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Evaluating fuel cost hedging for

SKYSS

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Abstract

The focus of this thesis is to analyse if Skyss, a Norwegian public transport company, can improve its budget certainty through hedging its diesel fuel cost. The hedging strategies is compared to the current contract situation of the company. Currently, Skyss enter contracts with operators, and the compensation payed is determined by the development of an index. The percentage change in the index, from one period to the next, decides the amount of compensation payed between the parties. Our challenge is to find a financial instrument that correlates with this index in such a way that we can create offsetting cash flows, hence improve budget certainty for Skyss. Ideally, when the index increases, and Skyss has an increased compensation to the operator, the financial instrument would profit the same absolute amount.

The financial instruments used in the analysis is futures and swaps. For the futures hedging strategy we have used two different contracts; Low Sulphur Gasoil Futures (QS) and Bloomberg Prices for ULSD 10ppm CIF NWE Futures (FLSOM). For the swap agreement, we have used ULSD 10ppm CIF NWE Cargoes NWE (Platts) as the underlying floating hedging product, and Low Sulphur Gasoil Futures (QS) to determine the fixed price.

We have used historical data to create a synthetical hedging strategy, and have divided this data into multiple sub-samples to test and compare results for different time periods. Our findings are that three out of four futures contract, and half of the swap-agreements, improves the financial results for Skyss. However, both hedging strategies increase the standard deviation in payments, which is not ideal from a budget certainty perspective. We find that Skyss' current contract situation alone gives higher predictability over future diesel fuel costs, and do not recommend Skyss to enter a diesel fuel hedging program.

Acknowledgments

This master thesis is the final part of our Master of Science in economics and business administration at the Norwegian school of economics (NHH). This topic came to our attention after Skyss contacted NHH with some potential thesis topics, and after a meeting with Skyss, we decided for the topic of hedging of fuel cost, as this is relevant both for Skyss and our self.

The work on this thesis has been educational, comprehensive and demanding, and we want to thank our supervisor, Malin Arve, Associate professor at the Norwegian School of economics, for helpful feedback throughout the semester. We also want to thank Odd Harald Dommersnes (CFO Skyss), Daniel Eide (Tide) and Sebastian Malmstein (DNB) for their help and guidance. We greatly appreciate their input to this thesis.

Bergen, May 2019

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1.0 Introduction

1.1 Motivation

This master thesis will be looking at the diesel fuel cost of a public transport company, and analyse whether the company would benefit from hedging this specific cost, more precisely the auto diesel cost related to bus. Auto diesel is correlated with the oil price, and oil price has been highly volatile for the last 25 years. The goal for our hedging strategy is not to speculate in the market and earn a profit, but to compensate for any increases or decreases in the diesel fuel price and therefore improve budget certainty. We will do that by focusing on two different hedging strategies; futures contracts and a swap agreement, and we find it interesting to analyse whether the company benefits from one of those strategy, or if the current situation is more effective. The company we will be looking at for this thesis is Skyss, a Norwegian public transport company in Hordaland, Norway.

1.2 Problem statement

The goal of this thesis is to look at how Skyss currently protects itself against fluctuations in its fuel cost and analyse two different hedging strategies. We want to emphasize that our aim with the study is for Skyss to improve its budget certainty, meaning that we want to make future expenses more predictable by trading financial instruments. This approach excludes any speculation in trading financial instruments solely to make a profit from the trade. Budget volatility is particularly difficult for public transport companies, as they often have limited operational and budget flexibility.

Problem statement:

"Could Skyss improve its budget certainty by hedging their auto diesel fuel costs, or is the current contract situation more effective?"

1.3 Structure

Chapter 1 is the introduction to the thesis. Our motivation, problem statement and the structure of the thesis is presented is this section.

Chapter 2 gives a short presentation of Skyss, and the market they operate in. We will also illustrate how a contract between Skyss and one operator works.

Chapter 3 gives an overview of the oil market, factors that drives the price of oil and the its development.

Chapter 4 is the theoretical fundament of the thesis. In this chapter, we will present hedging, different kinds of risk, and financial instruments. We will also discuss advantages and disadvantages of hedging.

Chapter 5 is the methodology chapter of this thesis. We will discuss the thesis' research design, how we gathered information and data, and how we processed the data. The hedging instruments used in the analysis will be presented here.

Chapter 6 present the results from the futures and swap hedging strategies. We will discuss specifics surrounding these strategies, as well as currency exposure.

Chapter 7 is a discussion about some overall points regarding both strategies

Chapter 8 Conclusion

2.0 Background

2.1 Skyss

Skyss is a Norwegian public transport company established in November 2007, operating in Hordaland, Norway. Its responsibility is to plan, purchase and market public transport services, and enter contracts with operators who will execute the operations of the service. Its overall goal is to help the Norwegian government reach its zero-growth goal for private passenger traffic, by taking the essential part of the expected traffic growth in the county (Skyss, 2019).

Skyss spent 193M NOK on auto diesel cost related to bus in 2017 and 202M NOK in 2018, which constitutes just under 15% of its total costs (email, 11. march 2019). Remaining costs are related to personnel, administration, and repair and maintenance. Skyss is budgeting with a deficit and receives subsidies from Hordaland county to cover for it. Since 2013 the subsidy has been between 1,2-1,3 billion NOK.

In addition to bus transportation, Skyss is also responsible for different light rail, express boats and ferries. Operating costs associated with bus make up just under 60% of total operating costs. While Skyss has also non-diesel fuel cost from, for example, light rail, which uses electricity, other energy sources are left out of the thesis as these only make up a small share of total operating cost. Cost towards diesel fuel for buses makes up the largest share of Skyss' total fuel cost (Skyss, 2017), hence this cost will be the focus of our thesis.

2.2 Public transport market

The public transport traffic in Norway grows each year, partly due to the Norwegian government's zero growth goal (Regjeringen, 2017). From 2004-2017, Norway experienced an increase of 100 million yearly passengers (SSB, 2016 & 2019a). The same rise can be seen in Hordaland, as shown below. The increase in public transportation has been driven by rising fuel cost, and increased population growth, especially in big cities (Statens vegvesen, 2017).

	2013	2014	2015	2016	2017
Bus passengers	41 416 000	42 502 000	43 352 000	44 741 000	56 162 000
Total Passengers	50 859 000	52 707 000	54 365 000	56 380 000	69 863 000
Growth bus passengers		2,62 %	2,00 %	3,20 %	25,53 %

Table 1: Public transport passengers in Hordaland county

The implementation of a new passenger counting system in 2017 caused a significant increase in the number of yearly passengers. Nevertheless, we can see an increase in passengers each year before the new system. This implies that the need for public transport in the future will not fade away, if anything, it will continue its positive growth.

2.3 Contract

Skyss and the operator negotiate a gross-cost contract, which states that Skyss pays the operator a specific sum each period for them to provide a specific service over the duration of the contract, while they keep the revenues from the service provided themselves (Skyss, 2017). The operators have the responsibility for implementing the services. Skyss use tendering to enter cooperation with an operator, which mean that who the operators are, can change. Right now, most of the contracts are with Tide, the second largest bus company in Norway.

The duration of the agreement is usually ten years and consist of multiple periods. Payment is due at the end of each period. If the payment is due quarterly, then one period equals one quarter. Depending on what is specified in the contract, payment can also be based on annually or semi-annually periods. We define a period as the period where a payment is due.

2.3.1 SSB Index

The payment between Skyss and the operator is regulated by a cost index for passenger transport by bus, created and updated by the national statistical institute of Norway (SSB), which describes the price trends for bus operating costs (SSB, 2019b). The index is divided into six different cost groups: labour costs, auto diesel (fuel), depreciation, real interest rates, repair and maintenance costs, and administrative costs (table 2). The contract between Skyss and the operator is divided into four parts; 63% of the total cost is counted as personnel costs, 15% as fuel cost, 12% as administration cost and 10% repair and maintenance. Fuel cost is taken out of the contract and regulated against the auto diesel index. We solely focus on fuel cost in this thesis, and therefore focus only on the auto diesel index, as this is the part that drives the contract regulation related to fuel cost. Consequently, when referring to the SSB index for the rest of this thesis, we are referring to the SSB auto diesel index. The index number itself is uninteresting. What we want to know is the change each period, as this is what causes an increase or decrease in payment to Skyss' operator. The statistics are updated quarterly.

Periode	Total	Labour	Auto diesel	Real interest	Repair	Admin
2013Q2	84,8	88,6	95,5	56,9	86,8	87,2
2013Q3	85,8	89	99,5	58,1	87,4	87,7
2013Q4	86,4	89,8	99,5	59,4	87,9	88
2014Q1	86,7	90,4	99,7	56,6	89,4	88,7
2014Q2	86,1	90,9	97,3	52,1	90,2	89
2014Q3	86,7	92	98,2	50,2	90,7	90
2014Q4	86,3	92,2	95,3	47,8	91	90,5
2015Q1	86,4	93,2	92	46,2	91,7	91,3
2015Q2	86,9	93,6	92,7	46,9	92,3	91,3
2015Q3	86,6	94,3	90,7	43,2	93,3	91,4
2015Q4	86,4	94,5	88,9	41	94,3	92,7
2016Q1	87,1	95,1	85,5	44,7	95,2	93,7
2016Q2	87,2	95,4	85,8	43,9	95,7	94,4
2016Q3	86,8	96	87,5	36,2	96,2	95,1
2016Q4	90,6	96,3	88,5	60,6	96,7	96,2
2017Q1	95,9	97,7	96,3	85,6	97,7	96,9
2017Q2	95,4	97,5	91,8	86,7	98,4	97,3
2017Q3	98,6	99,5	94,4	98,8	98,8	97,8
2017Q4	98,7	99,8	94,1	98,1	98,8	98,8
2018Q1	100	100	100	100	100	100
2018Q2	100,5	99,8	103,3	110,7	100,3	100,9
2018Q3	102,3	102,2	105,1	103,6	101,1	102,3
2018Q4	102,9	102,5	106,9	117,9	100,8	102,8

Table 2: SSB index

In the auto diesel pump price, which the SSB index is based on, three different fees are included; VAT, CO2 tax, and diesel tax (Pedersen, 2019). These fees have the last ten years made up, on average, 55% of the auto diesel pump price [1]. An increase in one or more of these fees will have an impact on the index and therefore an impact on the compensation from Skyss to the operator. The correlation between the SSB index and the diesel pump price is 93%[2].

2.3.2 Payment

The payment of the contract is regulated by the SSB index, meaning that an increase in the index from period A to period B will give Skyss a higher payment to its operator in period C, relative to the payment in period B (table 3). The notations are as follow:

[1] Calculation is posted in the appendix (1)

[2] Data used for the correlation is posted in the appendix. (2)

$$S_1 = (\frac{Index\ T_1}{Index\ T_0} - 1) * P_0$$

$$P_1 = P_0 + S_1$$

Where P equals the total payment and S equals the increase or decrease in the compensation between Skyss and its operator, based on the development of the SSB index.

To further illustrate how a contract between Skyss and one operator works, we have created the following example. Let's say that there is a contract with quarterly payments equal to 750 000 NOK in fuel cost each period, and the first period is 2017Q1. In this case, the payment from Skyss to its operator would be equal to the agreement of 750 000 NOK in the first period. The closing contract in period A becomes the opening contract in period B. In period B (2017Q2), the payment would be regulated equally to the increase in the SSB index from 2016Q4 to 2017Q1, which is 65 476 NOK as shown below. The total net payment from Skyss to its operator in 2017Q2 is 815 476 NOK.

$$S_1 = (\frac{95,9}{88,2} - 1) * 750\ 000\ NOK = 65\ 476\ \text{NOK}$$
$$P_1 = 750\ 000 NOK + 65\ 476\ NOK = 815\ 476\ NOK$$

The reason for the delay in regulation is that the index doesn't get published until a few months after the end of that quarter. The 2018Q4 index didn't get published until March 2019, and so on. Because of this delay, the increase from period A to period B will be regulated in period C.

Period	Contract (Opening)	Increase/decrease index	Increase/decrease NOK	Payment	Contract (Closing)
A	kr 750 000	8,73 %	kr -	kr 750 000	kr 750 000
B	kr 750 000	-4,59 %	kr 65 476	kr 815 476	kr 815 476
C	kr 815 476	2,73 %	-kr 37 415	kr 778 061	kr 778 061
D	kr 778 061	-0,32 %	kr 21 259	kr 799 320	kr 799 320

Table 3: Contract example

This example is based on a contract worth 20 million NOK each year. With quarterly payments, this equals 5 million NOK each quarter, and 15% of the contract is related to fuel, which is 750 000 NOK. We will use the same example throughout this thesis to simplify the analysis.

3.0 Oil Market

The oil market is a trillion-dollar industry, and therefore, one of the most crucial commodities on earth (Desjardins, 2016). Some of the most powerful countries in the world produce oil, with USA, Russia and China all being one of the ten highest producers of oil. In this chapter, we will look at the factors that drive the oil price, as well as the historical development of the oil price.

As seen in figure 1, the oil price is highly correlated with diesel fuel, and an increase in oil price would indicate an increase in diesel fuel price, and therefore have consequences for those with high consumption of diesel fuel. As we can observe, diesel fuel trades at a premium of crude oil. This is because it's a refined product and cost more to produce than crude oil.

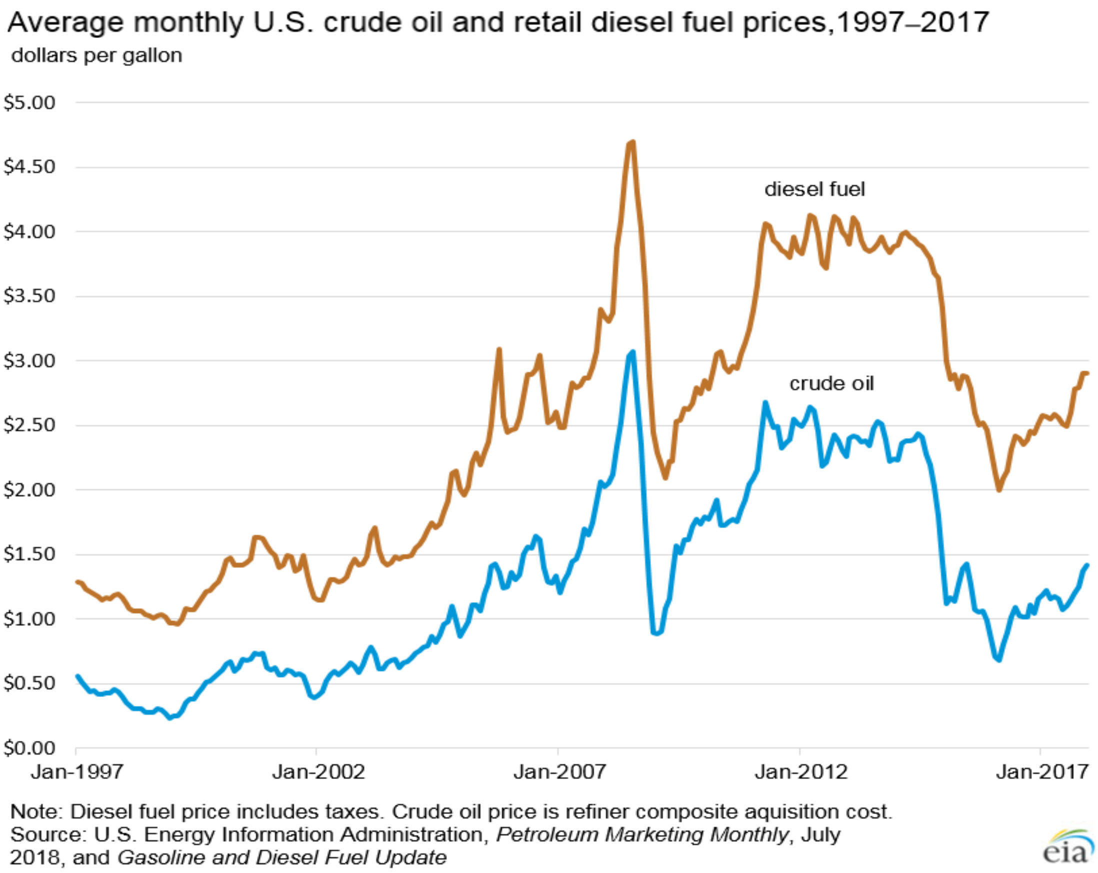

Figure 1: Monthly diesel fuel and crude oil [3]

[3] Source: U.S Energy Information Administration (2018), https://www.eia.gov/energyexplained/index.php?page=diesel_factors_affecting_prices

3.1 Factors

The price of crude oil is highly volatile and is driven by different factors. One of the main actors that can influence the price is Organization of Petroleum Exporting Countries (OPEC); an intergovernmental organization consisted of countries that produce oil. OPEC's mission is to ensure the stabilization of oil markets (OPEC, 2019). They control a significant amount of the world's oil reserves (82%) (OPEC, 2018), which means they can influence both the price and the production of crude oil.

New oil discoveries will cause an increase in oil production and therefore reduce the price. This is connected to the countries oil reserves, high oil reserves will decrease the price, while low reserves give a higher price. World conflicts that can threaten trading or production of oil, as well as climate, could also have an impact on the oil price. Lastly, the price of oil is driven by supply and demand characteristics. A financial crisis can, for example, lead to lower consumption, hence lowering demand and furthermore the oil price. (Circle K, 2018).

3.2 Oil price development

Figure 2 shows the development in Brent Crude Spot price from 1987-2018. Until the rise in 2003-2004, prices rarely exceeded 30 USD, except for the sudden increase in 1990, which was caused by the ensuing Gulf War. The US invasion of Iraq in the early 2000s created uncertainty of the future of oil supply, and at the same time, Asian demand increased massively, contributing to the rise in 2003-2004. The positive trend continued until the financial crisis in 2007-2008. After the financial crisis, a new period of economic growth and positivity arose. Prices collapsed in the summer of 2014, caused primarily by share oil production in the US, and technological advancements, especially within transport (IG group, 2019).

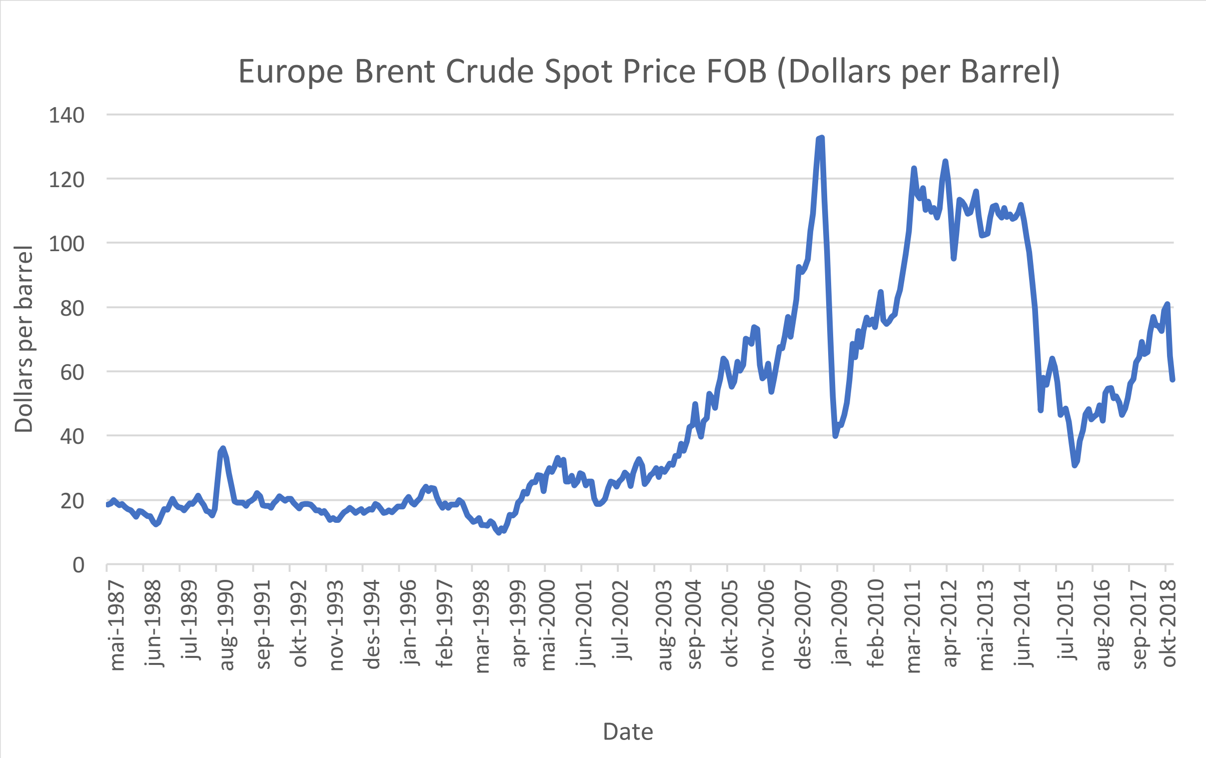

Figure 2: Brent crude spot price

The last couple of years, the rise in oil prices are caused by high demand in Asia, and limited supply due to the decision by Saudi Arabia and Russia to freeze production. In addition to this, high producing countries like Venezuela, Nigeria and Libya, has experienced a domestic economic crisis in recent years, which have limited how much they can produce.

This underlines the volatility in the oil price, and how this affects the diesel price. Skyss, as a public transport company, pay for a considerable amount of diesel each year and is therefore affected by this volatility in the oil price.

4.0 Hedging

4.1 What is hedging?

Hedging is taking an offsetting position in an asset, currency, or commodity that a company normally faces. If a company sells a commodity, they have what is described as a "long position" in the price of the commodity, i.e., when prices go up, they gain and when prices go down, they lose. The opposite position is described as a "short position". To reduce the uncertainty of future prices, a company can enter an offsetting short position in the commodity, and lock in a price for a predetermined period. Undertaking a hedging program should not be a speculative move. The company should not hedge more than its actual exposure and should not consider the hedge as a mean to increase profits. Instead, the hedge should lead to a smoother cash flow for the company, where they are protected against extreme peaks and troughs in prices.

For a public transport company like Skyss, one would take an offsetting position in for example the diesel fuel price. The way contracts are set up between Skyss and operators, when diesel fuel prices tend upwards, this results in an increased cost for Skyss. Hence, it has a short position in the diesel price. One would want to offset this effect by entering a derivative contract on the diesel price which increase in value as prices go up. This long position will lose value if prices go down, but in theory this will be offset by a decreased compensation to the operator. An efficient hedge is valuable as it can give better predictability over future cost. Hedging does not mean that the average price they are paying is lower than the market price, but as long as future prices are more predictable, that do not necessarily matter (Friedman & DeCorla-Souza, 2012).

There are four components of a hedging strategy; hedging instrument, hedging level, hedging duration and hedge timing. We will introduce the financial instruments used for hedging later in this chapter, the remaining three components will be introduced in this subsection.

4.1.1 Level

By hedging level, we mean how much of the fuel cost exposure is covered, and this is often expressed as a percentage. It can range from zero percent (no coverage) to 100 percent (full coverage). Whenever more than 100 percent of actual exposure is covered, this is considered a speculative investment. If the hedge is efficient in offsetting actual fuel costs, a hedging level of 100 percent will lead to better predictability over future fuel cost. The rationale for having less than 100 percentage coverage could be that a company avoids the risk of being over-hedged since actual fuel exposure was less than forecasted. Over-hedging can occur when a company consumes less fuel than it had originally anticipated, leaving it with more protection than it needs and exposing it to the risk that loss on some of its hedge positions will not be offset by gains in physical purchases, thus leading to a net monetary loss and an increase in budget fuel spend (Friedman & DeCorla-Souza, 2012).

Friedman & DeCorla-Souza (2012) also state that, as a conservative rule, a company should not hedge more per month than its expected fuel consumption less two standard deviations, in order to avoid over-hedging. In the case of Skyss, being over-hedged in this sense is not much of an issue. They know their exposure towards fuel in NOK at the beginning of the contract, and since they do not physically consume the commodity, they do not run the risk of being over-hedged when covering 100 percent of this exposure. Skyss do not have an expected fuel consumption, they only have an expected fuel cost.

4.1.2 Duration

The duration of a hedge is the length of which a company is protected against price fluctuations, often expressed in months. For a public transportation company, it would be ideal to match the duration of the hedge with the company's budget term. If for example the company has an annual budget, one would ideally wish to hedge 12 months of exposure.

One typically has two duration strategies, either fixed or rolling. Fixed duration hedging means that the company has hedged its exposure for a given period. We can again think of the case where a company has an annual budget term and wish to lock in a price for the duration of the term. Rolling duration hedging, on the other hand, means that one enters a new hedging contract once one month has passed. Effectively, the company then has a continuous hedge.

Figure 3: 12-month forward hedge durations: budget constrained versus rolling [4]

The figure above shows that while both policies cover 12 forwards months at the beginning of the year, the fixed-term hedging policy has shorter forward hedge duration for every month during the year, except for January (Friedman & DeCorla-Souza, 2012). The fixed-term hedging strategy is easier to implement, as entering one hedging contract covers the duration of the budget. While the rolling-strategy implies entering a new contract every month, increasing transaction cost and organizational complexity.

4.1.3 Timing

Hedge timing means that a company seeks to hedge at a price that will be lower than the market price, or at least avoid hedging at a price that will be significantly above the market price (Friedman & DeCorla-Souza, 2012). If a company has the capability of correctly predicting the development in prices, one can choose to increase or decrease hedge level and/or duration to accommodate these beliefs. In practice, if the belief is that prices will go up in the future, one would increase the hedging level/duration, protecting more of its exposure. On the other hand, if the belief is that market prices will fall, one would decrease the hedging level/duration. For hedge timing to add value, the company should have in-house competence that accurately can predict the market. If the company actively tries to time the market, there is also a risk that one mispredict the price path, resulting in increased losses.

[4] Source: Friedman & DeCorla-Souza (2012)

Hedge timing is not something that will be covered in this thesis, as we do not wish to speculate, or predict future market price development. Instead, our aim is to give Skyss predictability over future fuel costs, with all the value this brings for a public transport company.

4.2 Risk

When entering a hedging program, it is important to know the type of risk the company want to control for, and what kind of additional risk the program might impose on the business. For a hedge to be as efficient as possible, it is important to know the specific factors that drives the market price of the underlying product. Risk is defined by Knight (1921) as something measurable, separating risk from the term uncertainty, which is not measurable. Risk in this sense is a "known uncertainty". Hence, companies can control for, and mitigate risk, while uncertainty is unmeasurable and cannot be controlled for. In the following sub section, we will discuss some of the risks Skyss currently are exposed to, and consider risks that could be introduced through implementation of a hedging program.

4.2.1 Commodity risk

Commodity risk can be defined as the exposure that the company will face as a result of a change in commodity prices (Schofield, 2012). The risk implies uncertainty in the price of a specific good in the future. Over the last few years, the Crude oil price has become increasingly volatile, impacting Skyss through volatile diesel fuel prices. Diesel fuel is a significant input in Skyss' operations, and fluctuations in the price of this commodity have direct implication for their financial results.

The price of diesel mainly embodies three sources of risk; delivery risk, tax price risk and commodity price risk (Friedman & DeCorla-Souza, 2012).

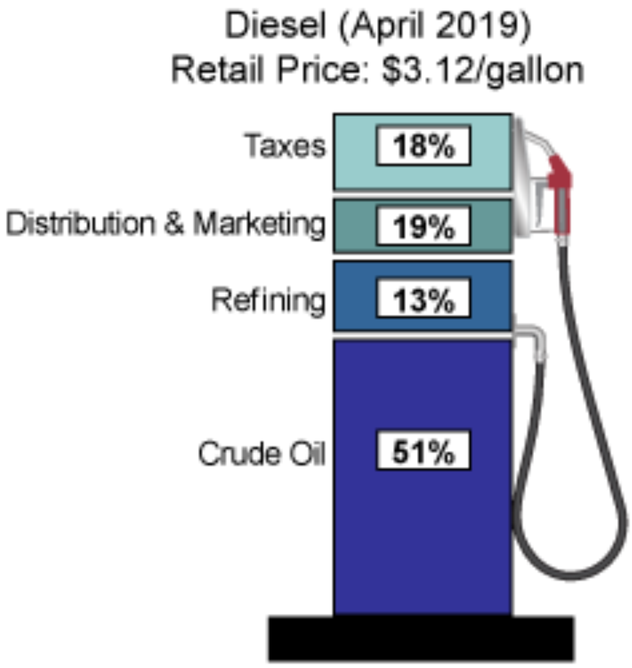

Figure 4: Components of diesel fuel price [5]

Diesel is a refined Crude Oil product, and is to a large extent dependent on the price of oil and refinery capacity. From Figure 4 we see the components affecting the retail price of diesel. The above numbers are taken from the US market, but is also transferable to the Norwegian market. The commodity price risk consists of the overall price of oil (51%) and the cost of refining (13%) this crude oil into diesel. Summing up, 64% of the price of diesel is commodity price risk, and it is this price risk that can be hedge away using financial intruments. When hedging the diesel price, we are not able to control for the tax or delivery risk, as these components are not part of the traded diesel prices and they will vary depending on the region one operates in. Secondly, taxes will be kept more constant and not vary as much as the price of crude oil. In Norway, any changes to taxes on diesel happens once a year, on the 1st of January[6]. Delivery risk is not considered to be of importance for Skyss as they do not procure, store, or consume the physical diesel product.

The increased volatility has led Skyss to investigate if financial instruments can mitigate their exposure and improve their predictability of futures expenses. There do not exist much literature covering public transport companies and hedging, while the topic is highly covered in the airline

[5] Source: U.S Energy Information Administration (2018), https://www.eia.gov/petroleum/gasdiesel/
[6] Posted in the appendix (1)

industry. Still, airlines are divided on the topic, where some do not hedge at all and others are fully hedged. We will highlight advantages and disadvantages of hedging in later chapters.

While hedging the commodity can mitigate this type of risk for Skyss, a hedging program will also introduce new types of risks that the company is not currently exposed to.

4.2.2 Basis risk

Basis in a hedging situation follows this equation (Hull, 2015):

$$Basis\ risk = Spot\ price\ of\ asset\ to\ be\ hedged - price\ of\ derivative\ contract$$

The above equation shows the price basis risk, namely that the spot price of the underlying asset being hedged, differs from the price of the instrument used to hedge. If the two assets do not follow the same price path, i.e. they are poorly correlated, basis price risk will rise. At maturity of the hedge, there will be a mismatch in profit/loss from the hedge and income/cost for the company. Skyss currently has a structure that compensates operators the percentage increase in the SSB index from one period to another, if the chosen instrument does not replicate this price path, this is a source of price basis risk. A second source of basis risk is location risk. This could be the case where the underlying asset price is based on certain regional or national fundamentals, while the hedging contract is based on different fundamentals. The index is produced by SSB and reflect the Norwegian price environment, while when trading the diesel price on an exchange, the price is based on delivery in, for example, the Rotterdam or New York harbour. A third source of basis risk, is calendar risk. This risk arises when spot selling date differ from the maturity of the contract used to hedge the underlying. To illustrate this risk, we can think of the case where your contract produces a loss, and payment from selling the spot do not materialize at the same time. This could lead to liquidity problems for the companies. Lastly, we have quality basis risk. A simple illustration could be that your spot is diesel, while the instrument used to hedge is based on crude oil. Diesel is a refined product, and while its price is dependent on the price of crude oil, it also depends on other factors, such as refinery capacities. If one or more of these sources of basis risk are observable in the hedge, the effectiveness will take a hit, and the hedge may not be useful for the company (Bourgi, 2019).

4.2.3 Currency risk

Foreign exchange risk arises from two sources, transactional and translational. Transactional risk arises as a result of a company's day-to-day business, where the company has foreign currency payables from procurement of goods, services or other contractual obligations. Translational foreign exchange risk arises from expressing a foreign currency asset or liability in the company's domestic accounting currency (Schofield, 2012). Skyss has all of its capital expenditures and income denoted in domestic currency and undertaking a hedging program may change this for the company. Most instruments considered are traded and quoted in US dollars, and we have to take into account the added exposure associated with this when aiming for higher budget certainty for Skyss.

4.2.4 Counterparty risk

We consider two counterparty risk; credit and settlement risk. Counterparty credit risk is defined by Norges Bank Investment Management (NBIM) as the risk of financial loss if a counterparty to a transaction defaults before final settlement (NBIM, 2018). In the case of Skyss, this could be translated to an operator that defaults, and no longer can hold up its end of the contract. Hence, the operator cannot provide the service agreed upon. For Skyss, the financial cost is not of most significance, as the operator are service providers, and the default impacts Skyss in the way that they no longer provide the service they are mandated to. Nevertheless, financial cost occurs as Skyss will need to allocate a different operator to provide the given transport service.

NBIM define settlement risk as the risk of loss if a counterparty defaults and has not delivered the corresponding cash or security (NBIM, 2018). Skyss agrees on a contract with its operators which is settled quarterly, semi-annually or annually. With longer maturities, i.e. less frequent settlements, the settlement risk typically increases. With less frequent settlements, the payments from Skyss to the operator, as the index increases, results in a higher single compensation. A compensation that could be difficult to meet if they have bad liquidity.

4.3 Financial Instruments

Hedging using financial instruments is the preferred method for most companies. These are derivatives with standardized elements, such as location, quantity and quality for the delivered asset. The standardization makes the contracts highly tradable and more liquid, which is positive for companies trading the derivatives, as they can unwind and cancel their position at any time. Liquidity can mean many different things. One dimension of liquidity is the availability of credit or the ease with which institutions can borrow or take on leverage. This is generally referred to as funding liquidity. Another dimension of liquidity is the ease with which market participants can transact, or the ability of markets to absorb large purchases or sales without much effect on prices. This is what is generally called market liquidity (Federal Reserve Bank of New York, 2007).

Hence, a liquid, highly traded contract on a commodity will, to a greater extent, reflect fair value, and one do not run the risk of overpaying. Furthermore, liquid contracts will have a smaller bid-ask spread, resulting in smaller transaction cost. The bid-ask spread describes the difference between what the buyer is willing to pay for the asset or security, and what the seller is asking for it.

With a derivative hedge a company can lock in a price for delivery of an asset at a predetermined time in the future. We will introduce the financial instruments; future, forward, swap and option in this section.

4.3.1 Futures

Futures are standardized contracts that are traded on an exchange and can be based on different asset such as stock indices, currencies or commodities. The contract is an agreement between two parties for the delivery of the underlying asset for an agreed upon price at a specified date, also called maturity. In contracts for commodities the quality, quantity and delivery location is specified. Crude oil, for instance, has several contracts with different types of refined crude oil. There are also differences in whether the contract is financially settled, or if there is physical delivery. Physical delivery means that the buyer of the contract has to receive the underlying quantity of the asset, at the given delivery location. If the long position does not wish to take physical delivery, it has to close out its position by entering an offsetting, short, position in the same contract before maturity. Different location for delivery, even if the contract is settled financially or physically, leads to different prices due to macroeconomic differences. i.e. a one-month futures on 1000 barrels of heating oil for delivery at New York harbour will often have a spread towards the same quantity and quality delivered at the Rotterdam harbour.

Another feature of futures is that they are settled daily, which mean that both sides of the contract (short and long) are required to post an initial margin into a margin account with their broker (Hull, 2015). The gains and losses during a trading day are reflected in the margin balance. If the balance for, say the short position in the contract, goes below a predetermined threshold, they have to post additional margin (margin call) to the account. With exchange traded futures there is little to none counterparty risk, as the clearing house acts as the counterparty to both parties of the contract. The required margin also helps to reduce counterparty risk.

4.3.2 Forwards

A forward contract is an agreement between two parties to buy/sell an asset at a predetermined price in the futures. These contracts are not standardized and can be customized to suite both buyer and seller, also referred to as over-the-counter (OTC). The contracts are not traded on an exchange and have much higher counterparty risk compared to futures. If either party in the contract is unable to hold up their end of the agreement, there is little to be done about it. Forwards is usually only an option for companies when the underlying commodity is not traded on an exchange, if it is traded then futures are preferred. Forwards are physically settled, meaning that the buyer pays seller at maturity and seller delivers at the predetermined location. For most companies, when dealing with commodities, financial settlement is preferred as they do not have capacity to store the asset (Hull, 2015).

4.3.3 Swaps

A swap is an OTC agreement between two companies to exchange cash flows in the future (Hull, 2015). Interest rate swaps are the most common, where two companies can change from a fixed to floating rate, or vica versa, if they desire to. The company, which currently pays a floating rate but desires to pay a fixed rate can achieve this by paying a fixed rate to the counterparty and receive the floating from them. For a company that is short the spot price in a commodity, and wish to transform this to a fixed price, it can enter a swap agreement with a counterparty. The company then receives the spot price (floating rate) and can transform this to a fixed rate by paying the spot price to a counterparty, in exchange for a fixed price. In these types of agreements, the counterparty typically is large banks. Although interest rate swaps and currency swaps are the most common kinds of swaps, the use of swaps in commodity hedging has increased in popularity (Henriksen, Marsen & Thøgersen, 2000). This is known as a commodity swap, and allow, in this case, the transport company to trade the floating rate of fuel for a fixed rate. The underwriter of the swap would get paid a fixed price and makes a profit if the price of the underlying commodity is below the fixed price. The commodity is not actually exchanged, and the parties only make net payments.

4.3.4 Options

Options are versatile instruments and comes in many forms. A plain vanilla call option gives the buyer the right, but not an obligation, to buy an asset for a pre-specified price, called the strike price. If the price of an asset is above the strike price at maturity, the holder exercises the option and buys the asset for the strike price. If the asset price is below strike, the holder will not exercise the option to buy. Payoff from a plain vanilla call becomes:

$$Payoff\ \ Call = \max[S_t\ - K, 0] - C_0,$$

Where S_t is the price of the underlying asset at time t, K is the strike price, and C_0 is the price of the option at time zero. For hedging purposes, a call option creates a roof as to how much a company needs to pay for a commodity. Say that crude oil is an important input for a production company, hence, an increase in the price of oil would lower its profit margin. When buying a call option, the company can cap the price it has to pay for crude oil at strike price equal to K. Since options are financially settled, their exposure to the price of crude oil is capped out at the strike price. The price of the option, C_0, can be seen as the insurance one has to pay. A plain vanilla put option gives to holder of the option the right, but not an obligation, to sell the underlying asset at the strike price. The profit function for such an option is:

$$Payoff\ Put = \max[K - S_t\ , 0] - P_0,$$

The holder of the put option would exercise and sell the asset at the strike price, K, if the underlying asset price at time t is below K. P_0 is the price of the put option. Once again we can use crude oil as an example as to how a company can benefit from hedging using a put option. This time think of a company where its income is directly affected by the price of crude oil, meaning that it has a long position in the price of the asset. Buying a put option would effectively create a floor for its price of oil. Once the price of oil falls below the strike price, the company profits from the option trade, counteracting the effect of lower income from their main business.

If there is a market for option trading in the asset a company wants to hedge, there are almost endless ways in which one can structure the hedge. There are barrier options, which is calls and/or puts that activate once the price of the underlying asset hits a predetermined level. Asian options, where the strike price is determined by the average price of the asset during the lifetime of the option. One can also short and long puts and/or calls to create the payoff structure preferred by the company (Hull, 2015).

4.4 Advantages of hedging

An effective hedge can have many benefits for a company. We will discuss how reducing volatility can increase debt capacity and create value for the company. We will also cover the important topic of budget certainty, meaning that a company more accurately can predict its income and/or costs for a given budget period. We will also discuss how hedging can smooth out cash flows.

4.4.1 Debt capacity

The theory explains that reduced volatility from undertaking a hedging program will increase a company's capabilities of undertaking debt. As we know, financing operations and projects with debt over equity is preferable, as debt financing is relatively cheaper. An effective hedge will reduce debt cost of capital an increase debt capacity, as the company are more unlikely to experience larger negative cash flows from a disadvantageous development in prices. Increased debt capacity could also result in increased tax benefits.

$$V_L = V_U + PV(TS) - PV(FD),$$

The extension of the Modigliani and Miller (1958, 1963) proposition states that the value of a levered company (V_L) is determined by the unlevered value (V_U), the present value of interest tax shield PV(TS), and the present value of the cost of financial distress PV(FD). If in fact hedging could increase debt capacity, hence increasing PV(TS), and reduce the probability of financial distress, hedging would increase the value of the levered company.

A paper published by Juliana (2016) examined the relationship between hedging and the cost of debt for 183 Indonesian companies. She found that hedging reduced the debt cost of with 141 basis points compared to non-hedged company. The results from a study by Graham and Rogers (2002) on the airline industry supports the hypothesis that company who hedge increase their debt capacity and the PV(TS). They also find support in that company hedge to reduce expected financial distress costs.

4.4.2 Value creation (increased share value)

Smith and Stulz (1985) argue that hedging can increase company value by both reducing volatility and the probability of ending up in financial distress. An effective hedge will be profitable when input factors that affect the core business of a company moves in an unbeneficial way. This could either be commodity prices or currencies. If a company successfully improves its financial capabilities compared to competitors in the industry during downturns, it can possibly take additional market shares. In this sense a hedging company can strengthen its position compared to a company that does not hedge.

Studies on the topic on hedging and value creation has produced mixed results. Jin and Jorion (2006) examined how hedging activities of 119 US oil and gas producers affected market value. Their findings could not sufficiently support the argument that hedging affected to market value for company in the industry. Carter, Rogers and Simkins (2006) studied the fuel hedging activities of 28 US airlines for the period 1992-2003 and found a positive valuation premium for company undertaking hedging programs. One important source for the valuation premium was the airlines ability to pursue investments opportunities when the industry suffers from lower operation margins.

4.4.3 Smooth cash flows

If a company does not hedge, there will be some variability in the cash flows generated by assets in place. Simple accounting implies that this variability in internal cash flow must result in either: (a) variability in the amount of money raised externally, or (b) variability in the amount of investment (Froot, Scharfstein & Stein, 1993). In theory, an effective hedge will smooth out peaks and throughs in a company cash flows, hence reducing volatility and risk. This could be done by entering a long derivative position in the price of crude oil if the company are negatively dependent on the price of oil (short position). In practice though, the opposite could be true, that hedging actually increase cash flow volatilities. The study by Morell and Swan (2006), which is focused on fuel hedging in the airline industry, are relevant for any industry where business performance is dependent on the price of oil and is procyclical in nature. For airlines, their profit is dependent on the overall GDP level, but also the price of oil, as Jet Fuel is highly correlated with this commodity. Morell and Swan (2006) states that a higher oil price is induced by strong economic growth, and since economic growth also strengthens the airlines core business, they will profit both from their hedging strategy and their business. In downturns, we will observe the opposite effect. Lower GDP will decrease the demand and supply constraints for oil, resulting in a lower oil price and derivative contract losses, simultaneously as demand for flights weakens. This is not necessarily the case for Skyss. While an increase in the oil price can lead to higher purchasing power for many businesses and therefore increase their flight frequency, a higher oil price does not necessarily increase passenger traffic for public transport companies.

Froot et. al. (1993) demonstrate the compelling argument that the value of hedging arises from its ability to preserve internal capital. Furthermore, they argue that company that do not hedge will have greater cash flow variability, which could lead to an underinvestment problem. Underinvestment could manifest itself in reduced preventive maintenance or inability to pursue valuable business opportunities.

4.4.4 Budget certainty

The primary reason that public transport companies manage fuel price risk is to achieve budget certainty (Friedman & DeCorla-Souza, 2012). Fuel prices has become increasingly volatile over the recent years, and as a result of this, transport companies have experienced that it becomes increasingly difficult to manage their budgets and meet what's required of them financially. A hedging program could reduce the likelihood that public transport companies end up with large budget deficits. Private businesses could in theory pass on the higher input factors onto its customers and hedge their exposure that way. This would be politically problematic for a public transport company, like Skyss, as a large share of the company's ridership is lower-income riders (Friedman & DeCorla-Souza, 2012).

The importance of budget certainty for a public transport company is significant. Skyss change their ticket prices once a year, and cannot increase the ticket price throughout the year if prices of fuel increase. Ticket sales are their primary source of income, and it is essential to be able to set an optimal price, in order to achieve budget certainty. Most companies operate with a fixed budget, and when the price of crude oil increases, this would lead to an increase in the fuel cost, which may force the company to cut costs or raise ticket prices to be able to maintain on budget. According to a survey on the impact of rising fuel costs on transit services, presented by the American public transportation association (APTA), nearly half of the respondents said that they would increase ticket prices as a response to higher fuel prices (APTA, 2008).

Some of the other measures Skyss can take, according to the survey, are cancelling or delaying capital improvements and much-needed services, downsizing or cutting existing services. The problem with these measures is that they can harm the long-run health of the company. Borrowing funds or increasing local or state contributions to account for higher fuel cost could also be problematic, as it might violate budget requirements. Given the limited operational and budget flexibility a public transport company might have, budget certainty becomes a very desirable goal and is a strong reason to manage fuel price risk (Friedman & DeCorla-Souza, 2012).

Standard deviation can be used as a tool when discussing budget uncertainty, which is a statistic that measures the dispersion of a dataset, for example, the payments made from Skyss to its operator. In this thesis, we will use standard deviation to look at the dispersion from the post-hedge payments and compare them with the unhedged cash flows. We will analyse whether hedging increases or decreases the standard deviation.

4.5 Disadvantage of hedging

4.5.1 Organizational structure

Undertaking a hedging program will lead to increased complexity in the day to day operation of a company, especially for a company who currently does not trade financial products. If the company does not have employees with expertise in the area, they might want to employ additional human capital to implement and monitor the program. Depending on the complexity of the preferred hedging program, it might be sufficient to train current employees to supervise the program, or there might be a need to hire an expert. In some cases, there may even be a need for an entire new division. Our study focuses on relatively simplistic measures as to how one could mitigate price risk through hedging. The reasoning behind this is to keep the complexity of the hedging program to a minimum, and hence also the impact on the organizational structure for Skyss.

4.5.2 Choice of derivative

The choice of derivative to be used in the hedge is of huge importance. It is essential that there is correlation between the price of the asset being hedged and the price of the underlying in the derivatives contract. If prices are not sufficiently correlated the hedging program can work against its intended purpose and lead to higher cash flow volatility.For this thesis it could be problematic to find a derivative contract that follow the same price path and deliver similar cash flow as Skyss' increase or decrease of settlement with operators. As explained, compensation to operators are calculated as the percentage increase in an index from one period to the next and few, if any, derivatives contracts have similar cash flows. Hence, financial instruments could have considerable price basis risk compared to Skyss current compensation policy.

4.5.3 Currency exposure

For a company like Skyss, having its current capital expenditure and income denominated in domestic currency, the introduction of hedging will lead to foreign exchange risks. When trading futures, swaps or options on exchanges the prices are quoted in US Dollars (USD). Settlements are also finalized in USD, meaning that its assets or liabilities will vary as the Norwegian Krone (NOK) weakens or strengthens. To illustrate, if the hedge is profitable a weakening of the NOK will improve the result, while a weakening of the NOK when the hedge is in the loss domain will increasingly worsen the result. One would experience a double negative.

Saskia Ter Ellen (2016) conducted a study on behalf of the central bank of Norway to investigate the relationship between oil prices changes and movements in the NOK. She found evidence of nonlinearities of the relationship between the oil price and the value of the NOK. Firstly, large oil price changes had twice the impact on the NOK as small price changes. Secondly there was a threshold effect. The effect on the NOK is far stronger when the oil prices goes above/below a certain threshold.

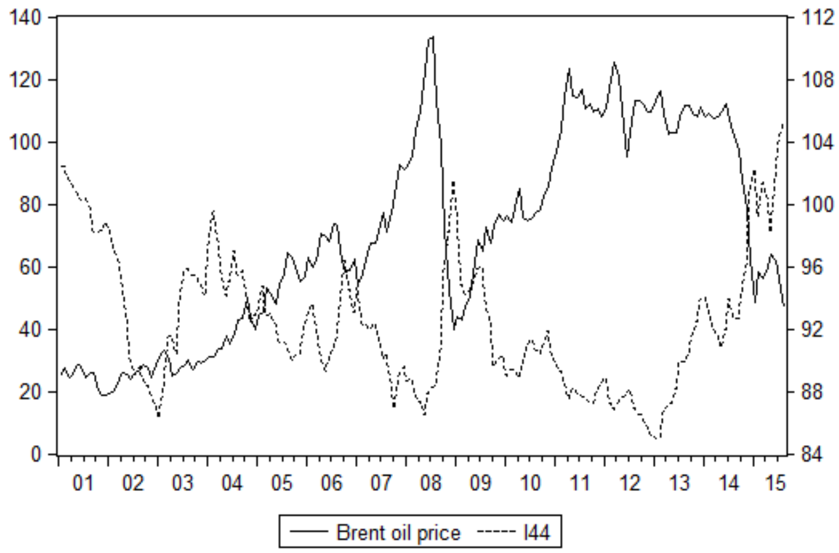

Figure 5: Oil price vs I44

The solid line shows the price of a barrel of Brent crude oil in USD (left-hand axis). The dotted line shows the value of I44, the import-weighted effective exchange rate for Norway (right-hand axis) (Ellen, 2016).

We know that the diesel fuel price is highly correlated with the price of Brent Crude Oil. The implication for Skyss could be that, without controlling for its currency exposure, the hedging program could tend to have more outcomes that are capped when profitable (high oil price → strengthening of the NOK → reduced profit) and experience double negatives when losing (low oil price →weakening of the NOK →increased loss).

While hedging foreign exchange risk is desirable, a study by Copeland and Joshi (1996) find that very few companies actually succeed in hedging this risk efficiently. A study on nearly 200 large companies casted serious doubt on the economic benefits of FX hedging programs. They find that most FX risk management programs destroy, rather than create value for a company, given the substantial human- and financial capital devoted to it.

5.0 Methodology

In this chapter, we will focus on our chosen research method. We will present our data material, show how we retrieved our data and where we collected it from. It is important to highlight our approach to strengthen the papers credibility.

5.1 Research design choice

When writing a thesis, you must organize your research, including the collection of data, in ways that are most likely to help achieve the goal of the thesis. Our problem statement involves comparing our result with Skyss' current situation. We will use a quantitative approach to answer our problem statement. A quantitative approach involves data which is either in the form of, or can be expressed as, numbers (Easterby-Smith, Thorpe & Jackson, 2008). We have collected data that we will use to see if Skyss can improve its budget certainty using futures and swaps.

5.2 Research design

The analysis is done comparing the net outcome for Skyss of using various hedging strategies to hedge the diesel costs of its current contracts. Based on the contracts Skyss has today, we have designed a standard, synthetic contract that we have analysed. This contract is presented below. To analyse whether Skyss could improve its budget certainty using these strategies, the core of our analysis is calculating the net result, and further holding these up against the standard deviations of the various alternatives. An efficient hedging strategy would need both to counteract the increase or decrease in cash flows, caused by the SSB index, and to have a lower standard deviation than being unhedged. In our analysis, we have analysed both futures and swap contracts, excluding forwards and options. The rationale for this is presented below.

5.2.1 The Skyss contract

The swaps and futures contracts considered in our analysis is based on synthetic 20M NOK contracts with one operator, and we use historic data to examine how the different strategies would have performed.

Contract Info		
Yearly contract size	kr	20 000 000
Semi-annually contract size	kr	10 000 000
Quarterly contract size	kr	5 000 000
Share of fuel cost		15 %
Semi-annually fuel cost	kr	1 500 000
Quarterly fuel cost	kr	750 000
Settlement Operator	SSB auto diesel index	
Currency	NOK	

Table 4: Contract informtion

Cash flows from the hedging strategies are compared to the contract above. In the analysis, we have considered both semi-annually and quarterly payments. The contract is originally for 20 million NOK per year, which make up 10 million NOK semi-annually, and 5 million NOK per quarter. 15% of the contract is related to fuel, which make up 1,5 million NOK semi-annually, and 750 000 NOK per quarter. The information is partially fictional. Information concerning the contract between Skyss and its operator is fictional, while all data used in the hedging strategy is real data taken from the market.

5.2.2 Choice of hedging instruments

In our analysis, we have analysed four futures contracts and a swap agreement. We have not included forwards and options in the analysis. The reason why forwards are not considered is that Skyss has no intention of taking physical delivery of the underlying commodity, and there is no way of cancelling a contract before maturity, as one can with futures. Skyss does not consume diesel fuel directly, but merely compensates operators for their diesel fuel costs based on the development of the SSB index. We do neither consider options, as the traded diesel options are exercised into futures contracts, so the effectiveness of the options can be implied from the performance of the futures contracts considered in the analysis.

The futures contracts

We consider two different futures contracts:

1. Low Sulphur Gasoil Futures (QS), traded on The ICE.
2. Bloomberg Prices for ULSD 10ppm CIF NWE (FLSOM).

For each of the contracts we consider two different maturities. All contracts are based on the deliverance of 100 metric tonnes of 10ppm diesel, which equates to roughly 118 300 litres of diesel. While the QS futures contracts analysed are physically settled, the FLSOM contract are cash settled, meaning that there are no risk concerning having to take delivery and store the underlying commodity.

In the futures hedging analysis we use historic prices on the aforementioned contracts for maturities of 3- and 6-months. The data is obtained from the Bloomberg Terminal, and rages from 2016 until 2019 with daily price quotations. The reasoning behind focusing on the FLSOM and QS futures contracts is because they have prices based on delivery of diesel in North Western Europe, namely the Rotterdam harbour. Hence, the prices to a greater extent reflects European fundamentals. Futures contracts traded on for example the NYMEX typically has prices based on delivery of the commodity at the New York harbour, with fundamentals that to a lesser extent reflect those who Skyss operator under. For example, there will be differences in refinery capacities between the US and Europe which will impact on the price of diesel. Hence, this is why we focus on futures traded on The Ice rather than NYMEX.

We also wanted to trade products that reflect the price of diesel. This excluded trading directly in Brent Crude Oil or West Texas Intermediate Crude Oil, since these are pure oil, non-refined products. Diesel is a refined product and will be traded at a premium compared to non-refined products to reflect this fact. In the table below we summarise some information about the four contracts considered in our analysis.

Contract	Description	Settlment	Size
QS3	3-month Low Suplhur Gasoil Futures	Physical	100 MT
QS6	6-month Low Suplhur Gasoil Futures	Physical	100 MT
FLSOM3	3-month ULSD 10ppm Futures	Cash	100 MT
FLSOM6	6-month ULSD 10ppm Futures	Cash	100 MT

Figure 1O: Overview of the futures contracts in our analysis

The swap agreement

The underlying product for this hedging strategy is Platts ULSD 10ppm CIF Cargoes NWE (Platts). To create a swap agreement between Skyss and a clearing house, Skyss need to buy a product at a fixed price. The fixed price is determined by the average market price of the 3-month ICE Gasoil Futures (QS3). Optimally, the money received from the hedge will be equal to the amount paid to the operator caused by an increase or decrease in the SSB index. In that case, Skyss would implicitly only pay a fixed price. To test whether a swap agreement would be beneficial for Skyss in our goal to improve budget certainty, we have created a swap agreement based on the data shown below. The data used ranges from 2011-2018 with daily price quotations.

Swap agreement	
Hedging level	100 %
Floating price	ULSD 10ppm CIF Cargoes NWE (Platts)
Fixed price	ICE Gasoil Futures (QS)

Table 5: Swap agreement information

5.3 Gathering of information

5.3.1 Literature

Theoretical literature is fundamental for us to conclude on our problem statement. Hulls (2015) *Options, Futures, And Other Derivatives* is the theoretically foundation in our thesis. Other authors, articles and literature have also been of value to supplement our theoretical foundation.

The report from 2012 *Guidebook for Evaluating Fuel Purchasing Strategies for Public Transit Agencies*, by Friedman & DeCorla-Souza, has given us an insight into different hedging- and purchasing strategies in the public transit industry. In addition to this, reports discussing hedging of fuel in the airline industry have been helpful, as it is not a lot of literature specific to the public transport sector.

5.3.2 Meetings

This hedging strategy involves three parties, and we have over the semester been in contact with both an operator and a clearing house, as well as Skyss themselves. We have received relevant documents and valuable information from all three parties. Skyss have given us relevant documents like contracts and index data. Tide, one of Skyss' operators, have been of help for us as the company have given us its point of view of the contract between the two parties. Our collaborator in DNB have given us input on the financial part of the hedging strategy. We greatly appreciate everyone who have contributed, and helped us throughout the thesis.

5.3.3 Data

In a quantitative approach, you could either collect data primarily or secondary. Primary data are data you obtain yourself, while secondary data are data already obtained by others (Larsen, 2017). We have used the latter in this thesis, by either collecting data from online databases, or receiving them from our collaborators on this project. In this thesis, we have not used any personal information, and therefore not needed to apply for this at the Norwegian Centre for Research Data (NSD, 2019).

Data used in this thesis, have been obtained from following sources:

- **SSB** – national statistical institute of Norway publish a cost index for passenger transport by bus quarterly. This index is the foundation for the contract regulation between Skyss and its operator each period. The index used in this thesis is the auto diesel index, and will be referred to as the SSB index throughout the thesis.

- **Platts** – For the swap agreement, we used Platts ULSD 10ppm CIF Cargoes NWE (Platts) as the underlying product. The Platts price is the spot price for diesel with delivery at North Western Europe. Platts data were also used for one of the futures strategies to determine final settlement payoffs.

- **The ICE –** For both the swap and futures strategies we use the Low Sulphur Gasoil Futures (QS), traded on The ICE. The swap agreements fixed price is based on the market price of this futures contract.

- **Bloomberg terminal** – FLSOM – Bloomberg Prices for ULSD 10ppm CIF NWE. As we failed to obtain pricing data on our preferred futures contract, the Diesel Outright traded on The ICE, we used the Bloomberg terminal at the Norwegian School of economics to obtain pricing data on the FLSOM.

5.4 Data Analysis

All the collected data material is historical data and downloaded as an excel file. Most of the data is given in different unit of measurement and currency, but we have transformed all of it to NOK/Litre. The only data that was initially in NOK/Litre was the SSB index.

Platts 10ppm CIF Cargoes NWE and Low Sulphur Gasoil Futures (QS) are set as the average of the highest and lowest price on the specific pricing date. Prices are stated for metric tons, and we wanted to have them stated in litre to have the same comparative basis for all our data.

Metric tonnes is a unit of weight and litre is a unit of volume, and we therefore need to know the density of the substance that we want to convert. We used the substance density of diesel fuel oil to find the conversion factor 1183 ltr/m.

To conclude on our problem statement, we have used this data to test, among other things, the correlation between the SSB index and the underlying hedging products, and find the standard deviation of the result, both unhedged and post-hedged. Throughout the analysis, the contract with the operator is maintained. The only difference between the analysis, is the hedging product as shown in table 6 below.

Operator	Clearing House
	Future
Contract	QS
	FLSOM
	Swap

Table 6: Hedging strategy

In our thesis, we define a period as the period where a payment is due, for example, one quarter, depending on when the payment is scheduled according to the contract. A sample is defined as the time period we test our data, for example the time period 2011-2018. A sample can be divided into multiple samples with shorter duration. The full Sample of 2011-2018 can be divided into two equal samples, 2011-2014 and 2015-2018.

5.5 Limitations

Unfortunately, we were unable to obtain price data on our preferred contract, namely the Diesel Outright Platts contract traded on The ICE. This is a futures contract on Platts (diesel) where final settlement is based on the average daily Platts spot prices during the period of the contract. The data we did obtain was the FLSOM, a Bloomberg produced futures price on ULSD 10ppm CIF NWE Cargoes futures. Prices are constructed using proprietary algorithms developed by Bloomberg Professional, which is a service to calculate fair value prices. The futures prices are calculated by mix of historical spreads, spot prices and other factors. The FLSOM mimics the Diesel Outright futures prices, and since we have data on daily Platts spot prices, we can reconstruct a trading strategy using the FLSOM.

5.6 Validity

In our thesis, there could be external factors leading to distortions in the results. For example, world conflict or climate can have an impact on the oil price, or the Norwegian government can increase diesel tax, which will lead to an increase in the SSB index. The latter will however not impact the underlying hedging product. To strengthen the thesis' validity, we have divided the analysis in chapter 6 into multiple samples, to test if different samples have different trends, or if the trend is equal for the entire sample. The data used, like QS and Platts, is taken from the market and would be the same whether Skyss or some other company use it. Our results from the financial derivates could be replicated by another company, whether it is a Norwegian or an international company, and therefore substantiate the thesis' validity. We believe that the validity of this thesis is high.

5.7 Reliability

This thesis is based on the volatility in the oil price, and this is something that differs over time. Therefore, it is not guaranteed that you would get the same results when focusing on another period. To make up for that, we have, in some cases, tested on different samples over a ten-year period to see how much the results would differ. We have used secondary data from trustworthy databases, which strengthens the credibility of the thesis' data. Therefore, we would think that the chances of another researcher ending up with the same result as us is significant. The oil price is highly volatile, and the results will differ depending on which period of time you look at. In a perfect world, our hedging strategy would nullify this volatility, and it would not matter which period you analyse. However, this is not the case, the result will differ, and we, therefore, test data in different periods and durations. Because of the above factors, we believe that the reliability of this thesis is moderately high.

6.0 Analysis

In this chapter we analyse the futures contracts and the swap-agreement separately, and in the subsections discuss specifics surrounding the two different hedging strategies. Our hedging results is compared to the development of the SSB index, which determines Skyss' cash flows towards its operators from an increase or decrease in its diesel fuel costs.

6.1 Futures

We assume that payments from the futures settlement and payment to the operator occurs simultaneously, the reason for this is to observe if there are correlation between payments. Ideally, when the SSB index increases and there is an increased cash outflow to operator, the futures hedge would provide a cash inflow to Skyss, and vice versa. In reality, there will be a lag in cash flow to the operator, as the index is published on a quarterly basis. In some cases, there could be as much as a 6-month delay. To illustrate, the futures contract could be settled in January, while the corresponding cash flow to operator from that same period do not materialize until June.

The reasoning behind choosing contracts with shorter maturities is because these contracts are more liquid, hence they reflect fair value to a greater extent. The implication of trading illiquid contracts with longer maturities is that the bid-ask spread is higher. This leads to higher transaction cost when trading these contracts. Furthermore, the price of illiquid contracts will fluctuate more and be more volatile. The reasoning behind this is that a single trade may change the price to a greater extent. Think of the case where there is a large trade going long in 12-month crude oil futures. This single trade will shift the price curve upward if the futures is less frequently traded.

For all contracts and maturities, we use fixed duration hedging. Meaning that we enter into a new futures contract once the duration of our hedge has expired. For example, if we consider the 3-month futures contracts, starting in January, we will not enter a new contract until this 3-month period has expired, so the next contract we trade is in April to cover the exposure of the next 3-month period. We prefer this strategy as it's easy to implement and allow for fewer transactions.

6.1.1 QS – Low Sulphur Gasoil Futures

QS3 – 3-month Low Sulphur Gasoil Futures

Trading date	Fuel exposure in NOK	Futures price/liter	QS1	QS3	QS3 NOK	Exposure in liters	# contracts	Litres hedged	Futures settlement	Index	Settlement operator	Post hedge CF
01.07.2016	kr 750 000	0,382		0,382	3,23	231 956	2	236 600		85,80		
30.09.2016	kr 750 000	0,378	0,378				2	236 600	-kr 6 775,68	87,50	-kr 14 860,14	-kr 21 635,82
03.10.2016	kr 764 860	0,385		0,385	3,14	243 243	2	236 600				
30.12.2016	kr 764 860	0,424	0,424				2	236 600	kr 79 626,60	88,50	-kr 8 741,26	kr 70 885,34
03.01.2017	kr 773 601	0,422		0,422	3,58	216 350	2	236 600				
31.03.2017	kr 773 601	0,400	0,400				2	236 600	-kr 43 822,90	96,30	-kr 68 181,82	-kr 112 004,71
03.04.2017	kr 841 783	0,400		0,400	3,43	245 497	2	236 600				
30.06.2017	kr 841 783	0,373	0,373				2	236 600	-kr 52 878,13	91,80	kr 39 335,66	-kr 13 542,46
03.07.2017	kr 802 448	0,380		0,380	3,11	258 230	2	236 600				
29.09.2017	kr 802 448	0,461	0,461				2	236 600	kr 149 142,45	94,40	-kr 22 727,27	kr 126 415,18
02.10.2017	kr 825 175	0,439		0,439	3,51	234 991	2	236 600				
29.12.2017	kr 825 175	0,508	0,508				2	236 600	kr 134 481,96	94,10	kr 2 622,38	kr 137 104,34
02.01.2018	kr 822 552	0,505		0,505	4,00	205 824	2	236 600				
29.03.2018	kr 822 552	0,524	0,524				2	236 600	kr 34 556,48	100,00	-kr 51 573,43	-kr 17 016,95
02.04.2018	kr 874 126	0,507		0,507	3,98	219 825	2	236 600				
29.06.2018	kr 874 126	0,571	0,571				2	236 600	kr 122 723,29	103,30	-kr 28 846,15	kr 93 877,13
02.07.2018	kr 902 972	0,562		0,562	4,56	197 825	2	236 600				
28.09.2018	kr 902 972	0,611	0,611				2	236 600	kr 97 377,14	105,10	-kr 15 734,27	kr 81 642,87
01.10.2018	kr 918 706	0,623		0,623	5,14	178 641	2	236 600				
31.12.2018	kr 918 706	0,426	0,426				2	236 600	-kr 400 109,25	106,90	-kr 15 734,27	-kr 415 843,52

Table 7: QS3 – 3-month Low Sulphur Gasoil Futures

QS6 – 6-month Low Sulphur Gasoil Futures

Trading date	Fuel exposure in NOK	QS1	QS6	QS6 NOK	Exposure in liters	# Contracts	Litres hedged	Futures settlement	Index	Settlement operator	Post hedge CF
01.07.2016	kr 1 500 000,00		0,391	3,25	461 685	4,00	473 200,00		85,65		
30.12.2016	kr 1 500 000,00	0,424			461 685	4,00	473 200,00	kr 135 279,60	88,00	-kr 41 155,87	kr 94 123,73
03.01.2017	kr 1 541 155,87		0,428	3,66	420 929	4,00	473 200,00				
30.06.2017	kr 1 541 155,87	0,373			420 929	4,00	473 200,00	-kr 217 874,80	94,05	-kr 105 954,47	-kr 323 829,26
03.07.2017	kr 1 647 110,33		0,383	3,24	508 263	4,00	473 200,00				
29.12.2017	kr 1 647 110,33	0,508			508 263	4,00	473 200,00	kr 490 134,94	94,25	-kr 3 502,63	kr 486 632,31
02.01.2018	kr 1 650 612,96		0,495	4,12	401 104	3,00	354 900,00				
29.06.2018	kr 1 650 612,96	0,571			401 104	3,00	354 900,00	kr 219 986,73	101,65	-kr 129 597,20	kr 90 389,53
02.07.2018	kr 1 780 210,16		0,560	4,54	391 950	3,00	354 900,00				
31.12.2018	kr 1 780 210,16	0,426			391 950	3,00	354 900,00	- 407 207,96	106,00	-kr 76 182,14	-kr 483 390,10
							SUM	kr 220 319		-kr 356 392	-kr 136 074

Table 8: QS6 – 6-month Low Sulphur Gasoil Futures

The above tables show futures and operator settlements, as well the post hedge cash flows for the Low Sulphur Gasoil Futures (QS) contracts, for both the three-month and six-month maturity.

The ‘QS1’ is the 1-month futures price per litres in USD, and QS3 is the 3-month futures price per litres in USD. The number of contracts traded is rounded to the nearest whole number, meaning that Skyss could be over/under exposed to the diesel fuel price relative to their actual exposure. The exposure in litres is calculated the following way:

$$Exposure\ in\ litres = \frac{Fuel\ exposure\ in\ NOK}{QS3\ in\ NOK}$$

Over the sample we observe an increase in the index and the futures prices, meaning that the long futures strategy will be profitable, and that Skyss would have an increased cash outflow to the operator to compensate for the increase in the SSB index.

As mentioned, the QS contract is physically settled with delivery in the Rotherdam harbour, which is not preferable for Skyss as they want cash settlements. To close out the long futures position we enter a short 1-month QS contract at the end of the month prior to maturity of the QS3 or QS6 contract. The profit equation, her exemplified using the 3-month contract, for the futures settlement becomes as follows:

$$Profit = (QS1t_1 - QS3t_0) * Litres\ hedged * NOK/USDt_1$$

QS3		
Futures Profit/loss	kr	114 322
Operator Profit/loss	-kr	184 441
Post hedge CF full sample	**-kr**	**70 119**

Table 9: Profit/Loss QS3

Over the full sample, the three-month futures contract profits from the futures trading, and gains almost exactly offset the loss to operator, as the SSB index increased. If Skyss were unhedged for the duration of our sample, there would be a loss of 184 441 NOK, this loss is counteracted by a gain from futures trading of 114 322 NOK. If hedged, the realized loss would be a little as 70 119 NOK.

Even though the long-term correlation between the index and futures prices seem to be sufficiently high, in the short-term things become more problematic. For a given three-month period we often observe losses both from futures trading and settlement with operator. For the last period especially, we observe that the is 400 109 NOK futures settlement loss and also an increase in compensation to operator of 15 753 NOK. Similar non-offsetting cash flows can be observed in period 1, 3 and 6.

For the six-month QS futures contract we analyse and compare the cash flows from the futures settlement, with semi-annual settlement between Skyss and the operator. We observe that Skyss has to enter four futures contracts to cover the six-month diesel exposure. This is solely from the fact that we hedge for a longer duration, hence we have to hedge a larger exposure in NOK compared to the three-month contract.

QS6	
Futures Profit/loss	kr 220 319
Operator Profit/loss	-kr 356 392
Post hedge CF full sample	**-kr 136 074**

Table 10: Profit/Loss QS6

As with the three-month futures contract, this six-month QS contract also improves the result for Skyss. A 356 392 NOK unhedged loss from the increased index is reduced to a deficit of 136 073 NOK, as we profit 220 319 NOK from the futures trading.

Even though the QS6 improves the result for Skyss over the full sample, we also have the same issues as with the QS3 contract. For a given period there are occurrences where we both lose in futures settlement and operator settlement, meaning that we at times do not have offsetting cash flows. For example, in period two there is a compensation loss to operator of 105 954 NOK and a loss from the futures trading of 217 874 NOK. We observe the same lack of offsetting cash flows in the last period of the QS6 futures contract.

6.1.2 FLSOM – Bloomberg price / ULSD 10ppm CIF NWE Cargoes futures

FLSOM3 – 3-month ULSD Futures

Trading date	Fuel exposure in NOK	FLSOM3 USD	FLSOM3 NOK	Avg platts spot price	Volum exposure(litres)	# Contracts	Litres hedged	Futures settlement	index	Settlement operator	Post hedge CF
01.07.2016	kr 750 000,00	0,3918	3,25		230429	2,0	236600		85,80		
30.09.2016	kr 750 000,00			0,35				-kr 80 974,81	87,50	-kr 14 860,14	-kr 95 834,95
03.10.2016	kr 764 860,14	0,39	3,22		237726	2,0	236600				
30.12.2016	kr 764 860,14			0,39				-kr 3 431,94	88,50	-kr 8 741,26	-kr 12 173,19
03.01.2017	kr 773 601,40	0,43	3,66		211365	2,0	236600				
31.03.2017	kr 773 601,40			0,41				-kr 35 859,84	96,30	-kr 68 181,82	-kr 104 041,66
03.04.2017	kr 841 783,22	0,41	3,45		244150	2,0	236600				
30.06.2017	kr 841 783,22			0,39				-kr 40 184,05	91,80	kr 39 335,66	-kr 848,38
03.07.2017	kr 802 447,55	0,39	3,27		245167	2,0	236600				
29.09.2017	kr 802 447,55			0,42				kr 54 179,96	94,40	-kr 22 727,27	kr 31 452,69
02.10.2017	kr 825 174,83	0,44	3,44		239932	2,0	236600				
29.12.2017	kr 825 174,83			0,47				kr 61 495,25	94,10	kr 2 622,38	kr 64 117,63
02.01.2018	kr 822 552,45	0,50	4,18		196714	2,0	236600				
29.03.2018	kr 822 552,45			0,50				-kr 75,87	100,00	-kr 51 573,43	-kr 51 649,30
02.04.2018	kr 874 125,87	0,51	3,98		219874	2,0	236600				
29.06.2018	kr 874 125,87			0,56				kr 91 938,43	103,30	-kr 28 846,15	kr 63 092,28
02.07.2018	kr 902 972,03	0,57	4,59		196817	2,0	236600				
28.09.2018	kr 902 972,03			0,57				kr 4 854,22	105,10	-kr 15 734,27	-kr 10 880,05
01.10.2018	kr 918 706,29	0,63	5,16		178118	2,0	236600				
28.12.2018	kr 918 706,29			0,55				-kr 161 913,36	106,90	-kr 15 734,27	-kr 177 647,62
							SUM	-kr 109 972		-kr 184 441	-kr 294 413

Table 11: FLSOM3 – 3-month ULSD futures

FLSOM6 – 6-month ULSD Futures

Trading date	Fuel exposure in NOK	FLSOM6 USD	FLSOM6 NOK	Avg Platts spot USD	Exposure in litres	# Contracts	Litres hedged	Futures settlement	Index	Settlemen operators	Post hedge CF
01.07.2016	kr 1 500 000,00	0,40	3,33		450848	4	473200		85,65		
30.12.2016	kr 1 500 000,00			0,37				-kr 124 267,34	88,00	-kr 41 155,87	-kr 165 423,20
03.01.2017	kr 1 541 155,87	0,43	3,72		414715	4	473200				
30.06.2017	kr 1 541 155,87			0,40				-kr 146 320,70	94,05	-kr 105 954,47	-kr 252 275,17
01.07.2017	kr 1 647 110,33	0,39	3,28		501577	4	473200				
31.12.2017	kr 1 647 110,33			0,44				kr 216 279,27	94,25	-kr 3 502,63	kr 212 776,65
02.01.2018	kr 1 650 612,96	0,50	4,12		400837	3	354900				
30.06.2018	kr 1 650 612,96			0,53				kr 104 599,14	101,65	-kr 129 597,20	-kr 24 998,06
02.07.2018	kr 1 780 210,16	0,56	4,56		390218	3	354900				
30.12.2018	kr 1 780 210,16			0,56				-kr 16 154,56	106,00	-kr 76 182,14	-kr 92 336,69
							SUM	kr 34 136		-kr 356 392	-kr 322 256

Table 12: FLSOM6 - 6-month ULSD futures

As earlier mentioned, we were unable to obtain price data on our preferred contract, namely the Diesel Outright Platts contract traded on The ICE. This is a futures contract on Platts (diesel) where final settlement is based on the average daily Platts spot prices during the period of the contract. The data we did obtain was the FLSOM, a Bloomberg produced futures price on ULSD 10ppm CIF NWE Cargoes futures. Prices are constructed using proprietary algorithms developed by Bloomberg Professional, which is a service to calculate fair value prices. The futures prices are calculated by mix of historical spreads, spot prices and other factors. We believe that the FLSOM mimics the Diesel Outright futures prices, and since we have data on daily Platts spot prices, we can reconstruct a trading strategy using the FLSOM. The profit from futures settlement is calculated as followed:

$$Profit = (Avg\ Platts\ Spot_t - \ Futures\ price_{t-1}) * Litres\ hedged * NOK/USD\ _t$$

FLSOM3		
Futures Profit/loss	-kr	109 972
Operator Profit/loss	-kr	184 441
Post hedge CF full sample	**-kr**	**294 413**

Table 13: Profit/Loss FLSOM3

For the 3-month futures contract we observe that both long- and short-term correlation of prices are weak. Our findings from the QS contract, where losses and gains are not offset in the short-term also holds for the FLSOM3 futures. In extension, the futures trading for the whole sample shows a loss of 109 972 NOK, simultaneously as there are a considerable loss of 184 411 NOK to compensate Skyss' operator from an increase in the SSB index. Hedging using this futures contract clearly is inefficient for Skyss.

FLSOM6		
Futures Profit/loss	kr	34 136
Operator Profit/loss	-kr	356 392
Post hedge CF full sample	**-kr**	**322 256**

Table 14: Profit/Loss FLSOM6

The six-month FLSOM futures contract shows gains of 34 135 NOK for the full sample, hence it performs slightly better than the three-month contract. Still, the hedge is way off in counteracting the compensation loss to operator of 356 392 NOK. Except for period 3 and 4, the strategy shows losses in both futures trading and compensation to operator from an increase in the index. Even though the FLSOM futures improves the post hedge result for Skyss, it is clear that the QS futures contracts, for both maturities, hedges the fuel cost exposure more efficiently.

Summary statistics of the four different contracts are presented in the table below:

Contract	QS3	QS6	FLSOM3	FLSOM6
Profit/loss	kr 114 322	kr 220 319	-kr 109 972	kr 34 136
Post hedge CF	-kr 70 119	-kr 136 074	-kr 294 413	-kr 322 256
Std. Un-Hedged	29063	50320	29063	50320
Std. Hedged	163708	383624	78114	176538

Table 15: Hedging results, future contracts

All futures contracts, except the FLSOM3 improves the post hedge result for Skyss. The QS3, with quarterly settlements, is the most efficient in counteracting the increase in cash outflow to operator, reducing the deficit to 70 119NOK. Following the QS3 in efficiency is the QS6 futures contract, which reduced deficit to 136 074NOK. The QS3 contract dominates the QS6 contracts as it also produces the smallest standard deviation in payments between the two. It's worth noting that the hedge in every case produces a higher per period standard deviation in payments, compared to the situation where Skyss is unhedged.

6.1.3 Hedging Level

In the examples above we rounded the number of contracts traded to the nearest whole number, which has the implication that Skyss could be over/under exposed in relation to their actual fuel exposure. Being over-hedged is not preferable, since the traded becomes more of a speculative move.

Next, we will test how hedging levels of *exactly* 100- and 50-percent improves the hedging results. We will consider the best performing contract, QS, for both maturities. This is a highly stylistic example, as we assume that Skyss can hedge *exactly* 100- or 50-percent of their fuel cost exposure with the futures contracts.

QS3			
Hedge level	100 %	50 %	Unhedged
Post hedge CF full sample	kr 15 589,86	-kr 84 425,35	-kr 184 440,56
Standard deviation	137014	72576	29063

Table 16: Different hedging levels, QS3

QS6			
Hedge level	100 %	50 %	Unhedged
Post hedge CF full sample	-kr 92 852,31	-kr 277 436,58	-kr 356 392,29
Standard deviation	406387	229670	50320

Table 17: Different hedging levels, QS6

We observe that the QS3 contract, with *exactly* 100% of fuel cost exposure hedged, gives us the result that we want, with an after hedge cash flow ($Futures\ settlement + Operator\ settlment$) of nearly zero. It's worth noting that we still observe a large loss from the last period of trading, which has considerable implication for the result.

The standard deviation in payments per period increases with the hedging level, and the result also becomes increasingly better as Skyss hedges more of its exposure. For the futures contract there seems to be a trade-off between standard deviation in payments per period and the reduced deficit over the full sample, as the futures trading profits.

6.1.4 Discussion

For the full sample in the futures analysis above, the diesel futures price are upward sloping, resulting in a, for the most part, profitable trade. We observe that the last period in our sample experience a sharp drop in futures price, leading to a large loss for both QS contracts. This loss in not offset by a reduction in compensation to operator. Throughout, for both the QS and FLSOM contracts, we often find that cash flows are not offset. This could be a source of liquidity risk for Skyss, if futures prices were in fact downward sloping. By liquidity risk we mean that when cash flows are not counteracted, and futures trading loses, Skyss may experience large liabilities which they may not have the ability to meet.

The lack of offsetting cash flows also becomes an issue from a budget certainty perspective. We observe that post hedge per period payments, in absolute term, are larger than if Skyss were unhedged. The current policy of compensating operators as a percentage of the increase in the SSB index actually generates the smallest standard deviation in per period payments. This holds true for every futures contract analysed. Hence, from a budget certainty standpoint, the current policy alone outperforms the futures hedging program.

The QS contracts for both maturities outperform the FLSOM contracts. Even though both QS contracts and the FLSOM 6-month futures contract improves the result for Skyss for the whole sample, it also increases the standard deviations in quarterly and semi-annual payments.

The 6-month QS contract profit more than the 3-month, but also has higher standard deviation in per period payments. Even though the QS6 profits more, the QS3 do a better job in offsetting cash flows, as it produces the smallest deficit in post hedge cash flows over the full sample. Throughout, there is a trade-off between risk and return, as there is a positive relationship between standard deviation of payments and profit from futures trading on the hedging level.

When trading futures, Skyss has to post an initial margin to the clearinghouse, which we have not considered in our analysis. The reason for this is that the margin has no implication for the effectiveness of the hedge, which is what we set out to find out. The margin percentage that has to be posted normally ranges from 3-12% of the notional value of the futures contract. The margin works at collateral for the clearinghouse if either party of the contract cannot deliver what's required. To clarify, the notional value is:

$$Notional\ Value = Contract\ size * Spot\ Price$$

We can demonstrate what initial margin has to be posted using the QS3 contract for the first period in our sample.

Trading date	Fuel exposure in NOK		QS1	QS3	QS3 NOK	Exposure in liters	# Contracts	# contracts	Litres hedged
01.07.2016	kr	750 000		0,382	3,23	231 956	1,96	2	236 600
30.09.2016	kr	750 000	0,378					2	236 600

Table 18: Notional value

The size of the two contracts is 236 000 litres, and the diesel spot price (Platts) per litre at 01.07.2016 was 0,369USD. If we assume an initial margin percentage of 8% the margin required to initiate the contract is:

$$Initial\ margin = 236\ 000 * 0{,}369USD * 8\% = \ 6967USD$$

The NOK value of the margin at that time was 58 975 NOK. If the value of the position decreases to a certain threshold, Skyss could be forced to post additional margin (margin call). One can think of this as additional collateral to the clearinghouse.

6.2 Swaps

Our swap agreement is a combination of a currency swap and a fuel swap. Skyss pay floating diesel NOK/ltr to its operator and receives floating diesel NOK/ltr from the clearing house, while paying a fixed diesel NOK/ltr to the clearing house. This is desirable for Skyss' as it makes it easy to compare the hedging strategy with the already existing payments to its operator. As the clearing house take care of the currency exposure, Skyss only need to account for one currency.

6.2.1 Full Sample

Sample	Accumulated settlement Operator	Accumulated settlement Clearing House	Result hedge (100%)
2011Q1-2018Q4	-kr 121 976	kr 530 061	kr 408 085

Table 19: Accumulated result of swap agreement, full sample

Presented in the following section will be result from the swap agreement, based upon a fictional contract between Skyss and an operator presented in the methodology chapter. Table 20 gives us the accumulated settlement between the three involved parties. Cash outflow from Skyss is visualised in negative numbers. We wanted different symbols, plus and minus, between the operator and clearing house to have a clearer visualisation of the strategy Accumulated results are calculated from the result each period added together, which is calculated as:

$$(Settlement\ operator + Settlement\ clearing\ house).$$

The clearing house settlement is calculated as:

$$(QS3 - Platts) * Volume.$$

	OPERATOR					CLEARING HOUSE						
Period	Fuel cost	Index (2018K1)	% Change	Settlement Operator	Sum Payment	Hedging amount in kr	QS3	Fixed price	Volume	Settlement price (ULSD)	Settlement Clearing House	Result Hedge
2011Q1	kr 750 000	96,5	6,75 %	kr -	kr 750 000	kr 750 000	3,90	4,02	186615	4,43	kr 76 429	kr 76 429
2011Q2	kr 750 000	98,2	1,76 %	-kr 50 625	kr 800 625	kr 750 000	4,67	4,02	186615	4,56	kr 100 713	kr 50 088
2011Q3	kr 800 625	97	-1,22 %	-kr 14 104	kr 814 729	kr 750 000	4,29	4,02	186615	4,52	kr 94 397	kr 80 293
2011Q4	kr 814 729	97,2	0,21 %	kr 9 956	kr 804 773	kr 750 000	4,14	4,02	186615	4,75	kr 137 179	kr 147 135
2012Q1	kr 804 773	100,3	3,19 %	-kr 1 659	kr 806 433	kr 750 000	4,53	4,02	186615	4,97	kr 177 874	kr 176 215
2012Q2	kr 806 433	98,2	-2,09 %	-kr 25 720	kr 832 152	kr 750 000	4,88	4,02	186615	4,73	kr 132 704	kr 106 985
2012Q3	kr 832 152	97	-1,22 %	kr 17 423	kr 814 729	kr 750 000	4,27	4,02	186615	4,93	kr 169 373	kr 186 796
2012Q4	kr 814 729	96,7	-0,31 %	kr 9 956	kr 804 773	kr 750 000	4,70	4,02	186615	4,74	kr 134 406	kr 144 362
2013Q1	kr 804 773	97,2	0,52 %	kr 2 489	kr 802 284	kr 750 000	4,38	4,02	186615	4,66	kr 119 236	kr 121 725
2013Q2	kr 802 284	95,1	-2,16 %	-kr 4 148	kr 806 433	kr 750 000	4,49	4,02	186615	4,52	kr 93 074	kr 88 925
2013Q3	kr 806 433	99,1	4,21 %	kr 17 423	kr 789 010	kr 750 000	4,34	4,02	186615	4,84	kr 152 405	kr 169 828
2013Q4	kr 789 010	99,1	0,00 %	-kr 33 187	kr 822 196	kr 750 000	4,59	4,02	186615	4,84	kr 153 836	kr 120 650
2014Q1	kr 822 196	99,2	0,10 %	kr -	kr 822 196	kr 750 000	4,88	4,02	186615	4,79	kr 143 097	kr 143 097
2014Q2	kr 822 196	96,9	-2,32 %	-kr 830	kr 823 026	kr 750 000	4,54	4,02	186615	4,68	kr 122 932	kr 122 102
2014Q3	kr 823 026	97,8	0,93 %	kr 19 082	kr 803 944	kr 750 000	4,72	4,02	186615	4,67	kr 121 042	kr 140 124
2014Q4	kr 803 944	94,9	-2,97 %	-kr 7 467	kr 811 411	kr 750 000	4,35	4,02	186615	4,08	kr 12 185	kr 4 718
2015Q1	kr 811 411	91,6	-3,48 %	kr 24 060	kr 787 350	kr 750 000	3,23	4,02	186615	3,49	-kr 98 104	-kr 74 044
2015Q2	kr 787 350	92,3	0,76 %	kr 27 379	kr 759 972	kr 750 000	3,54	4,02	186615	3,84	-kr 32 868	-kr 5 489
2015Q3	kr 759 972	90,4	-2,06 %	-kr 5 808	kr 765 779	kr 750 000	3,82	4,02	186615	3,40	-kr 114 902	-kr 120 710
2015Q4	kr 765 779	88,5	-2,10 %	kr 15 764	kr 750 016	kr 750 000	3,29	4,02	186615	3,01	-kr 189 171	-kr 173 407
2016Q1	kr 750 016	85,1	-3,84 %	kr 15 764	kr 734 252	kr 750 000	2,52	4,02	186615	2,32	-kr 316 430	-kr 300 667
2016Q2	kr 734 252	85,4	0,35 %	kr 28 209	kr 706 043	kr 750 000	2,61	4,02	186615	2,91	-kr 206 423	-kr 178 215
2016Q3	kr 706 043	87,1	1,99 %	-kr 2 489	kr 708 532	kr 750 000	3,16	4,02	186615	2,91	-kr 206 528	-kr 209 017
2016Q4	kr 708 532	88,2	1,26 %	-kr 14 104	kr 722 637	kr 750 000	3,11	4,02	186615	3,27	-kr 139 332	-kr 153 436
2017Q1	kr 722 637	95,9	8,73 %	-kr 9 126	kr 731 763	kr 750 000	3,67	4,02	186615	3,46	-kr 103 533	-kr 112 659
2017Q2	kr 731 763	91,5	-4,59 %	-kr 63 884	kr 795 647	kr 750 000	3,40	4,02	186615	3,29	-kr 135 454	-kr 199 338
2017Q3	kr 795 647	94	2,73 %	kr 36 505	kr 759 142	kr 750 000	3,13	4,02	186615	3,32	-kr 131 311	-kr 94 806
2017Q4	kr 759 142	93,7	-0,32 %	-kr 20 742	kr 779 883	kr 750 000	3,53	4,02	186615	3,85	-kr 32 427	-kr 53 169
2018Q1	kr 779 883	100	6,72 %	kr 2 489	kr 777 394	kr 750 000	4,21	4,02	186615	3,94	-kr 15 237	-kr 12 748
2018Q2	kr 777 394	103,3	3,30 %	-kr 52 269	kr 829 663	kr 750 000	4,03	4,02	186615	4,49	kr 87 140	kr 34 871
2018Q3	kr 829 663	105,1	1,74 %	-kr 27 379	kr 857 042	kr 750 000	4,66	4,02	186615	4,68	kr 124 093	kr 96 714
2018Q4	kr 857 042	106,9	1,71 %	-kr 14 934	kr 871 976	kr 750 000	5,03	4,02	186615	4,55	kr 99 665	kr 84 732
				-kr 121 976	**kr 25 245 806**						**kr 530 061**	**kr 408 084,88**

Table 20: swap, full sample

As we can see, this hedging strategy would have given Skyss a positive cash flow income over the given sample (2011-2018). Without hedging, Skyss would have had an increased cash outflow of a total of 121 976 NOK, but with an income of 530 061 NOK from the swap agreement, the accumulated result of the hedging strategy would have given Skyss 408 085 NOK in extra income. We can see that there are some periods where the hedge is off in counteracting the compensation to the operator, similar to what we saw with futures. For example period 2017Q2 where there is an extra payment of 63 884 NOK to the operator, and a payment of 135 454 NOK to the clearing house, making it a total increased payment of close to 200 000 NOK.

The optimal scenario for Skyss would have been if the payment from the clearing house were equal to the settlement between Skyss and its operator, meaning that the two settlements had the same absolute value each period, and the result is equal to zero, for example, -1000 to the operator and +1000 from the clearing house. In this case, it is not, but the duration of this period is quite long, and that could be a problem in this case. This causes a higher settlement risk for Skyss, because the duration of the strategy is long. The settlement risk would decrease with shorter duration. The fixed price in the settlement with the clearing house is based on the average of ICE Gasoil Futures (QS) over the given sample, and because of that, the fixed price would be more representative with shorter duration.

6.2.2 Two samples

Sample	Accumulated settlement Operator	Accumulated settlement Clearing House	Result hedge (100%)
2011Q1-2014Q4	-kr 61 411	kr 507 864	kr 446 453
2015Q1-2018Q4	-kr 81 188	-kr 40 645	-kr 121 833

Table 21: Accumulated results swap, two samples

Breaking the full sample into two, 2011-2014 and 2015-2018, we get a similar outcome in the first sample as the full sample, with an overall increase in the SSB index and therefore increased payment from Skyss to its operator. In both periods, the underlying hedging product, Platts, also experience an increase, but it is only in the first period that this leads to a cash inflow for Skyss.

2011-2014 (Sample 1)

	OPERATOR					CLEARING HOUSE						
Period	Fuel cost	Index (2018K1)	% Change	Settlement Operator	Sum Payment	Hedging amount in kr	QS3	Fixed price	Volume	Settlement price (ULSD)	Settlement Clearing House	Result Hedge
2011Q1	kr 750 000	96,5	6,75 %	kr -	kr 750 000	kr 750 000	3,90	4,48	167432	4,43	-kr 8 521	-kr 8 521
2011Q2	kr 750 000	98,2	1,76 %	-kr 50 625	kr 800 625	kr 750 000	4,67	4,48	167432	4,56	kr 13 266	-kr 37 359
2011Q3	kr 800 625	97	-1,22 %	-kr 14 104	kr 814 729	kr 750 000	4,29	4,48	167432	4,52	kr 7 600	-kr 6 505
2011Q4	kr 814 729	97,2	0,21 %	kr 9 956	kr 804 773	kr 750 000	4,14	4,48	167432	4,75	kr 45 984	kr 55 940
2012Q1	kr 804 773	100,3	3,19 %	-kr 1 659	kr 806 433	kr 750 000	4,53	4,48	167432	4,97	kr 82 496	kr 80 836
2012Q2	kr 806 433	98,2	-2,09 %	-kr 25 720	kr 832 152	kr 750 000	4,88	4,48	167432	4,73	kr 41 969	kr 16 249
2012Q3	kr 832 152	97	-1,22 %	kr 17 423	kr 814 729	kr 750 000	4,27	4,48	167432	4,93	kr 74 868	kr 92 291
2012Q4	kr 814 729	96,7	-0,31 %	kr 9 956	kr 804 773	kr 750 000	4,70	4,48	167432	4,74	kr 43 496	kr 53 452
2013Q1	kr 804 773	97,2	0,52 %	kr 2 489	kr 802 284	kr 750 000	4,38	4,48	167432	4,66	kr 29 885	kr 32 374
2013Q2	kr 802 284	95,1	-2,16 %	-kr 4 148	kr 806 433	kr 750 000	4,49	4,48	167432	4,52	kr 6 412	kr 2 264
2013Q3	kr 806 433	99,1	4,21 %	kr 17 423	kr 789 010	kr 750 000	4,34	4,48	167432	4,84	kr 59 644	kr 77 067
2013Q4	kr 789 010	99,1	0,00 %	-kr 33 187	kr 822 196	kr 750 000	4,59	4,48	167432	4,84	kr 60 929	kr 27 742
2014Q1	kr 822 196	99,2	0,10 %	kr -	kr 822 196	kr 750 000	4,88	4,48	167432	4,79	kr 51 294	kr 51 294
2014Q2	kr 822 196	96,9	-2,32 %	-kr 830	kr 823 026	kr 750 000	4,54	4,48	167432	4,68	kr 33 201	kr 32 371
2014Q3	kr 823 026	97,8	0,93 %	kr 19 082	kr 803 944	kr 750 000	4,72	4,48	167432	4,67	kr 31 505	kr 50 587
2014Q4	kr 803 944	94,9	-2,97 %	-kr 7 467	kr 811 411	kr 750 000	4,35	4,48	167432	4,08	-kr 66 162	-kr 73 629
				-kr 61 411	**kr 12 908 714**						**kr 507 864**	**kr 446 453**

Table 22: Swap, two samples (sample 1)

As we can see from table 23, the result from sample 1 is relatively similar to the result from the full sample. Accumulated settlement to Skyss' operator is 61 411 NOK, which is close to half of the settlement from the entire sample. The clearing house settlement, on the other hand, from this sample is close to the amount of the full sample.

2015-2018 (Sample 2)

	OPERATOR					CLEARING HOUSE						
Period	Fuel cost	Index (2018K1)	% Change	Settlement Operator	Sum Payment	Hedging amount in kr	QS3	Fixed price	Volume	Settlement price (ULSD)	Settlement Clearing House	Result Hedge
2015Q1	kr 750 000	91,6	-3,48 %	kr -	kr 750 000	kr 750 000	3,23	3,56	210761	3,49	-kr 13 753	-kr 13 753
2015Q2	kr 750 000	92,3	0,76 %	kr 26 080	kr 723 920	kr 750 000	3,54	3,56	210761	3,84	kr 59 925	kr 86 005
2015Q3	kr 723 920	90,4	-2,06 %	-kr 5 731	kr 729 651	kr 750 000	3,82	3,56	210761	3,40	-kr 32 724	-kr 38 456
2015Q4	kr 729 651	88,5	-2,10 %	kr 14 902	kr 714 749	kr 750 000	3,29	3,56	210761	3,01	-kr 116 603	-kr 101 701
2016Q1	kr 714 749	85,1	-3,84 %	kr 15 336	kr 699 414	kr 750 000	2,52	3,56	210761	2,32	-kr 260 329	-kr 244 993
2016Q2	kr 699 414	85,4	0,35 %	kr 27 459	kr 671 955	kr 750 000	2,61	3,56	210761	2,91	-kr 136 088	-kr 108 629
2016Q3	kr 671 955	87,1	1,99 %	-kr 2 466	kr 674 420	kr 750 000	3,16	3,56	210761	2,91	-kr 136 206	-kr 138 672
2016Q4	kr 674 420	88,2	1,26 %	-kr 13 376	kr 687 796	kr 750 000	3,11	3,56	210761	3,27	-kr 60 315	-kr 73 691
2017Q1	kr 687 796	95,9	8,73 %	-kr 8 517	kr 696 314	kr 750 000	3,67	3,56	210761	3,46	-kr 19 884	-kr 28 401
2017Q2	kr 696 314	91,5	-4,59 %	-kr 60 046	kr 756 359	kr 750 000	3,40	3,56	210761	3,29	-kr 55 935	-kr 115 981
2017Q3	kr 756 359	94	2,73 %	kr 31 948	kr 724 412	kr 750 000	3,13	3,56	210761	3,32	-kr 51 256	-kr 19 309
2017Q4	kr 724 412	93,7	-0,32 %	-kr 20 666	kr 745 077	kr 750 000	3,53	3,56	210761	3,85	kr 60 423	kr 39 757
2018Q1	kr 745 077	100	6,72 %	kr 2 312	kr 742 765	kr 750 000	4,21	3,56	210761	3,94	kr 79 837	kr 82 149
2018Q2	kr 742 765	103,3	3,30 %	-kr 50 096	kr 792 861	kr 750 000	4,03	3,56	210761	4,49	kr 195 461	kr 145 365
2018Q3	kr 792 861	105,1	1,74 %	-kr 24 511	kr 817 372	kr 750 000	4,66	3,56	210761	4,68	kr 237 195	kr 212 684
2018Q4	kr 817 372	106,9	1,71 %	-kr 13 816	kr 831 188	kr 750 000	5,03	3,56	210761	4,55	kr 209 607	kr 195 792
				-kr 81 188	**kr 11 758 255**						**-kr 40 645**	**-kr 121 833**

Table 23: Swap, two samples (sample 2)

In sample 2, the accumulated result from the hedging strategy is a net payment of 121 833 NOK, and is caused by an extra payment of 40 645 NOK from the swap agreement. The result without hedging would have been a payment of 81 188 NOK. We observed that Skyss would have to make an increase in payment to its operator, and a loss from the clearing house settlement in this sample. The clearing house settlement is inconsistent with the settlement from Skyss' operator. This could be caused by insecurity in the market, as a consequence of the collapse in the oil market in 2014.

6.2.3 Four samples

Sample	Accumulated settlement Operator	Accumulated settlement Clearing House	Result hedge
2011Q1-2012Q4	-kr 54 773	kr 380 018	kr 325 245
2013Q1-2014Q4	-kr 8 532	kr 130 925	kr 122 393
2015Q1-2016Q4	kr 61 644	-kr 27 244	kr 34 400
2017Q1-2018Q4	-kr 143 707	-kr 14 795	-kr 158 503

Table 24: Accumulated results swap, four samples

Breaking it further down into four samples, where each sample equals eight quarters, we get a more specific view over the development in both the SSB index as well as Platts, and the correlation between the two, as seen in table 25 above. What's interesting in this case, is to look at how the two settlements correlates with each other quarterly.

2011-2012 (sample 1a)

	OPERATOR					CLEARING HOUSE						
Period	Fuel cost	Index (2018K1)	% Change	Settlement Operator	Sum Payment	Hedging amount in kr	QS3	Fixed price	Volume	Settlement price (ULSD)	Settlement Clearing House	Result Hedge
2011Q1	kr 750 000	96,5	6,75 %	kr -	kr 750 000	kr 750 000	3,90	4,42	169528	4,43	kr 759	kr 759
2011Q2	kr 750 000	98,2	1,76 %	-kr 50 625	kr 800 625	kr 750 000	4,67	4,42	169528	4,56	kr 22 818	-kr 27 807
2011Q3	kr 800 625	97	-1,22 %	-kr 14 104	kr 814 729	kr 750 000	4,29	4,42	169528	4,52	kr 17 081	kr 2 977
2011Q4	kr 814 729	97,2	0,21 %	kr 9 956	kr 804 773	kr 750 000	4,14	4,42	169528	4,75	kr 55 946	kr 65 902
2012Q1	kr 804 773	100,3	3,19 %	-kr 1 659	kr 806 433	kr 750 000	4,53	4,42	169528	4,97	kr 92 915	kr 91 256
2012Q2	kr 806 433	98,2	-2,09 %	-kr 25 720	kr 832 152	kr 750 000	4,88	4,42	169528	4,73	kr 51 881	kr 26 161
2012Q3	kr 832 152	97	-1,22 %	kr 17 423	kr 814 729	kr 750 000	4,27	4,42	169528	4,93	kr 85 192	kr 102 614
2012Q4	kr 814 729	96,7	-kr 0	kr 9 956	kr 804 773	kr 750 000	4,70	4,42	169528	4,74	kr 53 427	kr 63 383
				-kr 54 773	**kr 6 428 215**						**kr 380 018**	**kr 325 245**

Table 25: Swap, four samples (sample 1a)

2013-2014 (sample 1b)

	OPERATOR					CLEARING HOUSE						
Period	Fuel cost	Index (2018K1)	% Change	Settlement Operator	Sum Payment	Hedging amount in kr	QS3	Fixed price	Volume	Settlement price (ULSD)	Settlement Clearing House	Result Hedge
2013Q1	kr 750 000	97,2	0,52 %	kr -	kr 750 000	kr 750 000	4,38	4,53	165388	4,66	kr 20 363	kr 20 363
2013Q2	kr 750 000	95,1	-2,16 %	-kr 3 878	kr 753 878	kr 750 000	4,49	4,53	165388	4,52	-kr 2 824	-kr 6 702
2013Q3	kr 753 878	99,1	4,21 %	kr 16 287	kr 737 590	kr 750 000	4,34	4,53	165388	4,84	kr 49 759	kr 66 046
2013Q4	kr 737 590	99,1	0,00 %	-kr 31 024	kr 768 614	kr 750 000	4,59	4,53	165388	4,84	kr 51 027	kr 20 004
2014Q1	kr 768 614	99,2	0,10 %	kr -	kr 768 614	kr 750 000	4,88	4,53	165388	4,79	kr 41 510	kr 41 510
2014Q2	kr 768 614	96,9	-2,32 %	-kr 776	kr 769 390	kr 750 000	4,54	4,53	165388	4,68	kr 23 638	kr 22 863
2014Q3	kr 769 390	97,8	0,93 %	kr 17 839	kr 751 551	kr 750 000	4,72	4,53	165388	4,67	kr 21 963	kr 39 802
2014Q4	kr 751 551	94,9	-2,97 %	-kr 6 980	kr 758 532	kr 750 000	4,35	4,53	165388	4,08	-kr 74 511	-kr 81 491
				-kr 8 532	**kr 6 058 170**						**kr 130 925**	**kr 122 393**

Table 26: Swap, four samples (sample 1b)

2015-2016 (sample 2a)

	OPERATOR					CLEARING HOUSE						
Period	Fuel cost	Index (2018K1)	% Change	Settlement Operator	Sum Payment	Hedging amount in kr	QS3	Fixed price	Volume	Settlement price (ULSD)	Settlement Clearing House	Result Hedge
2015Q1	kr 750 000	91,6	-3,48 %	kr -	kr 750 000	kr 750 000	3,23	3,16	237340	3,49	kr 79 092	kr 79 092
2015Q2	kr 750 000	92,3	0,76 %	kr 26 080	kr 723 920	kr 750 000	3,54	3,16	237340	3,84	kr 162 060	kr 188 140
2015Q3	kr 723 920	90,4	-2,06 %	-kr 5 532	kr 729 452	kr 750 000	3,82	3,16	237340	3,40	kr 57 728	kr 52 196
2015Q4	kr 729 452	88,5	-2,10 %	kr 15 016	kr 714 436	kr 750 000	3,29	3,16	237340	3,01	-kr 36 728	-kr 21 713
2016Q1	kr 714 436	85,1	-3,84 %	kr 15 016	kr 699 420	kr 750 000	2,52	3,16	237340	2,32	-kr 198 579	-kr 183 563
2016Q2	kr 699 420	85,4	0,35 %	kr 26 870	kr 672 550	kr 750 000	2,61	3,16	237340	2,91	-kr 58 670	-kr 31 800
2016Q3	kr 672 550	87,1	1,99 %	-kr 2 371	kr 674 921	kr 750 000	3,16	3,16	237340	2,91	-kr 58 804	-kr 61 175
2016Q4	kr 674 921	88,2	1,26 %	-kr 13 435	kr 688 356	kr 750 000	3,11	3,16	237340	3,27	kr 26 657	kr 13 222
				kr 61 644	**kr 5 653 056**						**-kr 27 244**	**kr 34 400**

Table 27: Swap, four samples (sample 2a)

2017-2018 (sample 2b)

	OPERATOR					CLEARING HOUSE						
Period	Fuel cost	Index (2018K1)	% Change	Settlement Operator	Sum Payment	Hedging amount in kr	QS3	Fixed price	Volume	Settlement price (ULSD)	Settlement Clearing House	Result Hedge
2017Q1	kr 750 000	95,9	8,73 %	kr -	kr 750 000	kr 750 000	3,67	3,96	189537	3,46	-kr 93 411	-kr 93 411
2017Q2	kr 750 000	91,5	-4,59 %	-kr 65 476	kr 815 476	kr 750 000	3,40	3,96	189537	3,29	-kr 125 832	-kr 191 308
2017Q3	kr 815 476	94	2,73 %	kr 37 415	kr 778 061	kr 750 000	3,13	3,96	189537	3,32	-kr 121 624	-kr 84 209
2017Q4	kr 778 061	93,7	-0,32 %	-kr 21 259	kr 799 320	kr 750 000	3,53	3,96	189537	3,85	-kr 21 192	-kr 42 450
2018Q1	kr 799 320	100	6,72 %	kr 2 551	kr 796 769	kr 750 000	4,21	3,96	189537	3,94	-kr 3 733	-kr 1 182
2018Q2	kr 796 769	103,3	3,30 %	-kr 53 571	kr 850 340	kr 750 000	4,03	3,96	189537	4,49	kr 100 248	kr 46 676
2018Q3	kr 850 340	105,1	1,74 %	-kr 28 061	kr 878 401	kr 750 000	4,66	3,96	189537	4,68	kr 137 779	kr 109 718
2018Q4	kr 878 401	106,9	1,71 %	-kr 15 306	kr 893 707	kr 750 000	5,03	3,96	189537	4,55	kr 112 969	kr 97 663
				-kr 143 707	**kr 6 562 075**						**-kr 14 795**	**-kr 158 503**

Table 28: Swap, four samples (sample 2b)

Both the settlement to Skyss' operator and to the clearing house differs quite a lot from sample to sample. Skyss is financially better off in 50% of the samples when we divide it into four. Sample 1a (2011-2012) would have had an increase in payments of 54 773 NOK to the operator, but with this hedging strategy, that would have been a total net inflow of 325 245 NOK instead. The only two samples where the hedging has a negative effect is in sample 2a and 2b. Nevertheless, this does not mean that the hedging strategy is a success. Looking at the total hedging result for each sample, we get results ranging from a net inflow of 325 245 NOK (period 1a) to an increased total payment of 158 503 NOK (period 2b), a difference of almost 500 000 NOK. The average result of these samples is 80 883 NOK, meaning that Skyss, on average, receive an accumulate inflow of 80 834 NOK each sample. The standard deviation of these four samples is 200 750 NOK (table 30) with hedging, and 86 104 NOK without hedging. The optimum result, in this case, would have been a standard deviation equal to zero, meaning that the SSB index and Platts follow the same development; however, this is not the case. As we can see, the standard deviation increases significantly because of this hedging strategy.

	Result hedge
Average	kr 80 884
Standard deviation, 100% hedge	kr 200 750
Standard deviation, 0% hedge	kr 86 104

Table 29: Avg. and std. swap agreement

6.2.4 Hedging level

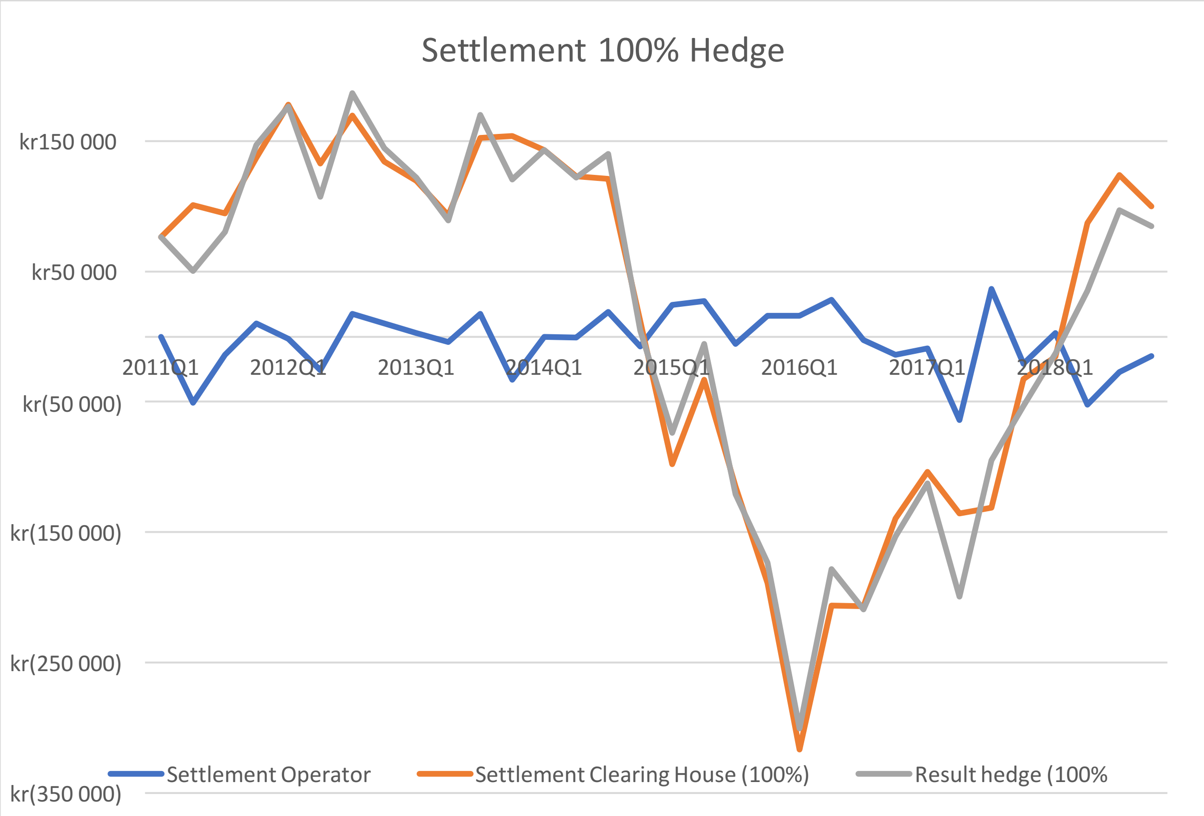

Figure 6: Settlement 100% hedge, swap

These examples show the results using 100% hedging level. We want to compare that result with the current unhedged situation. For this example, we will use a contract with longer duration, 2011-2018. Figure 6 shows the quarterly settlement with the operator (blue line), clearing house (orange line), and the result each quarter (grey line). As you can see, the results each quarter is highly dependent on the clearinghouse settlement. The hedging strategy improved the result whenever the grey line is above the blue line. Even though there are some quarters where Skyss is financial better off with 100% hedging, the cash flow from quarter to quarter, regardless if it is outflow or inflow, varies significantly more. With no hedging, the cash flow would be equal to the settlement with Skyss' operator, and as you can see, this settlement varies from an outflow payment of 63 000 NOK to a cash inflow of 36 000 NOK, an interval of almost 100 000 NOK. With Hedging, the same range would be from an outflow of 300 000 NOK to an inflow of 186 000 NOK, a difference of nearly 500 000 NOK. The opportunity set, of what Skyss could expect of net outflow/inflow each period increases with higher hedging level.

Hedging level	Std.dev
0% Hedge	23 969
10% Hedge	25 153
20% Hedge	32 793
30% Hedge	43 620
40% Hedge	55 809
50% Hedge	68 638
60% Hedge	81 806
70% Hedge	95 173
80% Hedge	108 665
90% Hedge	122 242
100% Hedge	135 877

Table 30: Std.dev different hedging level, swap.

Table 31 emphasizes this point. It shows the standard deviation for the post hedge result each period with different hedging levels. Higher hedging level equals a higher standard deviation. A higher standard deviation indicates, in this case, a greater difference between maximum cash outflow and maximum cash inflow. Hedging would mean more uncertain cash flows each period, ranging from a standard deviation of 23 969 unhedged, to 135 877 with 100% hedging. In other words, this hedging strategy would not help Skyss improve its budget certainty.

6.2.5 Correlation

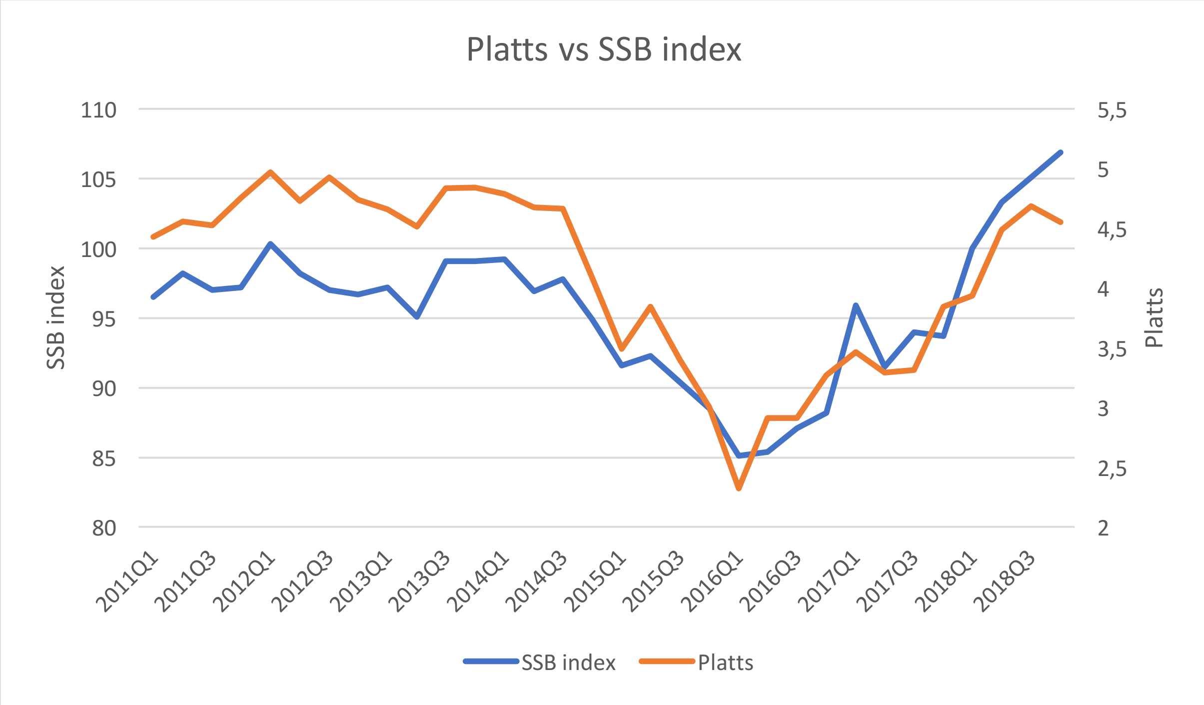

Figure 7: Correlation, platts vs SSB index

As we can see from the graph, the two factors follow each other's development to a certain extent. There are some quarters that move in opposite directions, and we can see this clearly towards the end of 2012, where there is an increase in Platts, but a decrease in the SSB index. This certainly affects the correlation, as we can see from table 32.

Sample	Correlation
2011-2012 (1a)	52,64 %
2013-2014 (1b)	86,84 %
2015-2016 (2a)	92,06 %
2017-2018 (2b)	93,35 %
2011-2018	82,99 %

Table 31: Correlation, swap

The correlation between the SSB index and Platts is 82,99%, this varies, depending on which sample we focus on. In our examples, the correlation is weak from 2011-2012, with only 52,64% correlation. At the end of the sample, the correlation gets more significant, reaching over 93 Basis price risk occurs if two assets do not follow the same price path, in this case, we can see that the basis price risk is high in the first sample, before decreasing towards later samples. 2017-2018 have the highest correlation measurement, but the accumulated settlement from the operator and the clearing house is inconsistent in that sample, with an increased payment from Skyss to the operator, and also an loss in the settlement to the clearing house. From table 29 (2017-2018, period 2b), we see that this is caused by quite high QS3 towards the end of the sample, creating a high fixed price. The correlation between the two used products in this hedging strategy, Platts and QS3, is 97%[7]. The variation in correlation could imply that external factors influence the SSB index, but not the financial product.

[7] Calculation is posted in the appendix (3)

6.2.6 Discussion

2011-2012 (sample 1a)

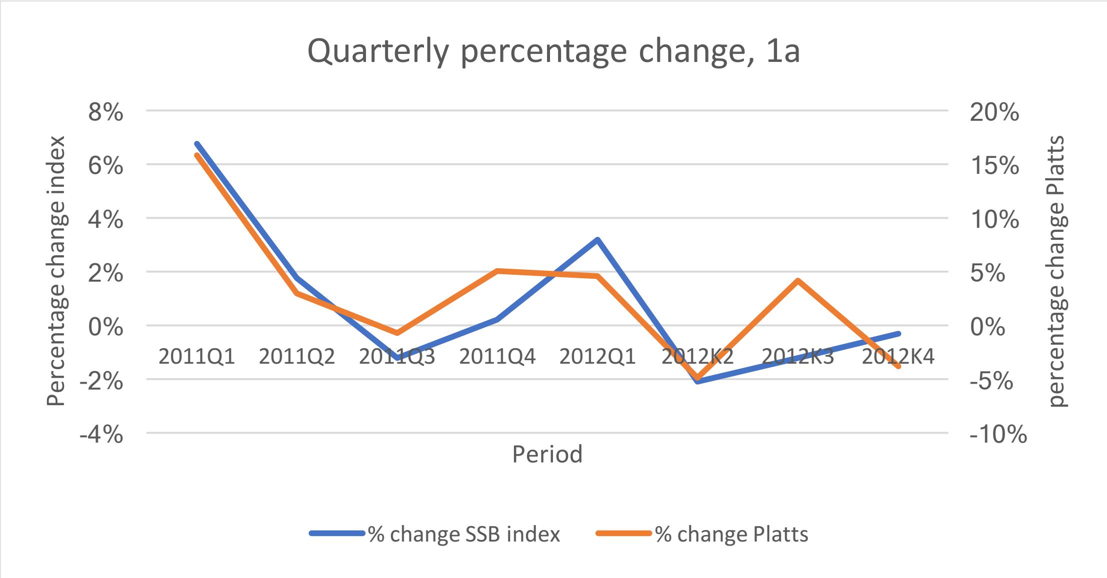

Figure 8: Quarterly percentage change, sample 1a

2013-2014 (sample 1b)

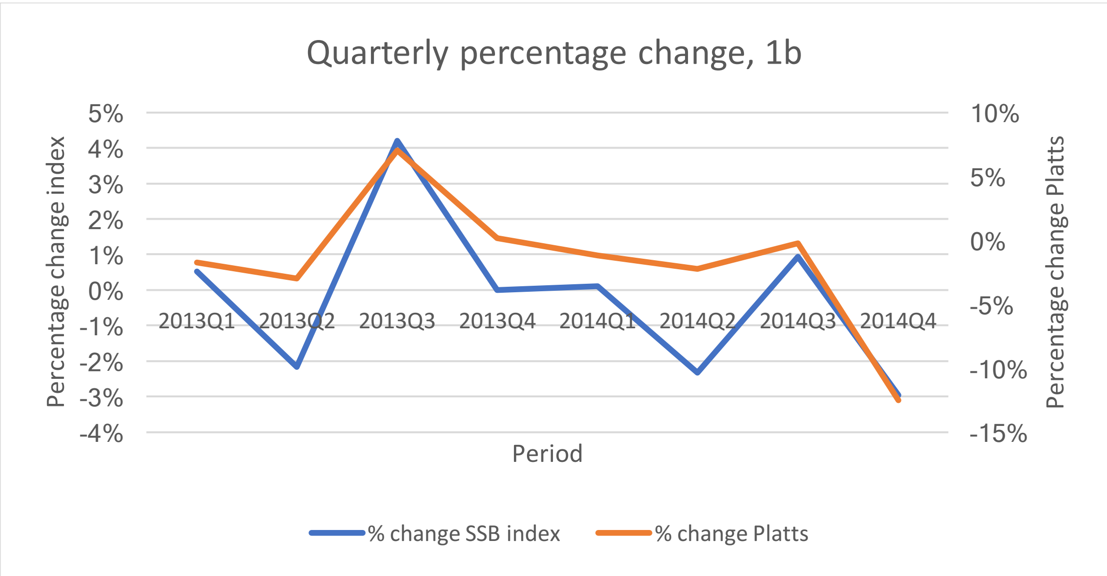

Figure 9: Quarterly percentage change, sample 1b

2015-2016 (sample 2b)

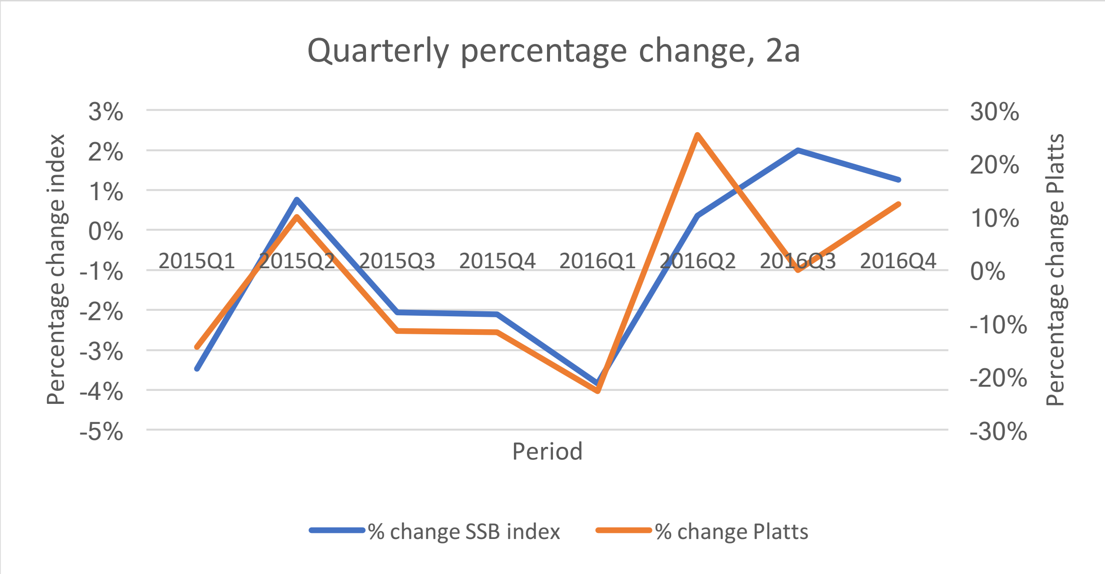

Figure 10: Quarterly percentage change, sample 2a

2017-2018 (sample 2b)

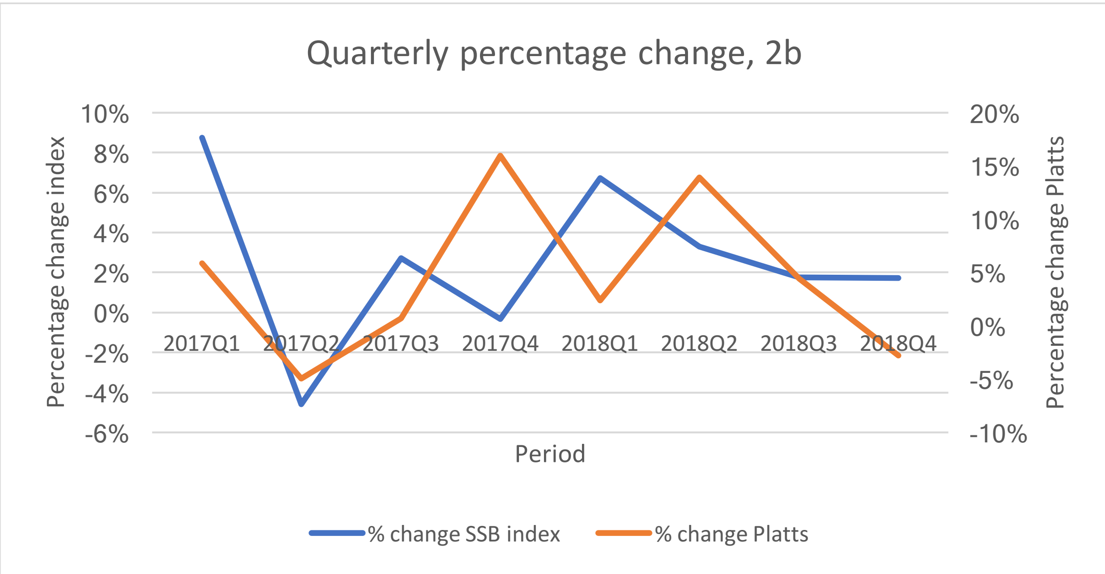

Figure 11: Quarterly percentage change, sample 2b

One of the issues with this strategy is that the underlying product (Platts) is more volatile than the SSB index, meaning that the quarterly change is more significant for Platts than the index. Looking at the four graphs, we see that in sample 1a and 1b the percentage change is somewhat correlated, while in sample 2a and, especially 2b, the quarterly change in Platts is significantly higher than the SSB index. This causes an increase in payment to the clearing house in the case of a decrease in Platts that are considerably greater than the reduction in compensation to the operator, caused by a decrease in the SSB index. The average percentage increase in the SSB index between 2011-2018 is 0,57%, with a standard deviation of 3,12%. Platts has an average increase of 1,01% and a standard deviation of 9,81% in the same sample [8]. This highlights the difference in volatility between the two factors.

Another problem with this strategy is that the increase or decrease in Skyss' payment to the operator is based on the change in the SSB index from period one to period two and so on. While the income/payment from the clearing house is based on the change in Platts, and this observed settlement price is traded against the fixed price. The consequence of this is that we can have a win-win or loose-loose situation where we have an increase in the SSB index, meaning Skyss would have to make an extra payment to its operator. And even though there is an increase in Platts at the same time, the increase is enough to go above the fixed price, and Skyss could find itself in a situation where they need to make a payment to both the operator and the clearing house. This is precisely what happens in 2017-2018, where we observed a high correlation between Platts and the index (93,35%), but Skyss ended up having an increased payment to the operator and an outflow to the clearing house, at the same time.

As pointed out in the previous chapter, the reason for the double payment in 2017-2018 is caused by quite high QS3 towards the end of the sample, creating a high fixed price. This is one of the risk elements when using commodity swap. In a perfect world, the settlement received from the clearing house would be equal to the increase compensation paid to Skyss' operator each period. That would have given Skyss budget certainty through the fixed price they would pay to the clearing house.

[8] Calculation is posted in the appendix (4)

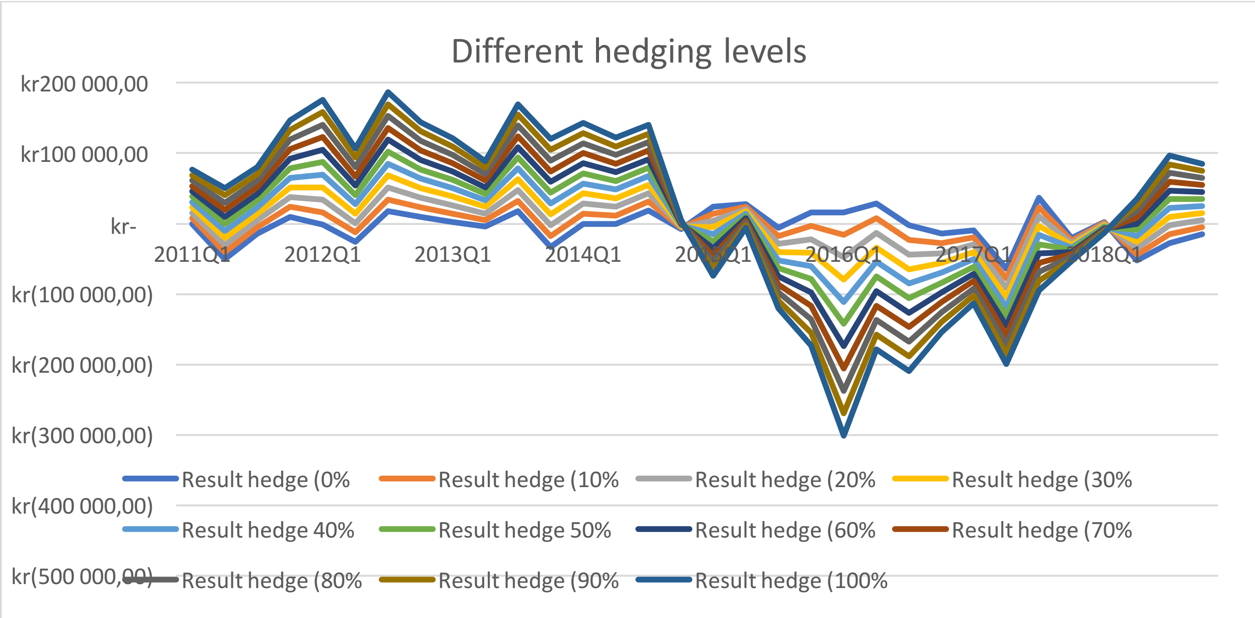

Figure 12: Different hedging levels, swap

The goal of this thesis is to compare the results of our hedging strategy with the current situation. The graph above shows the quarterly net outflow/inflow from/to Skyss as a consequence of this hedging strategy. As you can see, the gap between the quarterly payments is significantly higher throughout the sample for a 100% hedging strategy, than an unhedged strategy. This graph shows the same as figure 6 in section *6.2.4 hedging level*, except this one includes hedging level 10%, 20%, 30%, 40%,50%, 60%, 70%, 80% and 90% as well. The strategy with a 100% hedging level is, throughout the graph, the furthest from zero, and the closer the hedging level gets to 0%, the closer the line moves to zero. This indicates that a higher hedging level will give them uncertainty. The same trend can be observed when using the four samples, introduced earlier in this chapter. Those four graphs will be included in the appendix (5).

6.3 Currency exposure

One important factor which is not accounted for in the futures analysis is the impact of foreign exchange rates on our results. The payoff of each settlement is based on the USD/NOK at the time of the trade. Next, we want to look at how the strategies would have performed if the exchange rate were fixed for the duration of the futures contracts. We only test QS, the best performing future contract, for both maturities. We will focus on the future analysis in this subsection, as the swap agreement is a combination of fuel swap and currency swap.

QS3		
Period	Floating NOK	Fixed NOK
1	-kr 6 775,68	-kr 6 991,92
2	kr 79 626,60	kr 75 927,06
3	-kr 43 822,90	-kr 43 667,37
4	-kr 52 878,13	-kr 53 627,50
5	kr 149 142,45	kr 155 579,45
6	kr 134 481,96	kr 129 301,43
7	kr 34 556,48	kr 35 195,94
8	kr 122 723,29	kr 118 542,46
9	kr 97 377,14	kr 95 905,68
10	-kr 400 109,25	-kr 383 852,85
SUM	**kr 114 321,96**	**kr 122 312,37**
Diff	**kr**	**7 990,41**

Table 32: Floating and fixed NOK, QS3

QS6		
Period	Floating NOK	Fixed NOK
1	kr 135 279,60	kr 131 266,40
2	-kr 217 874,80	-kr 220 488,62
3	kr 490 134,94	kr 498 729,55
4	kr 219 986,73	kr 219 986,73
5	-kr 407 207,96	-kr 383 966,66
SUM	**kr 220 318,50**	**kr 245 527,40**
Diff	**kr**	**25 208,90**

Table 33: Floating and fixed NOK, QS6

In these two tables, we compare the futures settlement cash flows from holding the USD/NOK fixed and the case where it is floating. The "Floating NOK" column contains cash flows similar to the examples for subsection *6.1 futures,* where cash flows are dependent on the USD/NOK exchange rate at the settlement date. In the "Fixed NOK" column we have cash flows where the exchange rate is fixed equal to the first trade in the period, illustrated in the equation below;

$$Payoff\ period\ 1 = (QS1t_1 - QS3t_0) * USD/NOKt_0$$
$$Payoff\ period\ 2 = (QS1t_2 - QS3t_1) * USD/NOKt_1$$

The six-month futures contracts have the same payoff structure as the above equations. The exchange rate is held fixed for a 3- or 6-month period. As observed from the tables above, holding the exchange rate fixed improves the result slightly. The difference in cash flows largely stems from the last period, where the settlement with a fixed rate produces a smaller loss than the floating settlement. As noted earlier, the last period of our sample experience a sharp drop in futures prices. The effect on cash flows is worsened from a depreciation of the NOK of roughly 4% (400 109 / 383 852 –1) for the 3-month contract, and rougly 6% (407 207 / 383 966 –1) for the 6-month contract.

What is the effect on cash flows when FX rate is fixed equal to the first period for the whole sample? The payoff structure becomes as follows:

$$Payoff\ period\ 1 = (QS1t_1 - QS3t_0) * USD/NOKt_0$$
$$Payoff\ period\ 2 = (QS1t_2 - QS3t_1) * USD/NOKt_0$$

QS3		
Period	Floating NOK	Fixed NOK
1	-kr 6 775,68	-kr 6 991,92
2	kr 79 626,60	kr 78 722,64
3	-kr 43 822,90	-kr 43 593,72
4	-kr 52 878,13	-kr 52 905,00
5	kr 149 142,45	kr 161 254,44
6	kr 134 481,96	kr 136 909,68
7	kr 34 556,48	kr 37 668,36
8	kr 122 723,29	kr 128 038,56
9	kr 97 377,14	kr 99 884,64
10	-kr 400 109,25	-kr 393 613,20
SUM	**kr 114 321,96**	**kr 145 374,48**
Diff	**kr**	**31 052,51**

Table 34: Floating and fixed NOK (last period), QS3

QS6				
Period	Floating NOK		Fixed NOK	
1	kr	135 279,60	kr	131 266,40
2	-kr	217 874,80	-kr	213 947,62
3	kr	490 134,94	kr	489 739,98
4	kr	219 986,73	kr	225 263,11
5	-kr	407 207,96	-kr	393 176,10
SUM	**kr**	**220 318,50**	**kr**	**239 145,78**
Diff	**kr**			**18 827,28**

Table 35: Floating and fixed NOK (last period), QS6

Again, the result from holding fixed the FX rate improves the hedging result slightly. We observe that the last period in the sample, for both the QS3 and QS6 contract, that the NOK depreciate, which means that holding the exchange rate fixed reduces the futures trading deficit. The effect of this last period is greater for the QS6 contract, with a reduced deficit of 14 031 NOK $((-393\,176-(-407\,207))$, compared to a reduced deficit of 6 496 NOK for the QS contract.

Most of the gain from holding the FX rate fixed for the QS3 contract notably stems from increased gains when the hedge is profitable. We observe that from period 5 through 9, where the futures trading is profitable, that the floating NOK appreciate relative to the fixed price from the start of the sample. A higher USD/NOK exchange rate is preferable when the hedge is profitable.

Holding the FX rate fixed for a 3- or 6-month period, or throughout the full sample, improves hedging result slightly, even though per period differences in payments do not change significantly. Based on the above findings, we cannot conclude that hedging the currency significantly improves budget certainty for Skyss.

6.3.1 How to hedge currency risk?

How Skyss should hedge its currency exposure, if one decides to do so, is a complex task. Let's in the following discussion assume that there is nearly perfect correlation between the oil/diesel price and the USD/NOK conversion rate. If the oil price goes up, we would profit from the futures trade, but at the same time the NOK would strengthen (USD/NOK 8 → 7,5). In this case the strengthening of the NOK actually reduces the profit from the hedge. In the opposite case, where the oil price goes down, we will lose from the futures trading, and at the same time the NOK would weaken (USD/NOK 8 → 8,5). This weakening of the NOK in fact increases the loss from futures trading, as the liability denominated in USD gets multiplied by a higher "number". With the assumption about near perfect correlation, when the hedge is losing, Skyss would experience a 'double negative'.

The assumption about the dependency of the oil price on the NOK is not as clear cut as it once was. From the theory covered earlier, Ter Ellen (2016), found that the relationship was non-linear and that the effect on NOK from a large change in the oil price was twice as impactful as a small change in the oil price. She also described the threshold effect; when the oil price went above or below a certain threshold, this impacted the NOK to a greater extent.

Figure 13: Crude oil forward vs USD/NOK [9]

The above figure is a screenshot from the Bloomberg Terminal. On the left-hand axis; 1-month crude oil forward. Right-hand axis; USD/NOK conversion rate. The graph tells the story of lower correlation between the oil price and the NOK. Up until mid-2017 prices seemed to follow the same path, while it after this point is discrepancies between the two prices.

When fixing the foreign exchange rate, Skyss must be willing to give away some potential upside from a depreciating of the NOK. Meaning that when fixing the FX rate, one foregoes the potential additional benefit of a weaker NOK (8→8,5) when the hedge is profitable.

[9] Source: Bloomberg terminal

	Porfitable hedge	Losing hedge
Stronger NOK	Reduced profit (-)	Reduced loss (+)
Weaker NOK	Increased profit (+)	Increased loss (-)

Table 36: The impact of USD/NOK on hedging results

The above table shows the complexity of hedging the currency risk in relation to futures payoff. Furthermore, we do not know at $t_{=0}$ the magnitude of loss or gains at $t_{=1}$ so we do not know how much currency exposure Skyss actually has.

4.3.2 Options

Trading options on the foreign exchange rate will mitigate the double negative effect of a losing hedge and a potential weakening of the NOK. Specifically, buying a call option on the USD/NOK will profit If: $\frac{USD}{NOK}t_1 > K$, where K is the strike price. In the following example, we assume that the $t_{=0}$ USD/NOK is equal to 8.

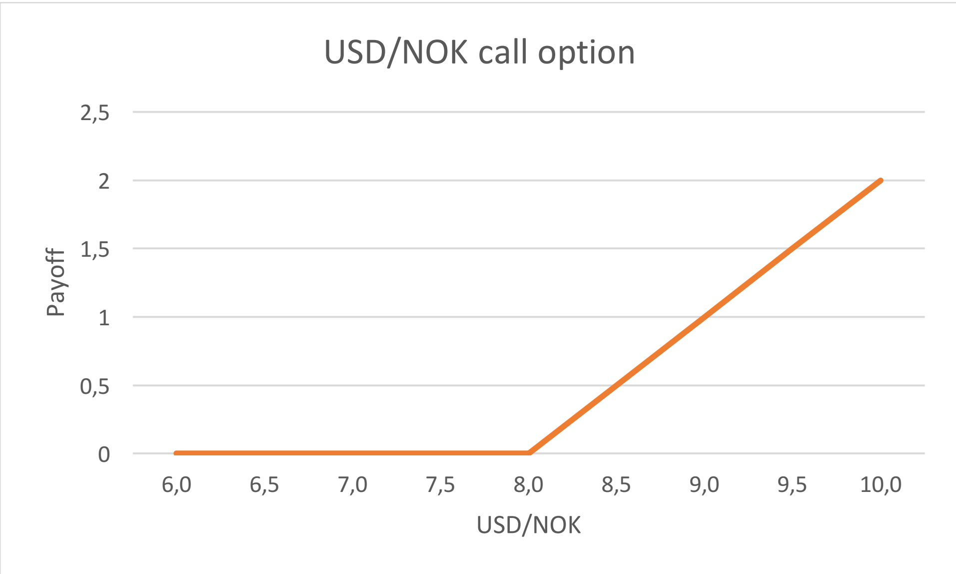

Figure 14: USD/NOK call option

The above figure shows the payoff structure off a call option on USD/NOK with strike price (K) equal to 8. On the y-axis: Payoff, and on the x-axis: USD/NOK conversion rate. If the hedge is in the loss domain, and the USD/NOK conversion rate increases, the loss from the hedge becomes larger in magnitude. The call option will in this case provide a cash inflow, counteracting the double negative effect. If the conversion rate is below 8, the option is not exercised and Skyss benefit from a stronger NOK and a reduction of hedge loss.

When the futures hedge is in the gain domain and the NOK weakens, Skyss will actually experience a triple positive. Skyss will benefit from a higher USD/NOK conversion rate, increasing the profit from the futures hedge and also profit from the currency hedge as the option gains. If the NOK strengthens, the option will not be exercised and Skyss would still have reduced profit from a lower USD/NOK conversion rate.

The drawback of using one single call option is that it could be a costly insurance, meaning that the price of the call, C_0, is high. To reduce this cost one could set a strike price that is higher than the current USD/NOK conversion rate. To illustrate, the closer to 10 the strike price is set in the figure above, the less valuable the call option becomes.

4.3.3 futures

Now let's discuss how a currency futures contract on the USD/NOK potentially could remove the undesirable double negative effect. As mentioned, we experience this effect when the commodity futures hedge is in the loss-domain and the NOK depreciates. A long USD/NOK currency futures would profit if the floating exchange rate at t_1 is above the t_0 forward rate, and lose if the floating rate is below the forward rate.

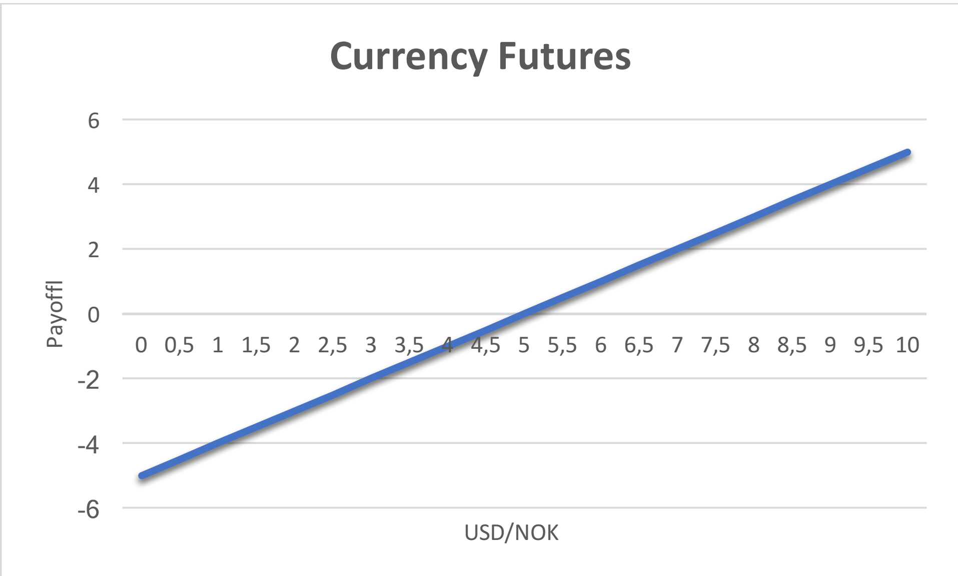

Figure 15: Currency futures

The above graph illustrates the payoff of a hypothetical long currency futures, with forward rate equal to 5.

As with the call option, the futures currency hedge will provide a cash inflow when the NOK depreciates, counteraction the double negative effect when the commodity futures is in the loss-domain. Likewise, if the commodity hedge is profitable and the NOK depreciates, the currency futures will provide a triple positive.

The difference from the currency option hedge is that the currency futures loses when the NOK appreciates. If the commodity futures are gaining, this will be counteracted by a weaker NOK, and profit is furthermore decreased from the currency futures loss. Furthermore, the currency futures will counteract the positive effect of a stronger NOK when the commodity futures are in loss-domain, as the currency futures then loses.

4.3.4 Summary

Based on the above subchapters and discussions surrounding currency exposure, together with our findings in the futures analysis that the USD/NOK conversion rate do not impact our results significantly, we do not recommend that Skyss enters a separate hedging program to control for currency exposure related to the futures commodity hedge.

7.0 Discussion

In our analysis in the previous chapter we presented and discussed the results specific to the financial instrument introduced in the subsection. In this chapter, we will discuss some overall points regarding both hedging strategies, the SSB index and how implementing this hedging strategy could affect the organizational structure.

7.1 SSB index

The SSB index is based on the diesel fuel pump price, which is a product that includes VAT, CO2 tax, and diesel tax. The underlying products used in these hedging strategies, on the other hand, is not included any fees. This could complicate the strategy because the Norwegian government could increase one of those fees, which would increase the SSB index. However, this increase would not affect the underlying hedging product, and we would find ourselves in a situation where the payment to Skyss' operator would increase, but the inflow from the hedge would not. This could be a source of price basis risk, as the fees included in diesel pump price may cause the underlying hedging product to differ from the SSB index. Another source of basis risk that could be relevant, is location risk. The SSB index only reflect Norwegian fundamentals, while the hedging products used is based on delivery outside Norway. This small fundamental differences may reduce the correlation.

This could also be an explanation for the correlation between the index and the underlying products. We know from chapter *2.3 contract* that the correlation between the index and diesel pump price is high (93%). Looking at the table below, we see the correlation between the underlying hedging products and Diesel pump price and the pure diesel product. We recognize that for QS3 and QS6 the increase in correlation is pretty low, and it is safe to say that even though the index would have been based on the pure diesel product instead of the pump price, it would not have made a significant difference to our analysis, and this imply that the fees included in the diesel pump price is not the main source of the price basis risk.

Correlation			
	Platts	QS3	QS6
Diesel Fuel pump	61,8 %	86,6 %	85,9 %
Diesel product	84,1 %	87,8 %	87,4 %

Table 37: Correlation

Platts experience a greater increase, from 61,8% to 84,1%. However, we know that the correlation between Platts and the index is 82,99% and the correlation between the index and pump price is 93%. This implies that this increase is not sufficient enough to conclude that the fees, as mentioned above, have a significant impact on the correlation between the hedging products and the SSB index.

7.2 Organizational Structure

As we mention in chapter *4.6*, Undertaking a hedging strategy could lead to a reorganization of the company structure. For a hedging strategy to be fully optimal, there has to be at least one person to follow up on the strategy and be a link to the clearing house. This person could either be an already existing employee that expands its working area, or a new employee with expertise on financial instruments. Our assessment for Skyss is that it is not necessary with a new hire for these hedging strategies to be implemented, but that a competent employee could take on this responsibility and be the link between Skyss and the clearing house.

If a hedging strategy is of significant magnitude, and the implementation of the strategy is complicated, a need for a whole new division may be necessary. Our approach excludes any speculation in trading financial products solely to make a profit from the trade. If Skyss were to use this hedging strategy in a speculative move, hedge timing would have been of more value. This could lead to the need of higher expertise on hedging and financial instrument. That person, or persons, would need to be able to follow the price movement of the oil price, and have a good understanding about finance, in general. However, we have tried to minimize the complexity of this hedging strategy to reduce additional cost in human resources needed, and we believe that a need for a whole new division is not necessary if Skyss were to implement either one of the analysed hedging strategies.

Because this hedging strategy is related to the SSB index, we believe that a good understanding of these contracts is essential to be able to implement one of these hedging strategies. We believe it would be more useful for Skyss if someone who already has knowledge about how the SSB index, and how this regulates the contracts between Skyss and its operators would take on this responsibility. Therefore, we do not think this hedging strategy would have implications for Skyss' organizational structure

8.0 Conclusion

The goal of this thesis has been to analyse two different hedging strategies, compare the results with the current contract situation, and conclude on our problem statement:

"Could Skyss improve its budget certainty by hedging their auto diesel fuel costs, or is the current contract situation more effective?"

In most cases, the hedging strategy improved Skyss' result. Three out of four futures contracts resulted in an overall improvement of Skyss' result, where the two QS contracts improved the result the most. What we do observe is that an increase or decrease in compensation to the operator is not offset by the cash flow from futures trading. This could be a source of liquidity risk when the futures trading experience losses. For the swap agreement, we saw a financial better result for Skyss in two out of four samples, when divided into four samples. Nevertheless, the same trend observed from the futures, also existed for the swap strategy. The cash flows from the hedge where inconsistent with the compensation to the operator in multiple periods.

Even though our analysis shows that foreign exchange risk does not alter our results significantly, it could become a factor which Skyss needs to account for, increasing the complexity of the hedging strategy. In addition to this, there do not exist financial products that follow the same price/compensation path as Skyss' current contract situation, where operators are compensated as a percentage of the increase in the SSB index from one period to the next.

$$S_1 = (\frac{Index\ t_1}{Index\ t_0} - 1) * P_0$$

The lacking presence of financial instruments that follow Skyss' increase or decrease in compensation from the development of the SSB index is a source of basis risk, which will reduce the efficiency of the hedge.

The long-term correlation in prices between the SSB index and our financial products varies significantly depending on which period you focus on. This implies that there could be external factors influencing the SSB index, but not the financial products. Furthermore, the prices underlying our hedging strategies are more volatile than the SSB index, leading to larger deviation in payments. Both hedging strategies increase the standard deviation in per period payments compared to how Skyss' compensation policy works right now. Hence, the current policy performs better from a budget certainty standpoint. We tested for different hedging levels, and we could clearly see the standard deviation increase gradually with a higher hedging level.

Based on the above findings, we believe that the current compensation policy alone is more efficient from a budget certainty standpoint, and do not recommend Skyss to enter a diesel fuel hedging program.

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Appendix

1

Period	kr/liter	VAT (25%)	CO2 tax	Diesel tax	Diesel product	% Diesel product	% fees
jan.09	10,99	2,198	0,57	3,5	4,722	42,97 %	57,03 %
feb.09	10,45	2,09	0,57	3,5	4,29	41,05 %	58,95 %
mar.09	10	2	0,57	3,5	3,93	39,30 %	60,70 %
apr.09	10,45	2,09	0,57	3,5	4,29	41,05 %	58,95 %
mai.09	10,6	2,12	0,57		4,41	41,60 %	58,40 %
jun.09	10,8	2,16	0,57	3,5	4,57	42,31 %	57,69 %
jul.09	10,79	2,158	0,57	3,5	4,562	42,28 %	57,72 %
aug.09	11,02	2,204	0,57	3,5	4,746	43,07 %	56,93 %
sep.09	10,88	2,176	0,57	3,5	4,634	42,59 %	57,41 %
okt.09	10,6	2,12	0,57	3,5	4,41	41,60 %	58,40 %
nov.09	11,06	2,212	0,57	3,5	4,778	43,20 %	56,80 %
des.09	10,96	2,192	0,57	3,5	4,698	42,86 %	57,14 %
jan.10	11,43	2,286	0,58	3,56	5,004	43,78 %	56,22 %
des.17	13,39	2,678	1,2	3,8	5,712	42,66 %	57,34 %
jan.18	14,37	2,874	1,33	3,75	6,416	44,65 %	55,35 %
feb.18	14,46	2,892	1,33	3,75	6,488	44,87 %	55,13 %
mar.18	14,12	2,824	1,33	3,75	6,216	44,02 %	55,98 %
apr.18	14,34	2,868	1,33	3,75	6,392	44,57 %	55,43 %
mai.18	15,16	3,032	1,33	3,75	7,048	46,49 %	53,51 %
jun.18	14,84	2,968	1,33	3,75	6,792	45,77 %	54,23 %
jul.18	14,94	2,988	1,33	3,75	6,872	46,00 %	54,00 %
aug.18	15,04	3,008	1,33	3,75	6,952	46,22 %	53,78 %
sep.18	15,13	3,026	1,33	3,75	7,024	46,42 %	53,58 %
okt.18	15,33	3,066	1,33	3,75	7,184	46,86 %	53,14 %
nov.18	15,75	3,032	1,33	3,75	7,048	44,75 %	55,25 %
des.18	14,75	3,032	1,33	3,75	7,048	47,78 %	52,22 %
jan.19	14,52	2,904	1,35	3,81	6,456	44,46 %	55,54 %
Average							55,19 %

Pump price auto diesel and fees included, used in *2.3.1 SSB index* and *4.2.1 Commodity risk.*

2

Date	Autodiesel index (2018K1)	Diesel pump price
2010Q3	86,3	11,63
2010Q4	90,4	12,19333333
2011Q1	96,5	13,01666667
2011Q2	98,2	13,23666667
2011Q3	97	13,08666667
2011Q4	97,2	13,03666667
2012Q1	100,3	13,51333333
2012Q2	98,2	13,24333333
2012Q3	97	13,08
2012Q4	96,7	13,04333333
2013Q1	97,2	13,1
2013Q2	95,1	12,83333333
2013Q3	99,1	13,36666667
2013Q4	99,1	13,33333333
2014Q1	99,2	13,36666667
2014Q2	96,9	13,06666667
2014Q3	97,8	13,16666667
2014Q4	94,9	12,8
2015Q1	91,6	12,36666667
2015Q2	92,3	12,43333333
2015Q3	90,4	12,2
2015Q4	88,5	11,96666667
2016Q1	85,1	11,47333333
2016Q2	85,4	11,52666667
2016Q3	87,1	11,75666667
2016Q4	88,2	11,89333333
2017Q1	95,9	13,72333333
2017Q2	91,5	13,11666667
2017Q3	94	13,49
2017Q4	93,7	13,43333333
2018Q1	100	14,31666667
2018Q2	103,3	14,78
2018Q3	105,1	15,03666667
2018Q4	106,9	15,27666667
Correlation	**0,934608191**	

Correlation between Autodiesel index and diesel pump price, used in *2.3 contract*

3

	ULSD	QS3
jan.10	3,129	2,904
feb.10	3,153	3,186
mar.10	3,409	3,418
apr.10	3,669	3,693
mai.10	3,577	3,420
jun.10	3,678	3,564
jul.10	3,499	3,508
aug.10	3,516	3,370
sep.10	3,551	3,608
okt.10	3,649	3,495
nov.10	3,800	3,721
des.10	4,025	3,903
jan.11	4,154	4,176
feb.11	4,386	4,550
mar.11	4,728	4,669
apr.11	4,762	4,753
mai.11	4,434	4,464
jun.11	4,478	4,292
jul.11	4,608	4,493
aug.11	4,397	4,434
sep.11	4,569	4,139
okt.11	4,691	4,462
nov.11	4,870	4,617
des.11	4,698	4,532
jan.12	4,900	4,759
feb.12	4,920	4,845
mar.12	5,088	4,884
apr.12	5,012	4,863
mai.12	4,776	4,328
jun.12	4,383	4,273
jul.12	4,745	4,641
aug.12	5,014	4,942
sep.12	5,006	4,701
okt.12	4,962	4,556
nov.12	4,751	4,603
des.12	4,508	4,379
jan.13	4,589	4,575
feb.13	4,762	4,401
mar.13	4,617	4,489
apr.13	4,373	4,181
mai.13	4,706	4,177
jun.13	4,474	4,336
jul.13	4,769	4,651
aug.13	4,852	4,863
sep.13	4,884	4,586
okt.13	4,780	4,630
nov.13	4,784	4,837
des.13	4,966	4,882
jan.14	4,829	4,725
feb.14	4,854	4,736
mar.14	4,675	4,540
apr.14	4,687	4,539
mai.14	4,616	4,494
jun.14	4,731	4,716
jul.14	4,754	4,677
aug.14	4,668	4,567
sep.14	4,577	4,350
okt.14	4,332	4,113
nov.14	4,232	3,821
des.14	3,629	3,229
jan.15	3,131	3,104
feb.15	3,651	3,696
mar.15	3,699	3,541
apr.15	3,795	4,004
mai.15	3,871	3,797
jun.15	3,857	3,825
jul.15	3,613	3,428
aug.15	3,261	3,435
sep.15	3,331	3,290
okt.15	3,222	3,256
nov.15	3,203	3,149
des.15	2,573	2,517
jan.16	2,158	2,383
feb.16	2,229	2,447
mar.16	2,574	2,608
apr.16	2,607	2,895
mai.16	2,985	3,172
jun.16	3,148	3,162
jul.16	2,905	2,753
aug.16	2,898	2,965
sep.16	2,932	3,108
okt.16	3,221	3,068
nov.16	3,067	3,242
des.16	3,532	3,673
jan.17	3,512	3,586
feb.17	3,510	3,475
mar.17	3,369	3,397
apr.17	3,506	3,320
mai.17	3,305	3,225
jun.17	3,071	3,125
jul.17	3,163	3,355
aug.17	3,236	3,315
sep.17	3,537	3,532
okt.17	3,624	3,695
nov.17	3,900	3,873
des.17	4,017	4,212
jan.18	4,098	4,083
feb.18	3,845	3,829
mar.18	3,870	4,030
apr.18	4,245	4,289
mai.18	4,683	4,661
jun.18	4,535	4,655
jul.18	4,525	4,536
aug.18	4,668	4,855
sep.18	4,861	5,031
okt.18	5,067	4,843
nov.18	4,553	3,909
des.18	4,014	3,722
jan.19	4,058	4,200
Correlation	**0,974**	

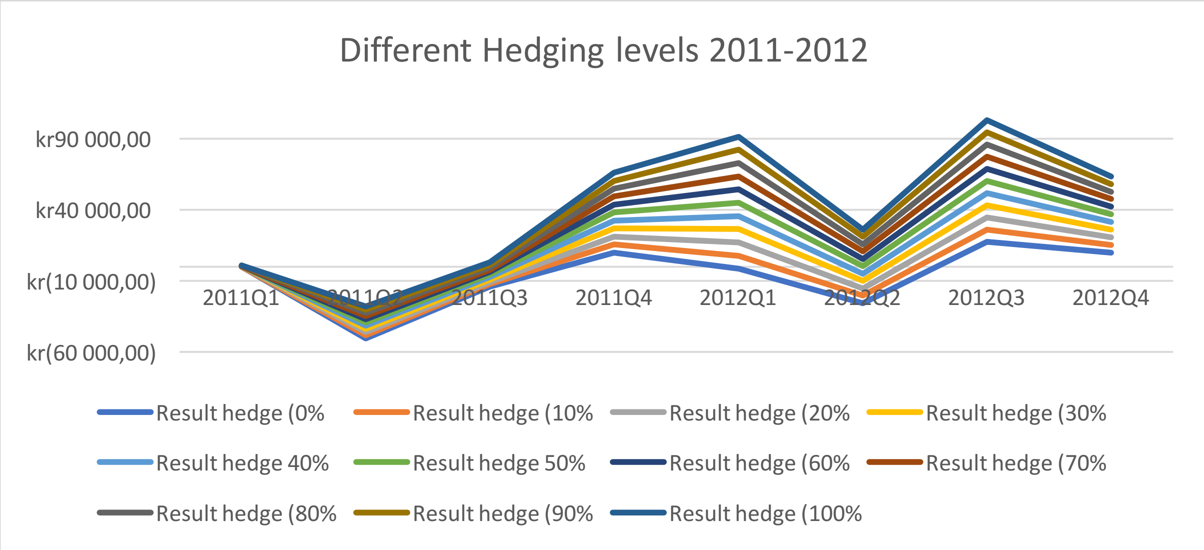
Correlation between Platts and QS3, used in *9.2.4 correlation*

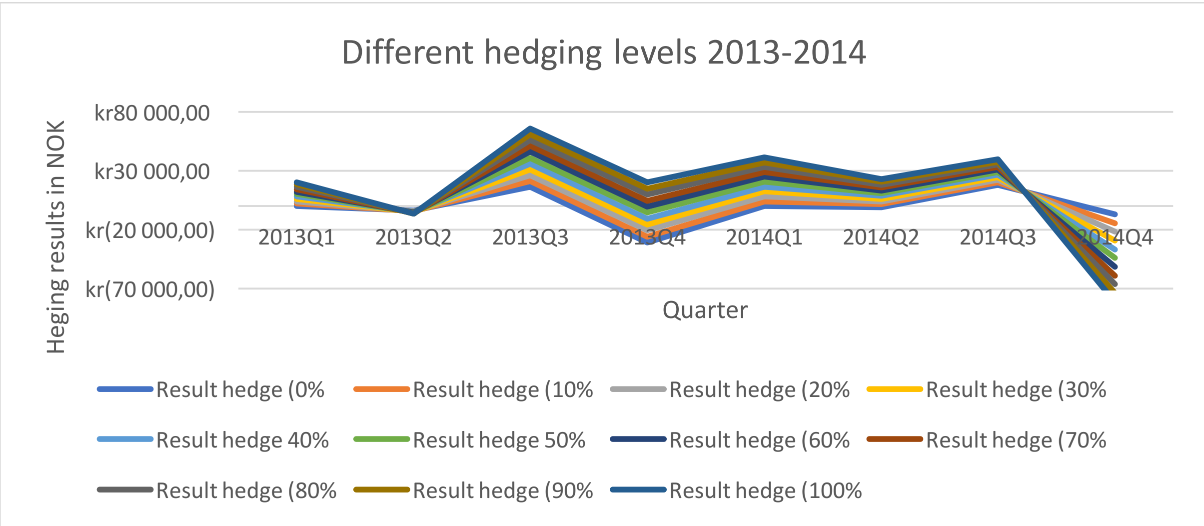
4

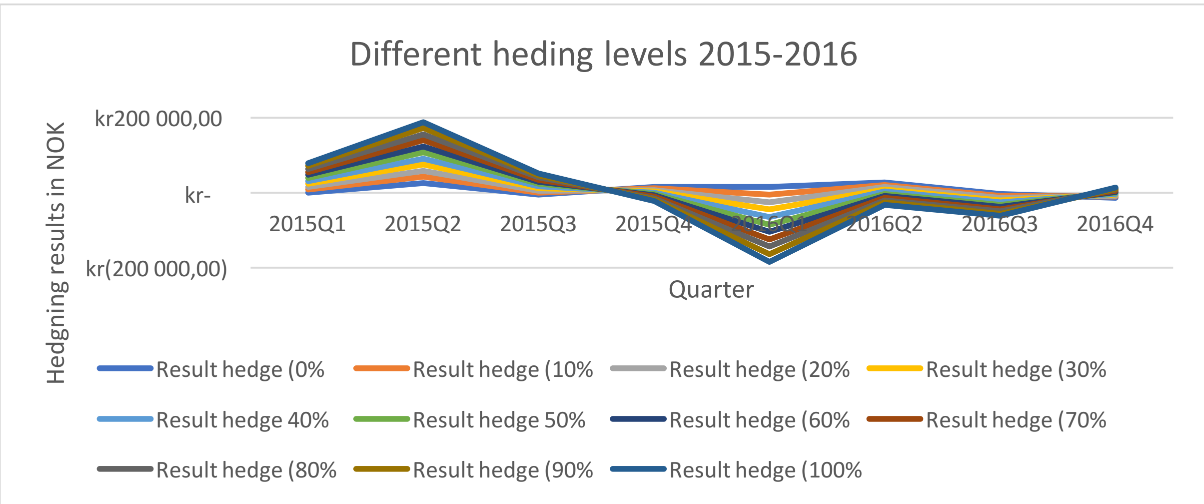
Period	% change index	% change ULSD
2011K1	6,75 %	15,82 %
2011K2	1,76 %	2,94 %
2011K3	-1,22 %	-0,74 %
2011K4	0,21 %	5,07 %
2012K1	3,19 %	4,59 %
2012K2	-2,09 %	-4,87 %
2012K3	-1,22 %	4,15 %
2012K4	-0,31 %	-3,80 %
2013K1	0,52 %	-1,72 %
2013K2	-2,16 %	-3,01 %
2013K3	4,21 %	7,04 %
2013K4	0,00 %	0,16 %
2014K1	0,10 %	-1,19 %
2014K2	-2,32 %	-2,26 %
2014K3	0,93 %	-0,22 %
2014K4	-2,97 %	-12,50 %
2015K1	-3,48 %	-14,47 %
2015K2	0,76 %	10,01 %
2015K3	-2,06 %	-11,44 %
2015K4	-2,10 %	-11,69 %
2016K1	-3,84 %	-22,69 %
2016K2	0,35 %	25,37 %
2016K3	1,99 %	-0,02 %
2016K4	1,26 %	12,36 %
2017K1	8,73 %	5,86 %
2017K2	-4,59 %	-4,94 %
2017K3	2,73 %	0,67 %
2017K4	-0,32 %	15,98 %
2018K1	6,72 %	2,40 %
2018K2	3,30 %	13,93 %
2018K3	1,74 %	4,41 %
2018K4	1,71 %	-2,79 %
Average	**0,57 %**	**1,01 %**
Std.dev	**3,12 %**	**9,81 %**

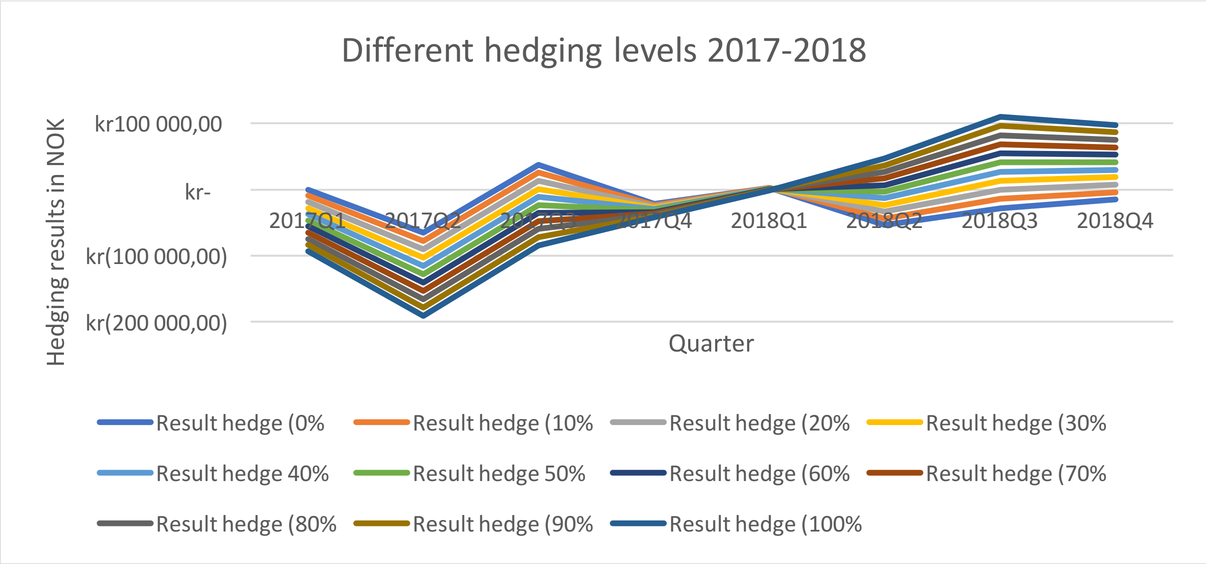
Average increase and standard deviation index and ULSD, used in *9.2.5 discussion*

5


Different Hedging levels 2011-2012
kr90 000,00
kr40 000,00
kr(10 000,00)
kr(60 000,00)
2011Q1
2011Q2
2011Q3
2011Q4
2012Q1
2012Q2
2012Q3
2012Q4
Result hedge (0%
Result hedge (10%
Result hedge (20%
Result hedge (30%
Result hedge 40%
Result hedge 50%
Result hedge (60%
Result hedge (70%
Result hedge (80%
Result hedge (90%
Result hedge (100%


Different hedging levels 2013-2014
Heging results in NOK
kr80 000,00
kr30 000,00
kr(20 000,00)
kr(70 000,00)
2013Q1
2013Q2
2013Q3
2013Q4
2014Q1
2014Q2
2014Q3
2014Q4
Quarter
Result hedge (0%
Result hedge (10%
Result hedge (20%
Result hedge (30%
Result hedge 40%
Result hedge 50%
Result hedge (60%
Result hedge (70%
Result hedge (80%
Result hedge (90%
Result hedge (100%


Different heding levels 2015-2016
Hedgning results in NOK
kr200 000,00
kr-
kr(200 000,00)
2015Q1
2015Q2
2015Q3
2015Q4
2016Q1
2016Q2
2016Q3
2016Q4
Quarter
Result hedge (0%
Result hedge (10%
Result hedge (20%
Result hedge (30%
Result hedge 40%
Result hedge 50%
Result hedge (60%
Result hedge (70%
Result hedge (80%
Result hedge (90%
Result hedge (100%



Different hedging levels, used in *9.2.5 discussion.*