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Executive summary

Most airlines have created fuel hedging programs to limit their exposure to fluctuations of jet fuel prices. In this paper, we use three different hedging strategies to show how airlines can reduce fuel price risk. This includes one strategy using futures and two strategies using options contracts. We will examine data from 31.01.2017 to 07.12.2018 to analyze the total costs each strategy will affect airlines, using Norwegian Air Shuttle as an example.

The first part of this paper discusses the connection between Kerosene jet fuel and Brent Crude oil. Then, the paper goes in depth on the rationale of the different strategies, and the conditions for the simulation are presented. We conclude that each hedging strategy has proven to be effective due to the increasing oil prices.

Finally, a few reflections are presented to understand why it is necessary for airlines to hedge against fuel price risk.

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1. Introduction

During the last year, the oil-price has fluctuated due to uncertainties regarding both OPEC production policy and the unpredictability of announcements from the President of the United States. This has led to uncertainties regarding the oil-price, and consequently trickled down on sectors that are highly exposed to the oil-price developments. Among those sectors, is the airline sector, where the fuel-costs makes up a considerable amount of the total expenses. In such an environment, the importance of reducing this cost-exposure, therefore becomes highly relevant. A solution to this, is to hedge against fluctuations in the fuel-price.

This assignment will discuss how airlines can reduce fuel price risk, using different financial instruments and hedging strategies. We will start by considering the market fundamentals in which hedging strategies are executed. Furthermore, we explain how fuel costs play a significant role in airline economy. We will then explain theory considered relevant for our trading topic and elaborate the mechanisms of the different financial instruments we use to construct our trading strategies. Following this, we will present different trading strategies we consider favourable for airlines hedging against fuel price risk. We conduct our analysis by executing our strategies using data from 2017 and 2018. Choosing this time-interval enables us to capture both a decline and rise in the oil-price, consequently showing the effects of the hedging-strategies in both scenarios. Lastly, we will reflect on our findings and the limitations to our analysis, before we conclude our paper.

2. Market fundamentals

In order to understand how airlines can hedge themselves against fuel price risk, it is necessary to establish an understanding of the commodities used in this hedging practice, namely Brent Crude Oil and its distillate Kerosene. This section will give an overview of the markets for and correlation of these products, before we continue our essay by explaining hedging strategies using derivatives-based trading commodities in these markets.

The Brent Crude-Oil, often referred to as North Sea oil, is considered the price barometer for approximately two-thirds of all global crude oil (ICE, 2018).

2.1 Brent crude oil

Brent Crude oil (BCO hereafter) is classified as a sweet, light crude, making it well suited for production of Kerosene jet fuel (Petroleum, UK, 2015). This fact, accompanied by the liquidity of the commodity, is why we have chosen to concentrate on this type of crude oil throughout our paper.

2.1.1 Brent crude oil spot market

The spot-market facilitates for trading commodities and financial instruments for immediate delivery (Harris, 2003). Hence, the spot-price for BCO is the price a trader must pay to obtain the commodity right away. The spot-price is determined in the immediate relationship between supply and demand. This means that an excess of supply leads to a lower spot-price, and conversely - a surplus of demand leads to a higher spot-price.

The Brent Crude spot-price is depicted in Figure 1 below, which shows the price development since the beginning of 2016. Figure 1 reflects the fluctuating nature of the spot-price for BCO. The overall trend, however, indicates an increase since 2016 until today (Macrotrends LLC, 2018). These fundamental indicators are both important elements to consider with regards to our topics.

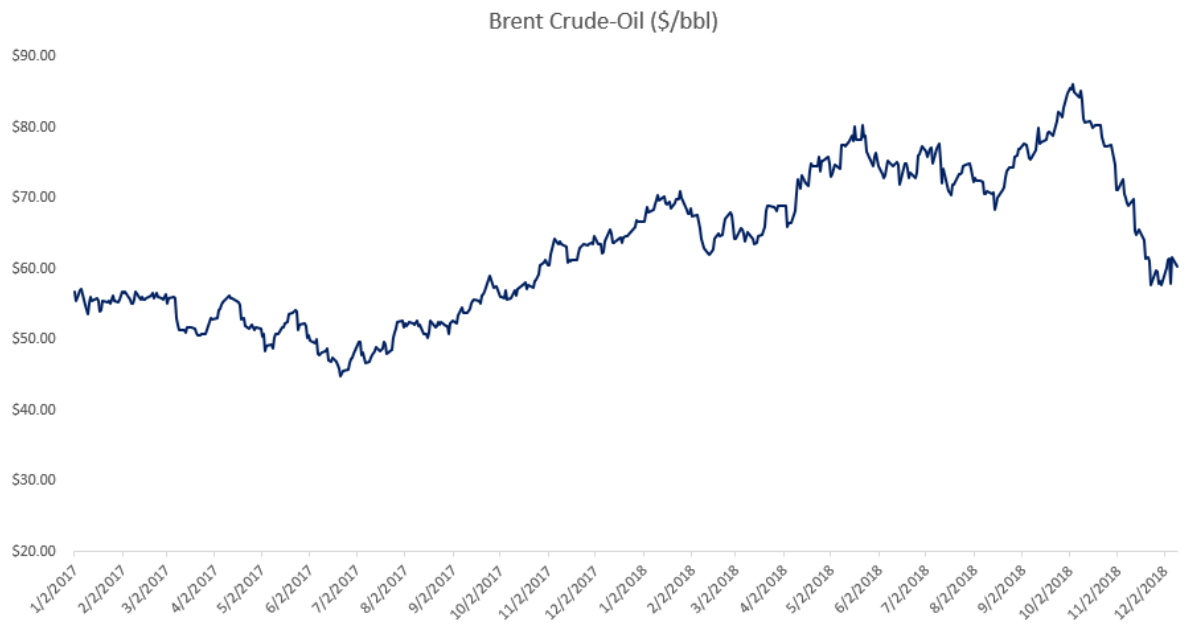


Figure 1 - Price of Brent crude oil per barrel in US$, 2017-2018

2.1.2 Brent oil futures market

Traditional hedging theory emphasizes how future contracts can be used for risk avoidance, by taking futures market positions with the opposite sign in the cash market (Ederington, 1979). A futures contract can be defined as a promise from a seller and a buyer to trade a standard quantity and quality of a commodity within a specified month at an agreed price (Johnson, 1960). The futures markets are exchanges in which traders can buy and sell these standardized futures contracts. These exchanges specify the standardized features of the contract (Hull, 2015). In addition, the exchange guarantees counter-party delivery by facilitating as a clearing-house (Harris, 2003). The BCO futures used in this paper are traded on the Intercontinental Exchange (ICE). In 2018, excluding December, 219,612,204 BCO futures contracts were traded on the ICE (ICE, 2018). One contract equals 1,000 barrels, or 42,000 gallons of BCO.

The price in the futures market, like the prices in the spot-market, is determined by the laws of supply and demand. In addition, the futures-market prices are fundamentally linked to the spot-market prices. Commodities that are consumption assets, such as Brent oil, may be subject to significant storage costs and no income. However, because airlines consume jet fuel and not Brent oil, we will not take storage costs into consideration.

2.2 Kerosene jet fuel

Kerosene is a distillate of BCO, commonly used for jet fuel. According to Hull (2015), Kerosene jet fuel futures are not as actively traded, compared to BCO futures. This is due to the fact that jet fuel often is traded “over the counter” (OTC) and not on exchanges. Therefore, we have chosen to focus on hedging with BCO futures, instead of futures on Kerosene. Kerosene as a commodity is typically traded on the Tokyo Commodity Exchange, denominated in YEN per kilolitre. The data on Jet-fuel Kerosene prices used in this paper is collected from US Energy Information Administration (EIA, 2018).

3. The airline-industry's dependence on fuel-prices

One of the main cost drivers for an airline is the price of jet-fuel. According to Scandinavian Airline System (SAS henceforth), jet-fuel costs constitute their single largest expense item, amounting to 17% of their total operating expenses in 2017 (SAS, 2018). Similar to SAS, the Lufthansa Group's (LHG) annual report of 2017 states that fuel-expenses amounted to 15% of their total operating expenses (Lufthansa Group, 2018). The growth in the crude-oil price beginning late in Q2 2017 can be considered a contributing factor to these high percentages. This is due to the apparent relationship between developments in the crude-oil prices and the kerosene jet-fuel prices. This relationship is depicted in Figure 2 showing that the developments since Q2 2017 reflects rising prices for both commodities. Furthermore, forecasts made by The International Air Transport Association (IATA) predict fuel costs to account for approximately 23.5% of operating costs for the global airline industry in 2018, given an average price of $73.0 per barrel of Brent crude oil (IATA, 2018).

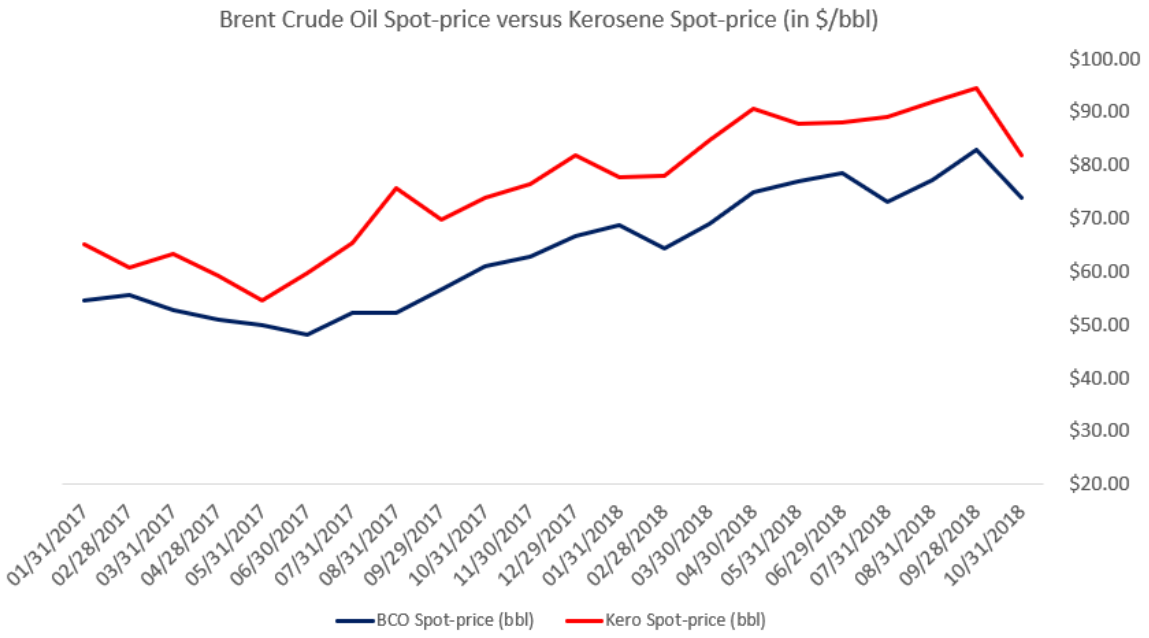


Figure 2 - Brent crude oil price vs. Kerosene spot-price, US$/barrel, 2017-2018

This illustrates that fuel-costs makes up a considerable amount of an airline's overall expenses, and with expectations of higher oil-prices the costs will continue to rise – a considerable factor of risk. There are however several measures airlines can take to reduce this risk, and in the following chapter we will present some of the common strategies used by airlines to hedge against the fuel price risk. Using monthly returns for the BCO spot-price and Kerosene spot-

price over a 10-year period from July 2005 to June 2015, the spot-prices are found to have a correlation of 0.9 (Dafir & Gajjala, 2016).

4. Hedging markets

It will be cheaper to set up and remove hedges in a liquid market where the transaction costs are low. A hedger will also be interested in markets that trade instruments which are closely correlated to the risks that they face (Harris, 2003). Trade instruments will be correlated with the airline's risk if the variation of its basis is small compared to the variation in the contract price. Successful hedging markets will generally trade intermediate commodities that are largely undifferentiated and cheap to transport. Intermediate commodities are produced by one industry and used by another (Harris, 2003). Furthermore, airlines will use contracts to hedge financial risk associated with transactions that they expect to do in the future. Commodity futures markets have constantly developed contracts to offer to potential hedgers, and this has helped airlines to reduce much of its risk associated with fuel price.

4.1 Hedging with futures contracts

Standardisation of the contracts ensures that all traders trade the same instruments. The main difference between a futures and a forward contract is that the futures contract is managed by a clearinghouse which guarantees the performance of both the seller and the buyer (Harris, 2003). The clearinghouse does this by acting as an intermediary between the buyer and the seller in every trade; for every buyer the clearinghouse acts as the seller. When a seller states its interest, the clearinghouse functions as the buyer. This clearinghouse guarantee allows buyers and sellers to trade with each other without needing to worry about credit risk (Vasigh, 2017). This removal of counterparty risk, accompanied with the standardisation of the contracts, makes the futures markets both attractive and highly liquid.

Futures contracts in any given commodity traded for the same month of delivery are identical. Their terms of delivery are the same. However, the number of traders that make or take delivery is significantly low, due to their different preferences in delivery terms. Therefore, buyers sell, and sellers repurchase their contracts before delivery (Vasigh, 2017) (Harris, 2003). To be released from the obligations carried by their contracts, market participators do not have to trade with the person they originally traded with. This is possible due to the fact that the clearinghouse

is on the opposite side of all positions, and that traders therefore are able to close their positions by trading with any other trader (Harris, 2003).

Hedging with futures contracts allows the trader to lock in a future price, minimising the risk of considerable price change in the underlying asset. This means that the possibility of loss from an adverse price change, as well as profit from a favourable price change, is eliminated (Harris, 2003). A futures hedge can be defined as a linear hedge. This can be explained by the similarity in the proportionality of gains and losses of the futures contract compared to changes in the underlying cash price (Harris, 2003). Futures contracts are considered a favourable tool for BCO hedging because of the speed, liquidity and low transaction costs of the contracts (Chang, McAleer, & Tansuchat, 2011).

4.1.1 Calculating the minimum variance hedge ratio

When hedging an exposure to the price of an asset with contracts on the same asset, it is natural to use a hedge ratio of 1,0. "The hedge ratio is the ratio of the size of the position taken in futures contracts to the size of the exposure" (Hull, 2015). One of the hedging strategies presented in our analysis involves buying futures contracts with an underlying asset different from the asset whose price is being hedged. This strategy is called cross hedging. When cross hedging is applied, a hedge ratio equal to 1,0 is rarely optimal. Finding the optimal hedging ratio is done by calculating the ratio that will minimise the variance of the value of the hedged position (Hull, 2015). The methodology is explained below:

ΔS: Change in spot price (S) during a period of time that is equal to the lifespan of the hedge
ΔF: Change in futures price (F) during a period of time that is equal to the lifespan of the hedge
h^*: Variance hedge ratio

$$h^* = \rho \frac{\sigma S}{\sigma F}$$

Where σF is the standard deviation of ΔF, σS is the standard deviation of ΔS and ρ is the correlation coefficient between the two of them. The correlation coefficient varies from [-1,1], where -1 indicates a perfect negative relationship, +1 indicates a perfect positive relationship and 0 indicates that there is no relationship.

Parameters ρ, σS and σF are estimated from historical data on change in futures price and change in spot price. The assumption here is that the future will, to some extent, look like the past. The model requires for an equal number of non-overlapping time intervals to be chosen.

4.1.2 Optimal number of contracts

Once the minimum variance hedge ratio is calculated, the number of contracts that should be used for hedging, can be found by using the following formula:

Qa: Size of the position being hedged (units)

Qf: Size of one futures contract (units)

N*: Optimal number of futures contracts to be used for hedging

$$N^* = \frac{h^* Qa}{Qf}$$

The minimum variance hedge ratio and optimal number of contracts calculations are retrieved from (Hull, 2015).

4.2 Hedging using commodity option contracts

Commodity option-contracts can either be characterized as call-option contract or put option contracts. The call-option contract gives the buyer of the option the right, but not the obligation, to purchase a specified commodity for a specified price at a specified future date. Conversely, the put-option contract gives the buyer of the option the right, but not obligation, to sell a specified commodity for a specified price at a specified future date. The seller, or writer, of both the call and put options must abide to the terms on the contract and either buy or sell the commodity to the buyer, should he choose to exercise his option (Black, 1970). The option contracts on liquid-commodities, and therein Brent Oil generally involves a contract size of 1000 barrels per contract and strike-prices are denominated in USD per barrel of oil (The Options Guide, 2018).

The option-contracts we will use in this paper are options on BCO, with expiry on the 9th of February 2019. These options have an American-style exercise, meaning that the holder can

exercise at any point in time between purchase and expiry. These contracts also have a futures-style margining options premium, such that premiums are not paid or received at the time of the transaction. All contracts are for 1000 barrels of Brent Crude Oil in USD and are available for trading on the Intercontinental Exchange (ICE) (ICE, 2018).

4.2.1 Hedging fuel price risk using spreads on options

A strategy an airline can use for hedging against fuel-price risk using option-contracts is a consumer two-way collar spread. This strategy involves writing a call option and purchasing a put option with different strike-prices and same expiry, thus creating a floor and a ceiling. The initiation costs for this strategy are low, due to the fact that the airline writes and purchase options simultaneously. This strategy works well when there are rising fuel prices, but in return expose the airline to declining prices.

Another, more conservative, strategy involving option-contracts to hedge against fuel-prices is the so-called consumer four-way collar spread. In essence, a four-way collar hedge involves a combination of a long call option spread and a short put option spread, whereas all the option-contracts have the same expiry. To create a long call option spread, the airline would purchase an out-of-the-money call option with a relatively low strike-price and write a second call option which is further out-of-the-money, i.e. with a higher strike price. Moreover, to construct the short put option spread, the airline would write one out-of-the-money put option and purchase a second put option which is further out-of-the-money, i.e. with a higher strike price. The combination of these spreads ultimately creates the four-way collar spread. The call option spread provides a hedge against rising fuel prices, but in return, the put option spread an exposure to declining oil prices. In addition to the hedge against higher oil prices, the four-way collar has the advantage of low initiation costs. This is due to the fact that the costs of purchasing the call option spread, is offset by the proceeds from selling the put option spread (Mercatus Energy Advisors, 2018).

4.3 Transaction costs

There are transaction costs associated with all hedging strategies used by airlines against fuel price risk. When airlines take use of derivatives such as options and futures there will be additional expenses due to brokers' commissions and spreads. The bid-ask spread reflects the supply and demand for a particular asset, and the liquidity will be the main factor determining

the size of the spread. Due to the liquidity of the Brent market, the hedging strategies in this paper will only use BCO instruments. Therefore, we will assume the transaction costs to be negligible as the spread is small (ICE, 2018).

5. Analysis

We have now presented the theory we find as a necessary basis for understanding our analysis. Moving on, we will explain and compare three different strategies airlines can employ for hedging against fuel price risk, using BCO instruments.

The first section will examine how airlines can lower their jet fuel price risk by cross hedging with BCO futures contracts. Further on, we will present our second strategy, which is executed by constructing a two-way collar using options on BCO prices. The last strategy we present involves constructing a four-way collar hedge, also on BCO prices. According to *Mercatus Energy Advisors*, a world leader in energy-hedging and risk-management, these strategies are presented as both widely used and highly effective when hedging against fuel-price risk (Mercatus Energy Advisors, 2018).

Costs of trading, such as initial margin and maintenance margin have intentionally not been included in our analysis. This assumption has been made in all strategies presented. Our decision to make this assumption is based on our difficulties in obtaining precise data on these costs, and lack of knowledge in what sort of assets airlines use to provide these margins. For the same reasons, we have also chosen to exclude brokerage fees for executing the trades in our analysis.

All data provided and presented in our analysis are obtained from the U.S Energy Information Administration and the Bloomberg database, accessed through the Bloomberg Terminal at the library at NHH. Data used is provided in the appendix. We have been careful when selecting our data, to get as precise results as possible, and used time intervals we believe are suitable for our case. The time interval for our hedging strategies spans no longer than two years, starting 31.01.2017. We have chosen this interval on the basis of hedging practices presented by several airlines. Both Norwegian Air Shuttle and Lufthansa, which are included as examples in this paper, do not hedge their fuel-consumption more than 24 months into the future, according to their annual reports (Norwegian Air Shuttle ASA, 2018) (Lufthansa Group, 2018).

5.1 Hedging with futures contracts on BCO

5.1.1 Assumptions and notional values

In this part of our analysis, we will present the findings from implementing our futures strategy. The strategy has been tested in the interval of 31.01.2017 to 31.10.2018. This is a time interval where the BCO and Kerosene prices both have seen great fluctuations, making it possible for us to examine the effectiveness of our futures hedging strategy in an unstable market.

The strategy is implemented as if an airline entered a long hedge position with monthly BCO futures contracts, which are rolled over each month. We believe the practice of rolling the contracts can be considered a realistic assumption, due to the fact that airlines do not have any interest in taking delivery of physical BCO.

We have calculated the minimum variance hedge ratio and the optimal number of contracts using the formulas presented in section 4.1.1 and 4.1.2. We use the fuel-consumption-estimates of Norwegian Air Shuttle in our analysis. The fuel-consumption for 2017 is as stated in NAS's annual report for 2017. Furthermore, fuel-consumption for 2018 is based on their 2017 estimate for the full-year consumption of 2018. The results are illustrated in Table 1. The optimal number of contracts is assumed to be the same each month.

BCO Futures hedge, notional values and calculations

Size Futures Contract	1,000	*bbl.*
Size Futures Contract, *Qf*	42,000	*gallons*
NAS Kero Demanded Total (whole period)	2,900,600	*tonnes*
NAS Kero Demanded/month	138,124	*tonnes*
NAS Kero Demanded/month, *Qa*	43,890,161	*gallons*
Std.dev ΔKero Spot, σS	0.13	
Std.dev ΔBCO Futures, σF	0.09	
Corr., ρ	0.42	
MVHR, h^*	0.62	*BCO vs. Jet Kerosene*
Optimal no. Contracts/month, N^*	645	

Table 1 - Notional values and calculations of minimum variance hedge ratio and optimal number of contracts for the BCO Futures cross hedging strategy

5.1.2 The results from implementing the BCO futures cross hedge strategy

The level of correlation between the change in the spot price of Jet Kerosene and one of the BCO futures contracts is measured to 0.42. This is because the hedging instrument, in this case, the BCO futures, is a different asset than the one we are hedging. Figure 4 and Figure 3 illustrate how the changes in the BCO futures price to some extent follows the same pattern as the Kerosene spot price. Although we can see steady growth in both prices throughout the whole hedging period, the growth in the futures price has been more modest, and not as fluctuating as the price of Kerosene Spot.

When considering the outcomes of our futures strategy, the BCO futures and Kerosene Spot gives a double-negative effect in months where we see a decrease in the BCO futures prices, and a concurrent increase in the Kerosene spot price. The lack of performance in these monthly periods can be explained by the non-perfect correlation in the prices of the two assets. One instance of this effect can be seen in Figure 4 and Figure 5 for august 2017. In this period, the double-negative effect caused a net loss of US$ 10,707,789.

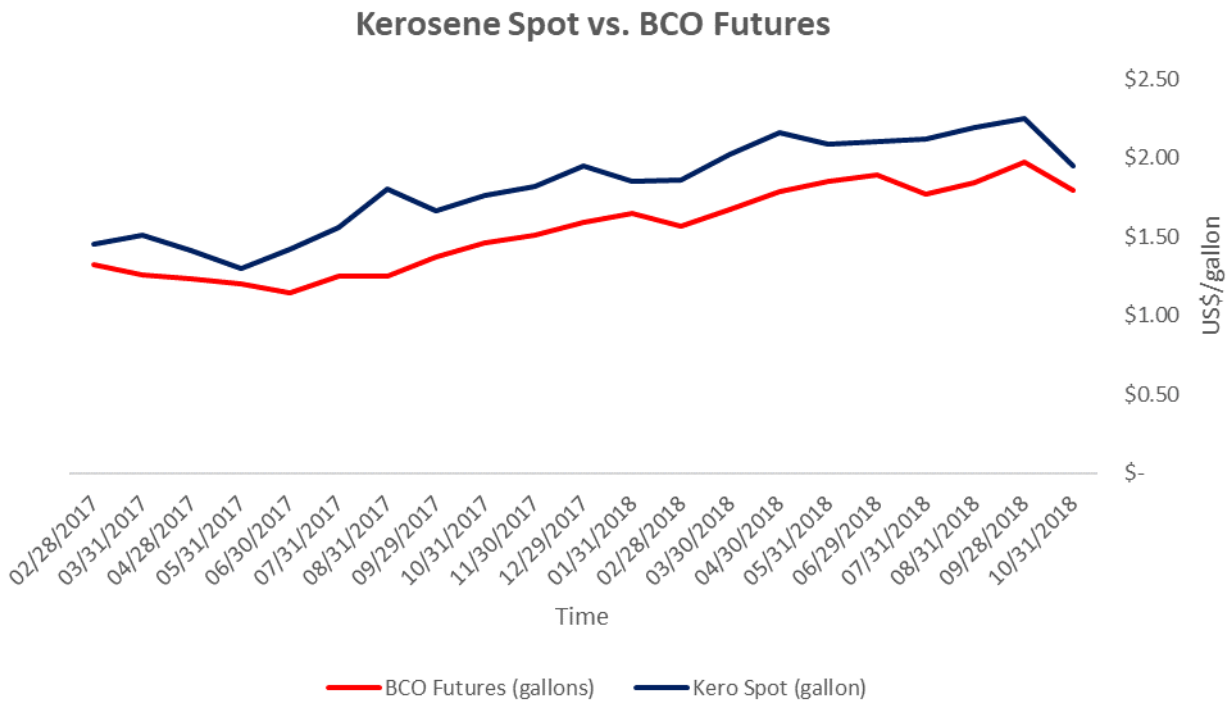


Figure 3 - Kerosene spot price vs. BCO futures price (per gallon)

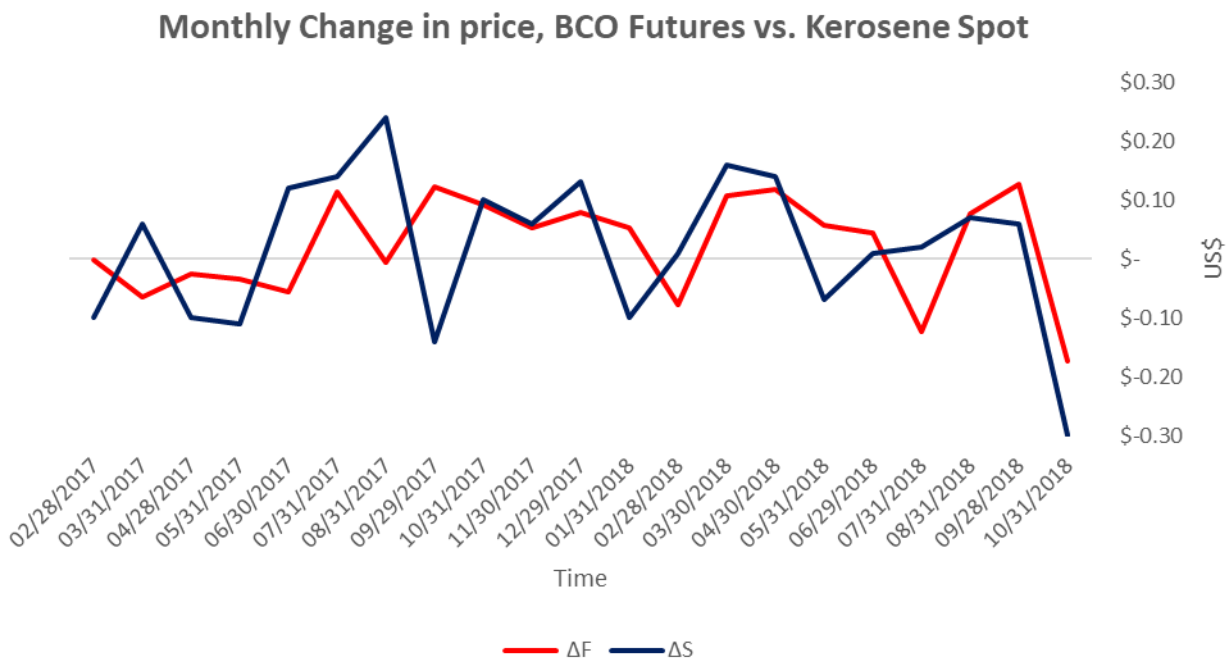


Figure 4 - Monthly change in the price of BCO futures and Kerosene jet fuel spot (per gallon)

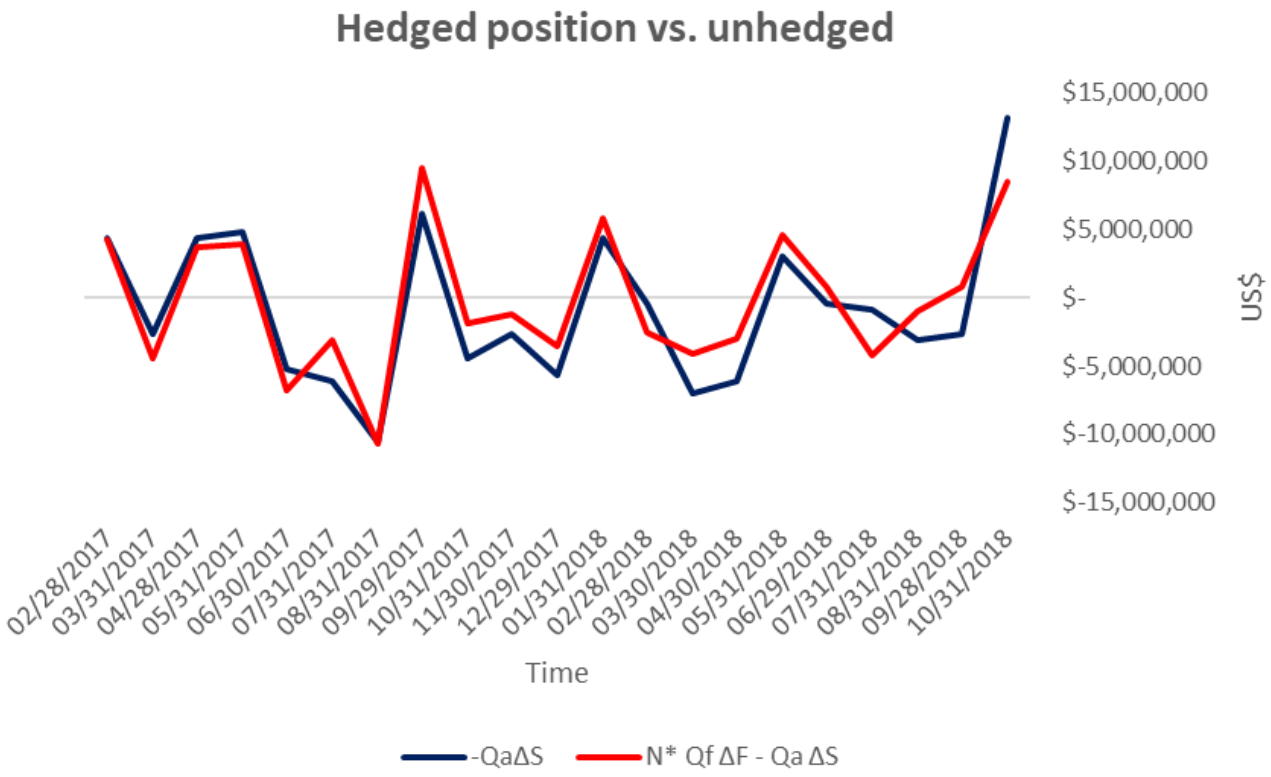


Figure 5 - Net P&L hedged position vs. unhedged

Contrary, our strategy results in a double-positive effect in periods where BCO futures prices increase, and Kerosene spot decreases. One distinct occurrence of this manner can be observed in September 2017, where net profit from our hedge amounted to US$ 9,472,822. This is illustrated in Figure 4 and Figure 5.

Throughout the period of interest, Figure 5 illustrates how our cross hedging strategy moderates the fluctuations in P&L from buying Kerosene at spot price. Apart from the months where the Kerosene spot and BCO futures prices are negatively correlated, the hedge proves its value by offsetting some of the losses when both prices increase. The fact that we hedge according to the minimum variance hedge ratio methodology, entails that the losses incurred from our hedge when both prices decrease, not exceed the gains from lower fuel prices. Table 2 illustrates the net P&L from our hedge. The result of our strategy is a total offset in losses by 72.63%. Thus, our strategy acts as intended by reducing the fuel price risk for Norwegian Air Shuttle.

Net P&L BCO Futures Cross Hedge	
Net P&L w/o hedge	$ -17,556,065
Net P&L hedge	$ 12,751,650
Net P&L w/ hedge	$ -4,804,414
P/L offset by hedge	0.7263

Table 2 - Net P&L from BCO futures cross hedge strategy

5.2 Option strategies

In this part of the analysis we will present our findings with regards to implementing the different options-strategies. We have tested the strategies based on approximately two-year time-frame, in the interval of 31.01.2017 to 07.12.2018. This time-frame enables us to analyse the effect of the option-strategy during both declines and rises in the Brent-price.

The reasons behind our choice of time-frame for the option-contract strategies is that it enables us to analyse the effect of the option-strategy during both declines and rises in the Brent-price. In addition, according to LHGs annual report of 2017, they execute hedging strategies for up to 24 months (LHG Annual report, 2017). As LHG uses options extensively in their hedging strategy, we therefore believe our time-frame acts as a fair representation of what one could

expect an airline to do in practice. We do however acknowledge that the time frames vary among different sector participants and that there are a variety of factors that might impact the choice of hedge-duration. We will comment this further under section 7, *Reflections.*

5.2.1 Two-way collar spread

5.2.1.1 Choosing the strike-prices for a two-way collar

At the time when the options were entered, at 31.01.2017, the BCO spot-price was at $54,68. Consequently, for the strike-prices for both the put and the call to be out-of-the-money (OTM), we chose a strike of $50 for the short put, and a strike of $60 for the long call. The collar hedge-position is summarized in Table 3, showing both the initiation costs and strike-prices:

Strikes and premiums for the 2-way collar spread

	Long call	*Short put*
Strike-price	*$60*	*$50*
Premium	*$5.41*	*$5.13*
Net premium		*($0.28)*

Table 3 - Strikes and premiums for the 2-way collar spread

Furthermore, for our chosen strike prices, Figure 6 below conceptually illustrate the payoffs according to different BCO prices. As the graph shows, if BCO prices are below the strike price of the short put ($50), the airline will suffer losses because the counterparty exercises the option. Between both the strike price of the put and the call, $50 and $60, both options are out-of-the-money and as such, the airline's position is effectively unhedged. For BCO prices above $60, the airline can exercise its call option and offset the higher costs of jet-fuel with the proceeds from rising BCO prices.

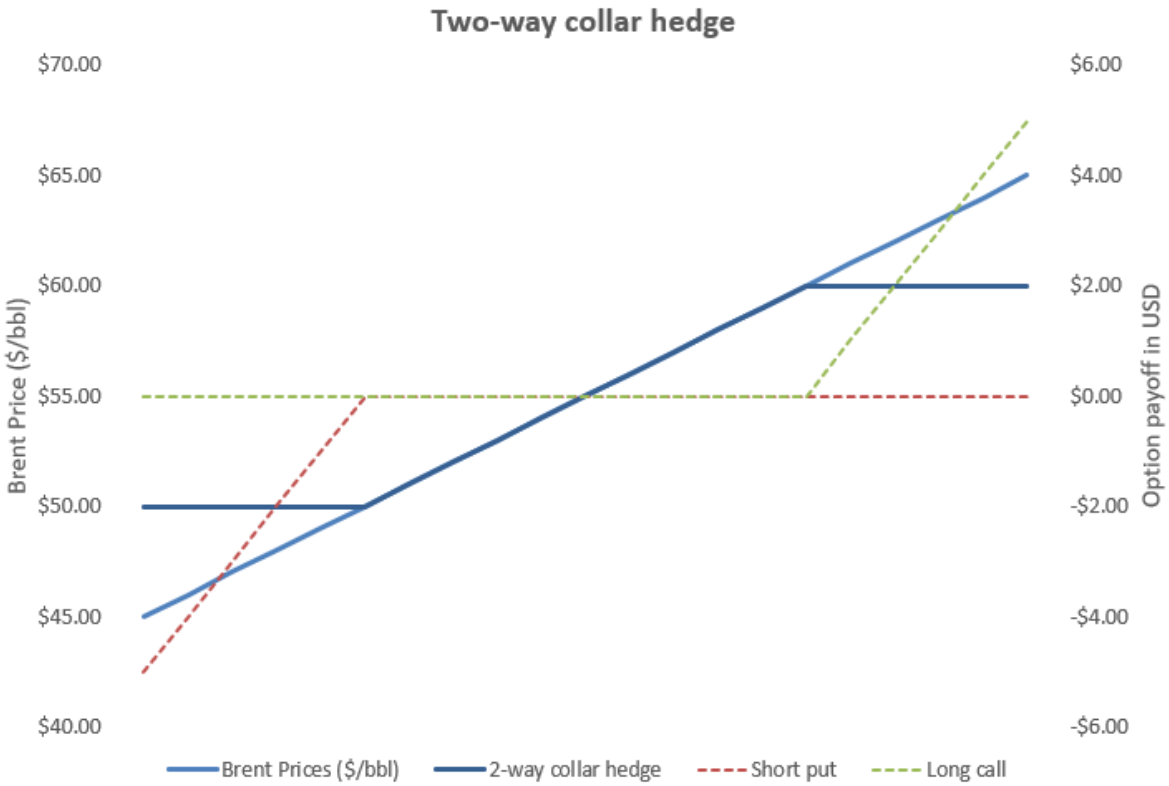


Figure 6 - Two-way collar hedge

5.2.1.2 The results from implementing a two-way collar hedging-strategy

Figure 7 depicts the effects of implementing a two-way collar hedge, and how the cost of airline fuel will be partially offset by a cross-hedge on Brent-Crude oil. The P&L from the hedge position is calculated on a monthly basis and graphically represented by the difference between the red and light-blue line. Figure 7 illustrates the movements between the two-way collar spread and the prices for BCO, in the same pattern as shown in Figure 6.

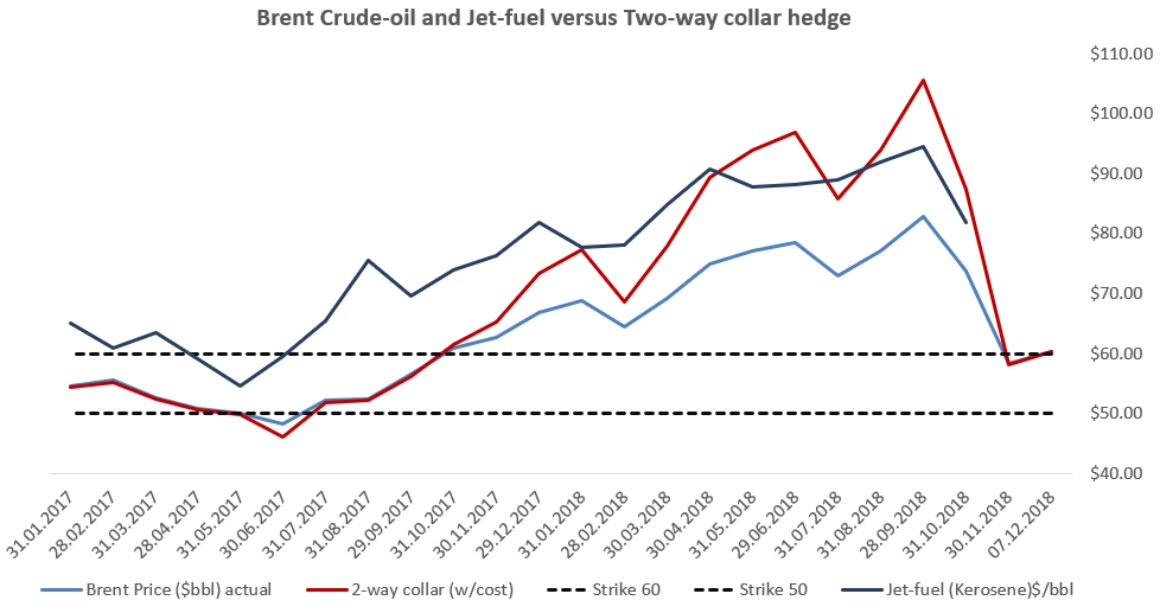


Figure 7 - BCO and Kerosene jet fuel vs two-way collar hedge

Considering the outcomes following the initiation of the hedging position, the two-way collar shows a lack of performance when the Brent-prices declined during the first half of 2017. At the point when the Brent-price decreased below the strike price of the put ($50), the hedge is, in fact, incurring losses. This is due to the downside exposure from the put-option, which is exercised against the airline. To illustrate the implications of the decline, we can assess a numerical example:

P&L of hedge on Brent-Crude Oil

	Actual Brent Price		*P&L per bbl*		P&L per tonne	
Low-price case	*$*	*48.23*	*$*	*(2.05)*	*$*	*(17.29)*
High-price case	*$*	*82.95*	*$*	*22.67*	*$*	*191.55*
NAS Fuel consumption 2017 (f.y.)		1465100	*tons*			
NAS Fuel consumption 2018		1444500	*tons*			
2 year fuel consumption (NAS)		2,909,600.00	*tons*			
% hedged by firm		24%				
Hedged volume		698,304.00	*tons*			
Loss low-price case	$	(12,072,829.05)				
Profit high-price case	$	133,761,886.11				

Table 4 - P&L of hedge on Brent crude oil

Solely focusing on the hedge-position, the losses from hedging parts of two years' worth of fuel consumption for a representative airline, here Norwegian Air Shuttle (NAS), is shown in Table 4. The fuel-consumption, denominated in tons, for 2017 is as stated in NAS's annual report for

2017. Consequently, the fuel-consumption for 2018 is based on their 2017 estimate for the full-year consumption for 2018. NAS also states that the portion of which their fuel-consumption was hedged for 2017, was 24% and in the lack of better estimates for their hedged volume in 2018, we assume the same portion for this year. As the results show, the loss incurred from the two-way collar when the BP was at $48.23 was approximately $20,6 million.

Conversely, we would expect to see quite a different outcome with increasing Brent-prices. As the BP rose above the strike price of the call ($60) towards the end of 2017, the airline's long call position started to yield profits. Reaching the “high-price” case in October 2018, the BP of $82.95 resulted in a total profit of $133.7 million from their two-way collar. This result reflects the strength of this hedging-strategy - it provides upside potential upon increasing prices in the underlying. However, increasing Brent-prices is, as we can witness in Figure 7, connected with increasing Jet-fuel-prices and thus increasing fuel costs for the airline. It is therefore interesting to see how the hedge decrease the total-fuel expenses for NAS, as shown in the Table 5.

Price of volume if hedged versus unhedged

Jet-fuel price "high-price" case	$	798.53	*$/ton*
Volume purchased in spot-market (unhedged)		698,304.00	*tons*
Cost of JF if purchased in JF spot-market	$	557,613,201.60	100%
Proceeds from hedge-position (high-price)	$	133,761,886.11	24%
Net cost of Jet-fuel	$	423,851,315.49	76%

Table 5 - Price of volume if hedged vs. unhedged

In this case, the hedge-position gives the airline an approximately 24% discount on its fuel expenses. This is because the total cost associated with purchasing the jet-fuel is reduced by the proceeds from the derivatives position, thus reducing the net costs of purchasing jet-fuel. This result reflects the very purpose of hedging against higher fuel prices, i.e. reducing its impact on the costs of the airline.

5.2.2 Four-way Collar Hedge

5.2.2.1 Choosing the strike prices for a four-way collar

The four-way collar hedge will provide airlines with a partial hedge against fluctuating oil prices, while it also limits exposure to declining prices and almost zero upfront premium costs. This can, therefore, be considered as a more conservative hedging-strategy than the two-way collar spread. Table 6 summarizes the strike-prices and costs of the different option-positions as if entered the 31.07.2017.

Strikes and premiums for the 4-way collar spread

	Long put	*Short put*	*Long call*	*Short call*
Strike-price	*$ 50.00*	*$ 52.00*	*$ 58.00*	*$ 60.00*
Premiums	*$ 5.13*	*$6.60*	*$6.70*	*$ 5.41*
Net premiums				*$0.18*

Table 6 - Strikes and premiums for the 4-way collar spread

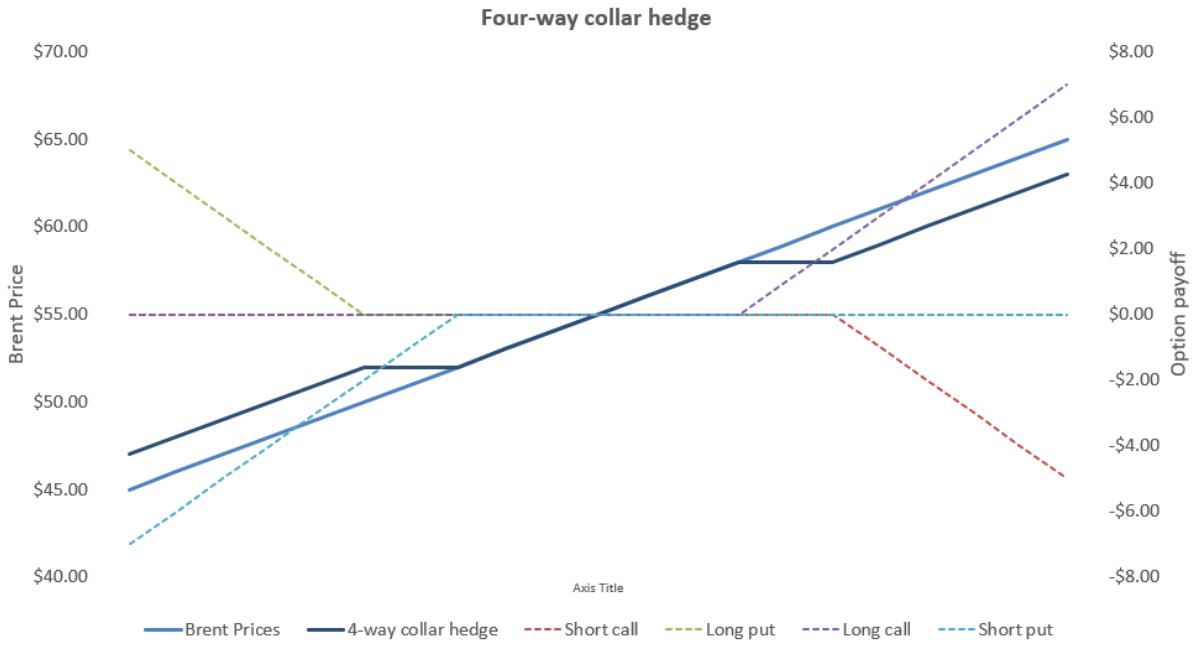


Figure 8 - Four-way collar hedge

The payoff in relation to the Brent-Price from this strategy is shown in Table 7. An airline implementing this exact strategy will be hedged with a call option spread and a put option spread. The options were entered at the same time as the 2-way collar spread, at 31.07.2017. As the Figure 8 depicts the airline will be hedged between an oil price between $58 and $60/bbl. If Brent prices average above $60/bbl, the airlines' net cost will be the market price minus $2/bbl due to the $2/bbl gain on the call option spread. Similarly, if Brent averages less than $50/bbl, the airline will have a net cost equal the market price plus $2/bbl due to the 2$/bbl loss on the put spread. If the Brent prices average between $52 and $58/bbl, the airline will have a total net cost equal the market price. This is because all the options are in that case out-of-the-money.

5.2.2.2 The results from implementing a four-way collar spread

Similar to the graph of the two-way collar spread, Figure 9 depicts the overall performance of the four-way collar spread from when it was entered the 31.12.2017. The developments in the hedge position are represented by the red line, and the P&L from the hedge position is the difference between this and the dark-blue line.

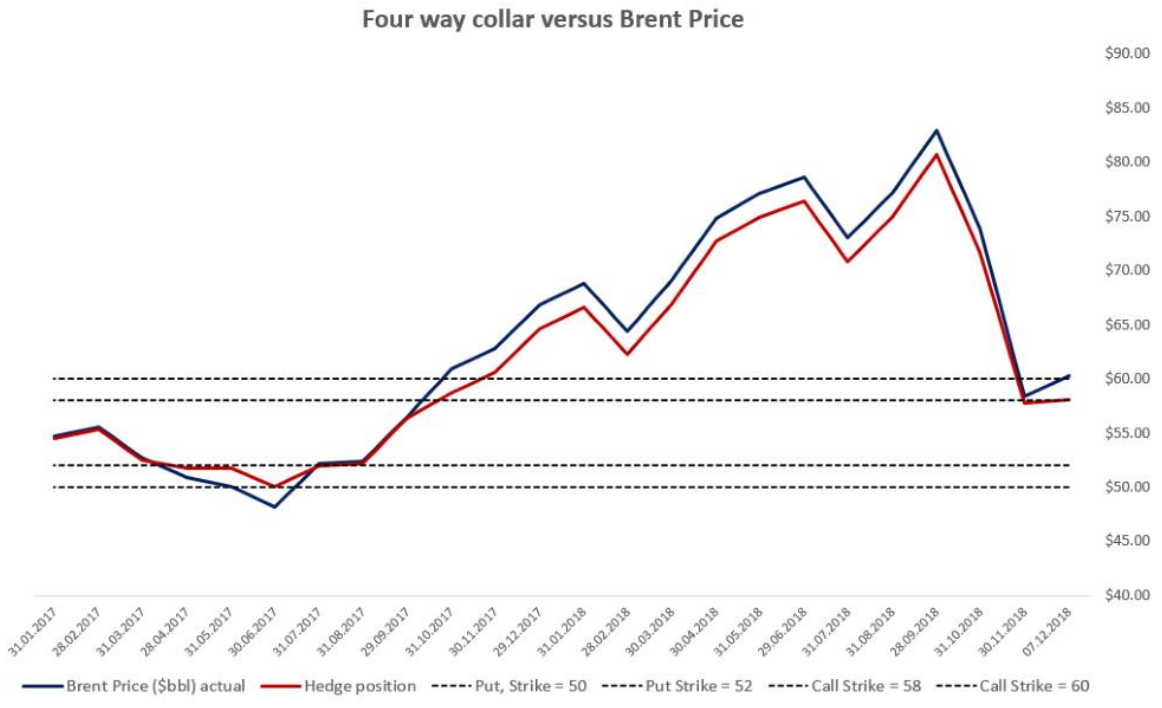


Figure 9 - Four way collar vs. Brent price

Like the two-way collar spread, this strategy shows a lack in performance when the Brent-Oil prices declined during the first half of 2017. This is because the position incurs losses when the price of the underlying is below the lowest strike-price of the short put-option spread ($50). Using the same numerical example with NAS, as for the two-way collar spread, we get the results illustrated in Table 7:

P&L of hedge on Brent-Crude Oil

	Actual Brent Price	*P&L per bbl*	P&L per tonne
Low-price case	*$ 48.23*	*$ (1.82)*	*$ (15.38)*
High-price case	*$ 82.95*	*$ 2.18*	*$ 18.42*
NAS Fuel consumption 2017 (f.y.)	1465100	*Tonnes*	
NAS Fuel consumption 2018 (3/4 year)	1444500	*Tonnes*	
2 year fuel consumption (NAS)	2909600.00	*Tonnes*	
% hedged by firm	24%		
Hedged volume	698304.00	*Tonnes*	
Result low-price case	$ (10,739,217.22)		
Result high-price case	$ 12,863,457.98		

Table 7 - P&L of four-way collar hedge on BCO

Table 7 shows the P&L of the four-way collar hedge strategy. With the same expected fuel consumption and hedged volume as with the example for the two-way collar, the loss from the four-way collar when BP was at $48.23/bbl, was approximately $10.7 million.

Furthermore, Table 7 shows that with this hedging strategy at a BP of $82.95/bbl, NAS would have made a profit of approximately $12.8 million from their derivatives exposure. This result reflects the limited protection the airline will get with an incline in the BP, but also the minimal downside exposure as the losses approximately equals the profits.

5.3 Discussion of the hedging strategies

All the derivative positions isolated resulted in losses when the BCO prices decreased during the first half of 2017, but yielded profits as it started to increase towards the end of 2017. As lower BCO prices are associated with lower fuel prices the airlines are saving costs on their fuel expenses, but incurring losses from their hedges and therefore miss the opportunity to fully enjoy the gains from lower fuel prices. On the contrary, as the trend reflects a rise in BCO prices overall, the derivatives positions managed to offset some of the higher expenses incurred as a result of a matching higher fuel price. The strategies therefore performed as intended.

When comparing the results from the two option strategies it seems that the two-way collar hedge provided a greater upside during rising BCO prices, but larger losses

during declining. Moreover, it seems that the upside is far greater from the two-way, compared to the modest differences in the losses.

To illustrate this point, we have compared four airlines and assessed their P&L from each strategy based on their stated fuel-consumption and hedging volumes. This is shown in Table 8.

As shown in Table 8, the two-way collar has been the superior hedging strategy. The reason behind this is because in our analysis the BCO prices never declined to a level where the four-way collar spread shows its strength in limiting downside potential. As the P&L from the four-way collar stays constant regardless of the Brent Oil-price, a sharp decline would mean that the losses would sustain at a lower level compared to the two-way collar.

Two-way collar comparison between airlines			**Pure derivatives position**	
Airline	% hedged	Estimated fuel-consumption 2017 and 2018 (tonnes)	2-way collar at $48/bbl	2-way collar at $84/bbl
NAS	24%	2,909,600	$ (12,072,829)	$ 133,761,886
Lufthansa	70%	20,950,000	$ (253,540,059)	$ 2,809,117,604
SAS	43%	2,698,000	$ (20,057,413)	$ 222,227,732
Finnair	74%	1,883,927	$ (24,102,388)	$ 267,044,362
Four-way collar comparison between airlines			**Pure derivatives position**	
Airline	% hedged	Estimated fuel-consumption 2017 and 2018 (tonnes)	4-way collar at $48/bbl	4-way collar $83 bbl
NAS	24%	2,909,600	$ (11,329,282)	$ 12,273,392
Lufthansa	70%	20,950,000	$ (237,924,926)	$ 241,143,935
SAS	43%	2,698,000	$ (18,822,108)	$ 20,390,623
Finnair	74%	1,883,927	$ 22,617,972	$ 24,502,809

Table 8 - Comparison NAS, Lufthansa, SAS and Finnair, two-way collar and four-way collar

6. Reflections

Our analysis presents three strategies that airlines may use to hedge against fuel-price risk.

This provides insight into how the different positions behave in a fluctuating oil price environment, and consequently how effective they are in terms of both declines and increases.

6.1 An additional insight into airlines' extensive focus on hedging

An additional insight we would like to add in the context of why airlines hedge as extensively as they do, regards the competitiveness of the sector as a whole. We believe that the core services provided by airlines are quite homogenous and as such, it is difficult to outcompete others by solely differentiating their services. Reducing costs to their bare minimum, therefore, becomes a focal point of competitive advantage for airlines.

Consequently, hedging against higher fuel prices, and thus reducing fuel-expenses, therefore plays a crucial role in airlines' battle to stay competitive (Bunting, 2018).

The present environment surrounding the direction of the future oil-price shows signs of uncertainty, as speculations regarding how potential OPEC production policies and ongoing trade wars might trigger substantial changes in the oil price. Therefore, we believe the topic of fuel-price hedging is highly relevant for airlines at the moment.

6.2 Limitations

Due to the fact that this paper is not written on the 31st of January 2017, the results of the analysis is to some extent biased. Which hedging strategy has resulted in reduced fuel expenses depend on the BCO prices, and as we knew these prices before writing this paper, the results of the analysis can be considered somewhat presumed.

Additionally, we have assumed the transaction costs associated with initiating the hedging strategies to be negligible, which is due to the high liquidity of the BCO futures market, as well as not considered brokerage fees. In reality, these costs may have an impact on the effectiveness of the strategies. The reason for not including these costs is due to the great challenge of obtaining this data, and even though we contacted a revenue analyst in Norwegian Air Shuttle, he had no information to give us about these fees. We have therefore written this paper with the assumption of zero transaction costs.

Another limitation of our paper is the correlation coefficient obtained when constructing the futures-hedge. Here, the scarce amount of 21 observations sets a limitation to the accuracy of our measure.

An explicit limitation to our analysis is that it does not provide a clear answer to whether the futures strategy was more effective than the options strategies, and vice versa. This is due to the approach we chose for constructing and executing each of the strategies, which have such different characteristics, with specific regards to the intervals of one month chosen for the futures strategy. As the purpose of this paper was to illustrate how airlines can hedge against fuel price risk, and not the respective strategies' sheer effectiveness, we believe our findings still fully serve the paper's purpose.

7. Conclusion

In conclusion, this paper shows how airlines can use different hedging strategies when seeking to reduce fuel price risk. Our analysis shows how the hedging strategies have performed in the fluctuating oil price environment during the last two years. Each hedging strategy has proven to be effective, in the sense that the trend since 31.12.2017 has been increasing oil prices. Consequently, the analysis concludes that each strategy offers a hedge due to the fact that airlines are able to save fuel expenses when implemented.

The paper concludes that implementing hedging strategies are crucial for airlines when fuel prices increase. This is substantiated by the fact that rising oil prices can be considered to pose a large threat to an airlines' total expenses and thus its profitability. We also emphasize the relevance of this topic in the present unstable oil market.

Bibliography

Black, F. &. (1970, May). The Valuation of Option Contracts and a Test of Market Efficiency. *The Journal of Finance, 27*, 399-417. Retrieved from https://www.jstor.org/stable/pdf/2978484.pdf

Chang, McAleer, & Tansuchat. (2011, September). *Crude Oil Hedging Strategies Using Dynamic Multivariate GARCH*. Retrieved from www.sciencedirect.com: https://www.sciencedirect.com/science/article/pii/S0140988311000296

Dafir, S., & Gajjala, V. (2016). *Fuel Hedging and Risk Management: Strategies for Airlines, Shippers and Other Consumers.* John Wiley & Sons.

Ederington, L. H. (1979, March). The Hedging Performance of the New Futures Markets. *The Journal of Finance, 34*, 157-170.

EIA. (2018). *www.eia.gov*. Retrieved from Petroleum & Other Liquids: https://www.eia.gov/dnav/pet/hist/eer_epjk_pf4_rgc_dpgD.htm

Harris, L. (2003). *Trading & Exchanges: Market Microstructure for Practitioners.* New York: Oxford University Press.

Hull, J. C. (2015). *Options, Futures, and Other Derivatives, Ninth edition.* Pearson.

ICE. (2018, 12 16). *Report Center: Intercontinental Exchange.* Retrieved from Intercontinental Exchange: https://www.theice.com/marketdata/reports/7

ICE. (2018, November 29). *www.mercatusenergy.com*. Retrieved from Brent Crude Futures: https://www.theice.com/products/219/Brent-Crude-Futures

ICE. (2018). *www.theice.com*. Retrieved from The Global Crude Oil Benchmark: https://www.theice.com/brent-crude

Johnson, L. L. (1960, June). The Theory of Hedging and Speculation in Commodity Futures. *The Review of Economic Studies, 27*, 139-151.

Lufthansa Group. (2018). *www.lufthansagroup.com.* Retrieved from Annual Report 2017: https://investor-relations.lufthansagroup.com/fileadmin/downloads/en/financial-reports/annual-reports/LH-AR-2017-e.pdf

Macrotrends LLC. (2018). *Brent Crude Oil Prices - 10 Year Daily Chart*. Retrieved from www.macrotrends.net: https://www.macrotrends.net/2480/brent-crude-oil-prices-10-year-daily-chart

Mercatus Energy Advisors. (2018, December 1). *www.mercatusenergy.com*. Retrieved from Three-Way Collars: A Conservative Airline Fuel Hedging Strategy: https://www.mercatusenergy.com/blog/bid/69920/three-way-collars-a-conservative-jet-fuel-hedging-strategy

Norwegian Air Shuttle ASA. (2018). *www.norwegian.no.* Retrieved from Annual Report 2017: https://www.norwegian.no/globalassets/ip/documents/investor-relations/annual-report-2017-interactive.pdf

Petroleum, UK. (2015). *www.petroleum.co.uk*. Retrieved from Benchmark Oils: http://www.petroleum.co.uk/benchmarks

SAS. (2018, January 30). *www.sasgroup.net.* Retrieved from SAS ANNUAL REPORT 2016/2017: https://www.sasgroup.net/en/sas-annual-report-2016-2017/

The Options Guide. (2018). *www.theoptionsguide.com*. Retrieved from Crude Oil Options Explained: http://www.theoptionsguide.com/crude-oil-options.aspx

Vasigh, B. (2017). Foundations of Airline Finance: Methodology and Practice. In B. Vasigh. Routledge.

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Other sources

Interview

Name	Company	Position	Date
Bunting, Robert Alexander	Norwegian Air Shuttle	Revenue Analyst	14. December 2018

Appendix

Date	BCO Futures (gallons)	ΔF	Kero Spot (gallon)	ΔS	-QaΔS	N* Qf ΔF	N* Qf ΔF - Qa ΔS
10/31/2018	$ 1.80	$ -0.173	$ 1.95	$ -0.300	$ 13,167,048	$ -4,676,250	$ 8,490,798
09/28/2018	$ 1.97	$ 0.126	$ 2.25	$ 0.060	$ -2,633,410	$ 3,418,502	$ 785,092
08/31/2018	$ 1.84	$ 0.075	$ 2.19	$ 0.070	$ -3,072,311	$ 2,044,649	$ -1,027,662
07/31/2018	$ 1.77	$ -0.124	$ 2.12	$ 0.020	$ -877,803	$ -3,347,542	$ -4,225,345
06/29/2018	$ 1.89	$ 0.044	$ 2.10	$ 0.010	$ -438,902	$ 1,193,244	$ 754,342
05/31/2018	$ 1.85	$ 0.058	$ 2.09	$ -0.070	$ 3,072,311	$ 1,560,899	$ 4,633,210
04/30/2018	$ 1.79	$ 0.117	$ 2.16	$ 0.140	$ -6,144,623	$ 3,160,501	$ -2,984,122
03/30/2018	$ 1.67	$ 0.107	$ 2.02	$ 0.160	$ -7,022,426	$ 2,896,049	$ -4,126,377
02/28/2018	$ 1.57	$ -0.078	$ 1.86	$ 0.010	$ -438,902	$ -2,109,153	$ -2,548,054
01/31/2018	$ 1.64	$ 0.052	$ 1.85	$ -0.100	$ 4,389,016	$ 1,406,100	$ 5,795,116
12/29/2017	$ 1.59	$ 0.079	$ 1.95	$ 0.130	$ -5,705,721	$ 2,128,502	$ -3,577,219
11/30/2017	$ 1.51	$ 0.052	$ 1.82	$ 0.060	$ -2,633,410	$ 1,419,000	$ -1,214,409
10/31/2017	$ 1.46	$ 0.091	$ 1.76	$ 0.100	$ -4,389,016	$ 2,470,349	$ -1,918,667
09/29/2017	$ 1.37	$ 0.123	$ 1.66	$ -0.140	$ 6,144,623	$ 3,328,200	$ 9,472,822
08/31/2017	$ 1.25	$ -0.006	$ 1.80	$ 0.240	$ -10,533,639	$ -174,150	$ -10,707,789
07/31/2017	$ 1.25	$ 0.113	$ 1.56	$ 0.140	$ -6,144,623	$ 3,050,852	$ -3,093,770
06/30/2017	$ 1.14	$ -0.057	$ 1.42	$ 0.120	$ -5,266,819	$ -1,541,552	$ -6,808,371
05/31/2017	$ 1.20	$ -0.034	$ 1.30	$ -0.110	$ 4,827,918	$ -915,899	$ 3,912,019
04/28/2017	$ 1.23	$ -0.026	$ 1.41	$ -0.100	$ 4,389,016	$ -709,501	$ 3,679,515
03/31/2017	$ 1.26	$ -0.066	$ 1.51	$ 0.060	$ -2,633,410	$ -1,780,199	$ -4,413,609
02/28/2017	$ 1.32	$ -0.003	$ 1.45	$ -0.100	$ 4,389,016	$ -70,950	$ 4,318,066
01/31/2017	$ 1.33		$ 1.55				

Data used in the futures cross hedging strategy.

Dates	Long Call (K=60) BZIG9C	Short Put (K=50)	Brent Price ($bbl) actual	Long Call	Short Put	Premiums	2-way collar (w/cost)	2-way collar w.o cost	Strike 60	Strike 50	Jet-fuel (Kerosene)$/bbl
07.12.2018	$ 2.96	$ 0.10	60.27	0.27	0.00	$ 2.86	60.25	60.53	60	50	
30.11.2018	$ 2.89	$ 0.55	58.44	0.00	0.00	$ 2.34	58.16	58.44	60	50	
31.10.2018	$ 15.21	$ 0.03	73.86	13.86	0.00	$ 15.18	87.44	87.72	60	50	$ 81.90
28.09.2018	$ 21.94	$ 0.02	82.95	22.95	0.00	$ 21.92	105.62	105.90	60	50	$ 94.50
31.08.2018	$ 17.18	$ 0.05	77.15	17.15	0.00	$ 17.13	94.03	94.31	60	50	$ 91.98
31.07.2018	$ 15.09	$ 0.17	73.07	13.07	0.00	$ 14.92	85.86	86.14	60	50	$ 89.04
29.06.2018	$ 17.96	$ 0.16	78.60	18.60	0.00	$ 17.80	96.92	97.20	60	50	$ 88.20
31.05.2018	$ 16.73	$ 0.36	77.13	17.13	0.00	$ 16.37	93.98	94.26	60	50	$ 87.78
30.04.2018	$ 13.08	$ 0.56	74.87	14.87	0.00	$ 12.52	89.47	89.75	60	50	$ 90.72
30.03.2018	$ 9.14	$ 1.03	69.13	9.13	0.00	$ 8.11	77.99	78.27	60	50	$ 84.84
28.02.2018	$ 6.31	$ 1.57	64.46	4.46	0.00	$ 4.74	68.63	68.91	60	50	$ 78.12
31.01.2018	$ 8.24	$ 0.91	68.83	8.83	0.00	$ 7.33	77.37	77.65	60	50	$ 77.70
29.12.2017	$ 7.01	$ 1.32	66.82	6.82	0.00	$ 5.69	73.36	73.64	60	50	$ 81.90
30.11.2017	$ 5.18	$ 2.24	62.78	2.78	0.00	$ 2.94	65.29	65.57	60	50	$ 76.44
31.10.2017	$ 4.76	$ 2.77	60.94	0.94	0.00	$ 1.99	61.59	61.87	60	50	$ 73.92
29.09.2017	$ 3.88	$ 3.89	56.53	0.00	0.00	$ (0.01)	56.25	56.53	60	50	$ 69.72
31.08.2017	$ 3.55	$ 4.69	52.41	0.00	0.00	$ (1.14)	52.13	52.41	60	50	$ 75.60
31.07.2017	$ 3.69	$ 4.98	52.17	0.00	0.00	$ (1.29)	51.89	52.17	60	50	$ 65.52
30.06.2017	$ 3.45	$ 6.08	48.23	0.00	-1.77	$ (2.63)	46.19	46.47	60	50	$ 59.64
31.05.2017	$ 3.05	$ 5.90	50.08	0.00	0.00	$ (2.85)	49.80	50.08	60	50	$ 54.60
28.04.2017	$ 4.40	$ 6.14	50.88	0.00	0.00	$ (1.74)	50.60	50.88	60	50	$ 59.22
31.03.2017	$ 4.52	$ 5.65	52.71	0.00	0.00	$ (1.13)	52.43	52.71	60	50	$ 63.42
28.02.2017	$ 5.54	$ 5.01	55.56	0.00	0.00	$ 0.53	55.28	55.56	60	50	$ 60.90
31.01.2017	$ 5.41	$ 5.13	54.68	0.00	0.00	$ (0.28)	54.40	54.68	60	50	$ 65.10

Data used in two-way collar hedge

Dates	Short Call (K=60)	Long Put (K=50)	Long Call (K=58)	Short Put (K=52)	Brent Price ($bbl) actual	Short call	Long call	Long Put	Short Put	Total initation cost	Gross/unit	Net/contract	Hedge position	Put, Strike = 50	Put Strike = 52	Call Strike = 58	Call Strike = 60	Jet-fuel $/bbl
07.12.2018	$ 2.96	$ 0.10	$4.42	$1.53	60.27	-0.27	2.27	0.00	0.00	$ (0.03)	2.00	$ 2.18	58.09	50	58	52	60	
30.11.2018	$ 2.89	$ 0.55	$3.96	$3.43	58.44	0.00	0.44	0.00	0.00	$ 1.81	0.44	$ 0.62	57.82	50	58	52	60	
31.10.2018	$ 15.21	$ 0.03	$17.17	$0.15	73.86	-13.86	15.86	0.00	0.00	$ (1.84)	2.00	$ 2.18	71.68	50	58	52	60	$ 81.90
28.09.2018	$ 21.94	$ 0.02	$23.91	$0.11	82.95	-22.95	24.95	0.00	0.00	$ (1.88)	2.00	$ 2.18	80.77	50	58	52	60	$ 94.50
31.08.2018	$ 17.18	$ 0.05	$19.09	$0.30	77.15	-17.15	19.15	0.00	0.00	$ (1.66)	2.00	$ 2.18	74.97	50	58	52	60	$ 91.98
31.07.2018	$ 15.09	$ 0.17	$16.87	$0.83	73.07	-13.07	15.07	0.00	0.00	$ (1.12)	2.00	$ 2.18	70.89	50	58	52	60	$ 89.04
29.06.2018	$ 17.96	$ 0.16	$19.76	$0.76	78.60	-18.60	20.60	0.00	0.00	$ (1.20)	2.00	$ 2.18	76.42	50	58	52	60	$ 88.20
31.05.2018	$ 16.73	$ 0.36	$18.45	$1.32	77.13	-17.13	19.13	0.00	0.00	$ (0.76)	2.00	$ 2.18	74.95	50	58	52	60	$ 87.78
30.04.2018	$ 13.08	$ 0.56	$14.68	$2.04	74.87	-14.87	16.87	0.00	0.00	$ (0.12)	2.00	$ 2.18	72.69	50	58	52	60	$ 90.72
30.03.2018	$ 9.14	$ 1.03	$10.55	$3.20	69.13	-9.13	11.13	0.00	0.00	$ 0.76	2.00	$ 2.18	66.95	50	58	52	60	$ 84.84
28.02.2018	$ 6.31	$ 1.57	$7.52	$4.60	64.46	-4.46	6.46	0.00	0.00	$ 1.82	2.00	$ 2.18	62.28	50	58	52	60	$ 78.12
31.01.2018	$ 8.24	$ 0.91	$9.64	$3.15	68.83	-8.83	10.83	0.00	0.00	$ 0.84	2.00	$ 2.18	66.65	50	58	52	60	$ 77.70
29.12.2017	$ 7.01	$ 1.32	$8.30	$4.03	66.82	-6.82	8.82	0.00	0.00	$ 1.42	2.00	$ 2.18	64.64	50	58	52	60	$ 81.90
30.11.2017	$ 5.18	$ 2.24	$6.29	$5.71	62.78	-2.78	4.78	0.00	0.00	$ 2.36	2.00	$ 2.18	60.60	50	58	52	60	$ 76.44
31.10.2017	$ 4.76	$ 2.77	$5.81	$6.66	60.94	-0.94	2.94	0.00	0.00	$ 2.84	2.00	$ 2.18	58.76	50	58	52	60	$ 73.92
29.09.2017	$ 3.88	$ 3.89	$4.76	$8.55	56.53	0.00	0.00	0.00	0.00	$ 3.78	0.00	$ 0.18	56.35	50	58	52	60	$ 69.72
31.08.2017	$ 3.55	$ 4.69	$4.36	$9.70	52.41	0.00	0.00	0.00	0.00	$ 4.20	0.00	$ 0.18	52.23	50	58	52	60	$ 75.60
31.07.2017	$ 3.69	$ 4.98	$4.52	$9.94	52.17	0.00	0.00	0.00	0.00	$ 4.13	0.00	$ 0.18	51.99	50	58	52	60	$ 65.52
30.06.2017	$ 3.45	$ 6.08	$4.18	$11.67	48.23	0.00	0.00	1.77	-3.77	$ 4.86	-2.00	$ (1.82)	50.05	50	58	52	60	$ 59.64
31.05.2017	$ 3.05	$ 5.90	$3.76	$11.28	50.08	0.00	0.00	0.00	-1.92	$ 4.67	-1.92	$ (1.74)	51.82	50	58	52	60	$ 54.60
28.04.2017	$ 4.40	$ 6.14	$5.11	$11.76	50.88	0.00	0.00	0.00	-1.12	$ 4.91	-1.12	$ (0.94)	51.82	50	58	52	60	$ 59.22
31.03.2017	$ 4.52	$ 5.65	$5.27	$11.05	52.71	0.00	0.00	0.00	0.00	$ 4.65	0.00	$ 0.18	52.53	50	58	52	60	$ 63.42
28.02.2017	$ 5.54	$ 5.01	$6.43	$9.67	55.56	0.00	0.00	0.00	0.00	$ 3.77	0.00	$ 0.18	55.38	50	58	52	60	$ 60.90
31.01.2017	$ 5.41	$ 5.13	$6.34	$6.70	54.68	0.00	0.00	0.00	0.00	$0.18	0.00	$ 0.18	54.50	50	58	52	60	$ 65.10

Data used in four-way collar hedge