation 23 – WACC with Three-Factor Model

CHAPTER SIX – DISCUSSION

Earlier chapters reviewed the relevant theory, presented Kongsberg Gruppen ASA's WACC calculation, and calculated and tested the estimates of the different WACC inputs. In this chapter, the complete WACC calculation will be presented, which will be compared with Kongsberg Gruppen ASA. The recommendation for the optimal WACC calculation, based upon results and best practices, are introduced.

6.1 COST OF EQUITY

We start with the Cost of Equity, more precisely the Capital Asset Pricing Model and the Fama-French Three-Factor Model. While CAPM consists of different inputs that require different calculation methods, the Fama-French Three-Factor Model gives us the Cost of Equity right away. Throughout this thesis, it has been the beta estimate that has required the most of us, as there are many different methods of calculating the beta. We have considered the Bottom-up beta and Time-series beta. From chapter five we calculated error measures for the different calculation methods, unfortunately, we do not have the same error measures for both the Bottom-up approach and Time-series beta. This can make the comparison across approaches difficult. We are therefore judging the approaches on individual results. As shown in chapter five, a Bottom-up beta produces a lower standard error than a single regression beta. The standard error for bottom-up beta is 0,0370, which we consider low, and therefore a good option based on the results. Our chosen Time-series beta is compared with our other Time-series beta estimates. Our chosen Time-series beta had the following results:

Forecast with 1 year beta data		
MAD	MSE/RMSE	MAPE
0,17	0,04	20,85 %
	0,199	

As stated in chapter five are the best amongst the other forecasts, but are they good enough compared to Bottom-up beta? As already expressed, it is difficult to compare across approaches when we do not have the same error measures, however, Time-series beta seems to vary significantly based on the period being used. The forecast that was chosen can predict any time into the future, however it was the two months prediction that produces the lowest error measures. While Bottom-up beta seems to be a more stable approach and claims to produce a forward-looking estimate, it is uncertain how far into the future the beta represents. When it comes to the practical part of the approaches; the Bottom-up approach was the easiest to use, which is one of Kongsberg Gruppen ASA's wishes to the calculation. The approach uses data from its peers and tries to paint a picture of Kongsberg Gruppen ASA's real market, as Time-series uses the general US market. The Bottom-up beta is estimated to be 0,99, which produces a WACC of 5,82%, Time-series beta is estimated to be 0,61 which produces a WACC of 3,87%. While a lower WACC indicates higher market value, we believe that a WACC of 5,82% is more reasonable. Looking at this with practical eyes, we believe that the Bottom-up beta produces a more reliable WACC than Time-series. Based on these arguments we believe that the Bottom-up beta produces the best beta for CAPM. Except for the beta adjustment and excluding taxation, Kongsberg Gruppen ASA also uses the Bottom-up beta. We recommend Kongsberg Gruppen ASA to continue using Bottom-up beta, but excluding the beta adjustment, as it forces beta towards 1 and including taxation due to a theoretical perspective.

When it comes to Equity Risk Premium, we knew that we wanted a forward-looking estimate. While Kongsberg Gruppen ASA used the pre-calculated Country Equity Risk Premium for Developed Markets, we wanted to calculate the Implied Equity Risk Premium to gain more control and insight into the complex estimate.

We were supposed to use MSCI World Index as our reference index, due to its international coverage. However, due to a lack of information and data about the index, we were forced to investigate other indexes. We considered whether we should use another index that dealt with Europe market since Kongsberg Gruppen ASA runs a large part of their business in Norway, but we concluded that it would have been controversial to work with premium limited to only Europe and is therefore not well diversified. We ended up using S&P 500 index. Not only is information and data easily accessible, but the MSCI World index does also contains most American companies, which makes the difference small. One might argue that using the S&P 500 also leads to undiversified premiums, but we believe that using an index that enables us to use Implied Equity Risk Premium provides a more forward-looking estimate.

The risk-free rate that we have calculated based on a Norwegian Government bond will give us a more up-to-date estimate, pre-estimated risk-free rate based upon historical data. Kongsberg Gruppen ASA has based its risk-free rate estimate upon a 10-year bond issued by Norway. This will give a more historical view, rather than a forward-looking view like we want for this WACC calculation. The risk-free rates ended up rather similar, as Kongsberg Gruppen ASA got a risk-free rate of 0,73%, and we calculated it to be 0,70%.

The other method we used to calculate the Cost of Equity was Fama-French Three-Factor Model. This model is very unlike the other method we have used, but it is an easy method to implement when using the variables from Kenneth French`s website. This is a method where you can calculate all the variables yourself and perhaps get an even more precise estimate. Calculating the variables is a big task, and beyond the scope of this thesis.

We believe that we do not have a substantial basis to compare CAPM against the Fama-French Three-Factor Model, this is due to lack of statistical measures that can compare the estimates. We have therefore compared the methods in a theoretical and practical way. CAPM only presents one factor, the beta calculated by the Bottom-up approach, while the Fama-French Three-Factor Model presents three factors that are supposed to address Kongsberg Gruppen ASA's abilities. CAPM only presenting one beta does not have to be a disadvantage, as the estimate is forward-looking and uses Kongsberg Gruppen ASA's peers to tell us about the relevant market.

In our Fama- French Three-Factor model with 10 years of data, all the factors are statistically significant, which means that it has a positive impact on the model. In other words, Kongsberg Gruppen ASA has substantial exposure to value and size, and the model therefore gives valuable information. By having more betas, we expand the capability of the model, and the factors will explain more of the returns than the CAPM could. Both methods were relatively easy to compute and seem very doable in practice. If one were to calculate the variables in the Fama-French Three-Factor we believe one would stand over a greater challenge, but using pre-calculated variables gives us the Cost of Equity within minutes.

We feel confident in both models, but since the estimate of the Fama-French Three-Factor Model is not calculated by hand, we conclude that the CAPM with Bottom-up beta presents the most relevant estimate. We are sceptical of the Fama-French Three-Factor model due to its more controversial choices in how they have divided the companies, compared to the composition of stock indexes, but it is not fundamentally different. More arguments against the factor models may underlie problems surrounding the estimation of risk premiums, that from a practical point of view they are more demanding for users to understand. We have also mentioned earlier that the theory behind the factor model is not as solid as, for example, CAPM.

Below you will find the comparison between our WACC calculation (Current WACC 2021), and Kongsberg Gruppen ASA`s calculation from the previous year (Previous WACC- KOG 2020). We can see an overall decrease in estimates causes the WACC for 2021 to decrease to 5,80% from 6,09% in 2020.

WACC Calculation	Current WACC 2021	Previous WACC - KOG 2020	Change
Unlevered Beta	0,94	1,00	-6,04 ppt.
Other Input Variables			
Risk Free Rate	0,70 %	0,73 %	-0,03 ppt.
Market Risk Premium	5,44 %	5,20 %	0,24 ppt.
Pre-Tax Cost of Debt	1,72 %	2,67 %	-0,95 ppt.
Tax Rate	22,00 %	22,00 %	0,00 ppt.
Capital Structure			
Equity	94,21 %	88 %	5,81 ppt.
Debt	5,79 %	12 %	-5,81 ppt.
Levered Beta	0,99	1,13	-14,38 ppt.
Cost of Capital			
Cost of Equity	5,72 %	6,61 %	-0,89 ppt.
Cost of Debt	0,08 %	2,08 %	-2,00 ppt.
WACC (after tax)	**5,80 %**	**6,09 %**	**-0,28 ppt.**
WACC (pre-tax)	7,44 %	7,80 %	-0,4 ppt.

Table 13 – WACC Calculation Summary 2021-2020

Figure 7 – Input changes in WACC 2021-2020

Figure 7 show the input variables that have caused the WACC to decrease from 2020 to 2021. The figure show that it is the beta and market return that have contributed the most to the change in WACC.

6.2 COST OF DEBT

When it comes to the Cost of Debt in our WACC calculation, our methods are the same as Kongsberg Gruppen ASA. The difference being the bonds included are updated and the rating is now an A- rating for Kongsberg Gruppen ASA, instead of BBB. This new rating gives 1,33% in credit spread for Kongsberg Gruppen ASA.

CHAPTER SEVEN – CONCLUSION

In this thesis we tried to answer the question:

"Consider the use of different calculation methods for WACC, and their weaknesses/strengths to obtain the best possible estimate for Kongsberg Gruppen ASA"

We have reviewed the relevant theory and approaches in the search for the method that produces the best possible estimate. The best possible estimate is an estimate that is reliable as possible, future-oriented, but is also a practically applicable estimate. Based on these desired characteristics, we recommend Kongsberg Gruppen ASA to use a WACC calculation that is similar to what they are using today, as their calculations already are highly updated with the academic theory and customized to practice. There are still some adjustments and changes we would recommend, to produce an even more updated and forward-looking estimate. We want to calculate as much as possible, instead of using pre-calculated estimates, so that we gain more control over what is included in Kongsberg Gruppen ASA's WACC calculation.

We recommend Kongsberg Gruppen ASA to use CAPM as their method for calculating the Cost of Equity. Within the CAPM we propose using Bottom-up betas without doing a beta adjustment, like the Blume adjustment performed by Kongsberg Gruppen ASA in earlier years. Risk-free rate should be the Yield to Maturity calculated of Norwegian Government Bonds, instead of using the pre-calculated estimate for Yield to Maturity on a 10-year Norwegian Government bond. For the Equity Risk Premium, we recommend calculating the Implied Equity Premium, which secures a more controlled and forward-looking estimate, versus using a pre-calculated Country Equity Risk Premium for Developed Markets.

Even though we recommend using CAPM, we would like to shed light on the Fama-French Three-Factor Model. As the model presents three factors, it expands the capability of the model compared to CAPM. We believe that the model could be a good option for Kongsberg Gruppen ASA, if they were to calculate the factors themselves.

In the Cost of Debt part in our WACC calculation, we have used the same calculation method as Kongsberg Gruppen ASA. This method is satisfactory in finding a market value of the Cost of Debt and is easy to use. We have simply just updated Kongsberg Gruppen ASA's credit rating and long-term debt.

We arrived at a Cost of Equity of 6,08% with the use of CAPM with Bottom-up beta and a Pre-tax Cost of Debt of 1,72%. Together with the debt and equity weights, these two merged to a WACC of 5,80%.

For further research, we recommend Kongsberg Gruppen ASA to look into the possibility of calculating the factors in Fama-French Three-Factor Model. We also recommend other researchers to investigate new methods and possibilities, such as the Fama-French Five-Factor Model, in calculating Cost of Equity and continue to question the good old method CAPM.

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