NORGES HANDELSHØYSKOLE
Bergen, Autumn Semester 2010

Determinants and Effects of Corporate Currency Hedging

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Master Thesis in Financial Economics

NORGES HANDELSHØYSKOLE

Abstract

The main purpose of this thesis is to examine whether firms' engagement in hedging activities is rewarded in terms of higher firm value. In the process of answering this question we have also conducted two additional analyses. The first one indicates common characteristics of firms that hedge while the second seek to answer whether hedging reduce the exposure to currency fluctuations.

According to our results there is no sign that hedging is rewarded by investors. In fact, we find that hedging firms are valued at a lower market value to book value ratio. Our second analysis indicates that large firms hedge more than small, and that those with a high share of foreign revenue are more likely to hedge. Furthermore, firms with more large owners (above 5% stake) are less likely to hedge. Finally, our third analysis shows the effectiveness of hedging derivatives as users of these are less exposed to fluctuations in foreign exchange rates.

Preface

After almost 5 years of studies at Norges Handelshøyskole we are proud to finally hand in our master thesis and finish an exciting period in our lives. This Master of Science thesis in Financial Economics is the result of extensive research on our topic over the last 5 months.

The thesis will aim to present both relevant theory and practical examples besides our own research on the topic. Obviously, neither theory nor our research will be exhaustive in explaining the aspects and value creation of currency hedging. However, we believe we have been successful in presenting insightful and relevant theory as well as research that contributes to the literature on currency hedging.

Throughout the process we have been in contact with several individuals that have provided us with insightful thoughts and invaluable information on the subject. First of all we want to express our gratitude to Professor Karin Thorburn for her helpful comments and guidance throughout the process. Also, we are very thankful for the dataset received from Øystein Børsum and Bernt A. Ødegaard, both former employees of Norges Bank. Further, we want to thank Roger Nordby and Tharald Stray Laastad at Pareto Securities for helping us understand from a practical point of view how Norwegian companies deal with currency risk. Greatly appreciated is also Oslo Børs' cooperativeness in giving free access to their Arena database. Lastly, we want to thank the companies covered in our sample for their helpfulness when asking for information not disclosed in the annual reports.

Even though the process has been demanding and challenging we have enjoyed working on the topic and feel that we have developed a great understanding of how to think about and address currency risk. We hope this thesis is of interest to the reader and could help executives in Norwegian companies manage currency risk properly.

Bergen, December 17th 2010

Hans Fredrik Ø. Årstad

Eirik Haavaldsen

Determinants and Effects of Corporate Currency Hedging

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1 Introduction

1.1 Description of Topic

Over the last two decades, we have seen a significant increase in companies' use of financial derivatives to control or minimize risks that traditionally have been beyond their control. Both large and smaller firms, public and private, have used derivatives to hedge against fluctuations in currency rates, interest rates and commodity prices. For example, while global daily turnover of foreign exchange instruments in 2001 was just over 1500 billion US dollars, the same figure had grown to nearly 4000 billion by April 2010. Similarly, the global interest rate derivatives market grew from nearly 500 billion US dollars per day in 2001, to almost 2100 in 2010. Even though the largest part of this is financial institutions' trading we know that non-financial firms contribute to about 13% of total turnover in foreign exchange markets (Bank for International Settlements 2010).

But does this hedging activity increase profits and thus add value to the shareholder? Or is it merely another source of income for the investment bankers? The purpose of this thesis is to investigate whether a firm's hedging activities are rewarded in the stock market through higher market values relative to book values. In the Modigliani and Miller theory, risk management is irrelevant in a perfect capital market, as a shareholder can eliminate any firm-specific risk by diversifying his own portfolio.

Also, in many cases, investors might seek a particular exposure when investing in the stocks of a corporation. If an investor invests in an oil company in order to be exposed to oil price fluctuations, he would not want the management of the company to hedge their cash flows by trading oil futures. Similarly, an investor who wants to be exposed to fluctuations in the USD/EUR exchange rate would not want the companies he invests in to peg their exchange rates by purchasing forward contracts.

However, many will argue that the conditions of Miller and Modigliani do not hold, so could an active risk management policy create additional value for the stockholders? In other words, will the company that hedges its currency risk trade at a premium compared to the company that does not? Does currency hedging increase firm value? This thesis aims to investigate this

further through an analysis of companies listed on Oslo Stock Exchange, as well as a thorough discussion of relevant theory on the matter.

In addition to examining whether hedging strategies are rewarded by investors, we will also conduct analyses investigating what are the common characteristics of hedgers and whether hedging actually reduces the exposure to currency fluctuations.

1.2 Background

Cash flow-hedging and risk management is not a modern phenomenon created by clever investment bankers in order to increase their bonuses. In fact, The Old Testament contains the story of the Egyptian Pharaoh who was told by Joseph that his dream foretold seven good corn years to be followed by seven years of famine. In order to hedge against the potential disaster, Joseph advises Pharaoh to store grain from the plentiful harvests to be used during the famine (Genesis 42:1-36). Egypt blossomed and became the leading nation in the area, and Joseph became the second most important man in Egypt.

Forward exchange contracts were established in Europe during the Middle Ages. Hedging was made easier, as one could buy crops today, for delivery in the future at a predetermined price, and thus not risking prices to skyrocket due to shortage of supply. Likewise, a risk-averse farmer could hedge the risk of falling prices by selling them today and thus control their future cash inflows (Froot, Scharfstein and Stein 1994).

Likewise, the idea of using options and futures for hedging purposes is also ancient. The Dutch traded options on tulip bulbs 400 years ago. By 1690, the stock option market in London was well developed. Even back then the financial derivatives market was blamed for contributing to a crisis, the South Sea Bubble of 1720, Britain's worst financial collapse during the 18th century. This ultimately led to the Barnard's Act in 1733, which banned the sale of stock options in order "to prevent the infamous Practice of Stock-jobbing", in other words aimed to regulate stock speculation (Poitras 2000). This ban was effective until 1860 (and again between 1939 and 1958). Meanwhile, the Japanese established a market for trading rice-futures in Osaka in the beginning of the 18th century, proving that hedging cash flows with derivatives is not a Western phenomenon (Watsham 1992).

Corporate hedging however, is a more recent phenomenon. Up until the 1970s both corporate management and investors accepted the essence of the Modigliani and Miller theorem: If an investor did not want to be exposed to e.g. USD and oil-price risk, he should simply offset his loss from stocks that benefits from a strong USD and a high oil price by holding some stocks that benefits from weaker USD and falling oil prices (Froot, Scharfstein and Stein 1994).

Over the last four decades a somewhat different view on the matter has evolved. The Modigliani and Miller view has been challenged, it has been recognized that there are, among other factors, taxes and bankruptcy costs that need to be taken into account. Hence, both cash flow and shareholder value could be affected of whether capital is raised through equity or debt (Froot, Scharfstein and Stein 1994). Thus, whether it is the objective of the company or the investor to diversify and hedge cash flows has become an increasingly discussed subject.

We hope that our thesis can shed light on this interesting discussion. Firstly, we provide a theoretical discussion of whether corporate hedging can be a source of firm value or just an additional cost to the company. Secondly, and the main focus of this thesis, is an empirical analysis of companies listed on Oslo Stock Exchange, to see whether those companies with an active currency hedging strategy in any way outperforms (or underperforms) those without. Lastly, we have conducted two additional analyses seeking to answer both whether currency derivatives are effective in reducing currency exposure and what the common characteristics of hedging firms are.

1.3 Why is Our Thesis Relevant?

Although there are extensive amounts of international research on the matter, it is our belief that whether an active hedging policy actually increases shareholder value has not been subject to thorough research in Norway during the last few years. For the most part, focus has been on getting an overview and description of what companies choose to do, and not to investigate whether hedging actions actually increase firm value. Norges Bank has graciously shared their material from a study conducted in 2004, but as we already have mentioned, the development in currency- and derivatives market has been explosive over the last couple of years. In addition, we have just experienced the most severe economic and financial crisis since the Great Depression, and this certainly has not made our subject less interesting and relevant.

We believe that Norwegian companies are particularly exposed to currency fluctuations, as we are a small, open economy, and mostly export driven. Looking at the companies traded at Oslo Stock Exchange, we see that a large part of these are related to the energy- and shipping-sectors that are very volatile. As we can see from the table below, Oslo Stock Exchange has been significantly more volatile than its peers, over the last decade.

Table 1.3-1: Index volatilities

Index	10Y standard deviation of monthly returns
S&P 500	4.63%
OSEBX	7.36%
OMX Stockholm	6.11%
CAC40 Paris	5.56%
DAX Frankfurt	6.82%

Source: Yahoo! Finance

Also, the Norwegian ownership structure is of interest when examining the subject. Davies et al. note that the ownership structure of Norwegian companies differs from what is the norm in both the USA and the UK. In these two countries, ownership is relatively dispersed, while we in Norway have an insider share ownership average of around 20% (Davies et al. 2006). This implies that Norwegian investors are less diversified than their American/British peers, or at least that a larger proportion of their portfolio/wealth is at risk from their investment in a single firm. One could assume that such investors would be more likely to favour hedging measures than investors with more limited stakes in a company.

But modern history has several examples of why cash flow hedging could be regarded as a destroyer of firm value. Brazilian pulp maker Aracruz Celulose lost 2.52 billion USD on speculation with foreign exchange options in 2008. They had committed on a bet that the Brazilian real would continue to appreciate after having doubled its value against USD over four years. When the real started to fall sharply, it was discovered that their obligations related to foreign exchange derivatives where too large to handle. Their stocks fell 19% overnight and the company was eventually taken over by a competitor. Another example is the German industrial conglomerate Metallgesellschaft who almost went bankrupt in 1993, after having lost 1.3 billion USD on hedging oil price exposure in the futures market. As oil prices dropped in 1993, they were left with extensive paper losses, as they were forced to pay more for the fuel they needed than they received from its customers who were locked into fixed prices (Metallgesellschaft).

The list of companies that looses billions of dollars on derivatives meant to stabilize cash flows goes further than these two examples. Although we are yet to see losses of these magnitudes in the Norwegian market, we do believe that a discussion of Norwegian companies' hedging practices is relevant. The increased volatility in the currency markets over the last couple of years, combined with the current economic situation in Euro-countries, particularly the PIIGS[1], further increases the relevancy of foreign currency risk management.

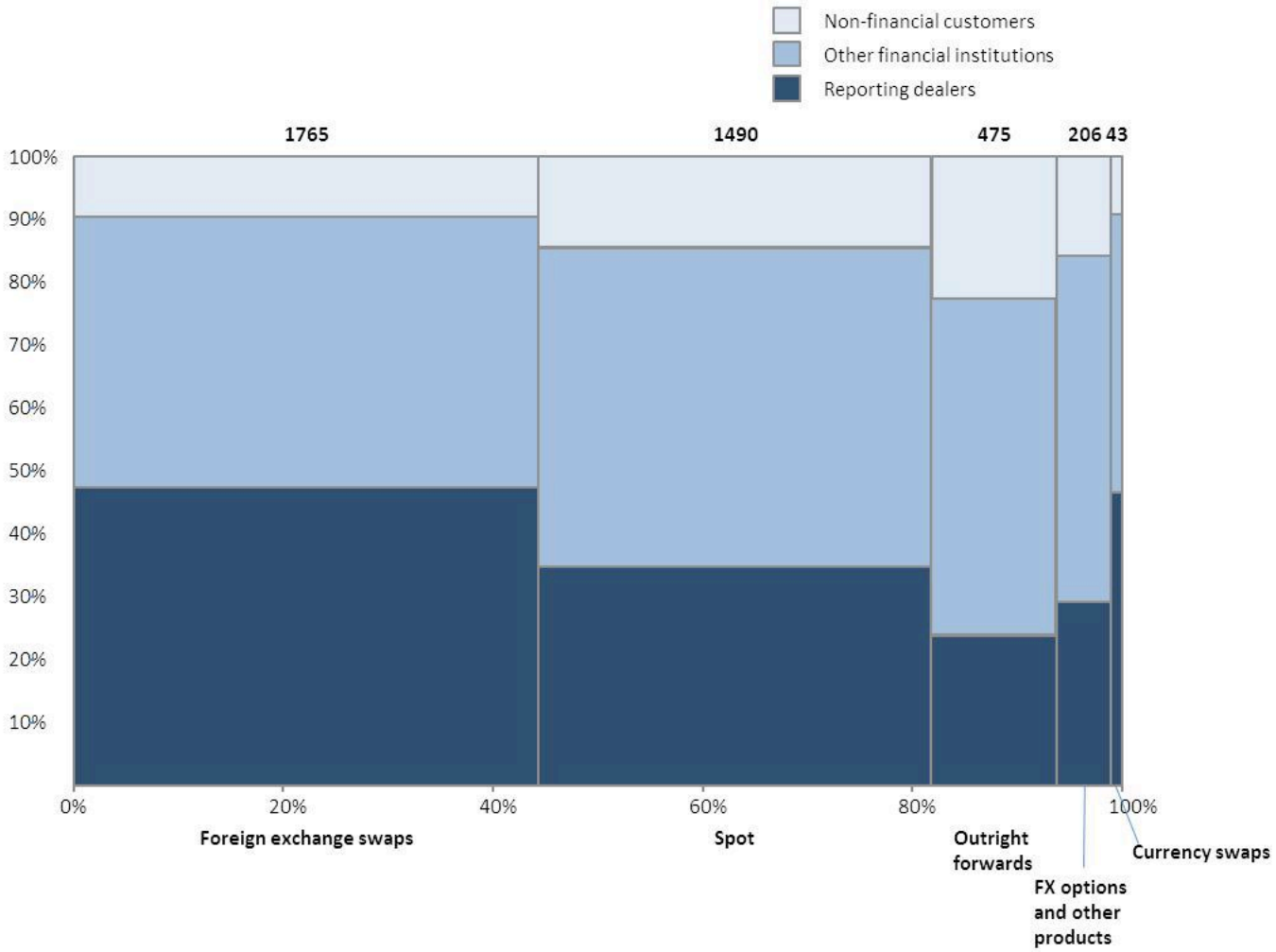
[1] Portugal, Ireland, Italy, Greece and Spain

1.4 Development and Structure in Currency Markets

1.4.1 International Currency Markets

Since the fall of the Bretton Woods system in 1971 the global currency market has evolved into the world's largest market. The daily turnover is now 4 trillion US dollars, which is more than a fourth of United States' gross domestic products and more than 10 times the turnover in stock markets. The following chart provides an overview of the current structure in global currency markets.

Chart 1.4.1-1: Structure of global currency markets[2]
USD Billions



Source: BiS Trennial Central Bank Survey April 2010

As we can see on the X-axis the turnover in foreign exchange swaps contributes to more than 40% of the total market. Further, about 35% of total turnover arise from trading currencies in the spot market. We can also see that, not surprisingly, reporting dealers (i.e. banks) and

[2] X axis shows the split between different derivatives while axis Y show the split between types of customers.

other financial institutions make up about 80-90% of the market (Y-axis). Non-financial customers, similar to the companies covered in this thesis, only contribute to about 10-15% of the market. This gives an indication of currency markets being more a place for speculation than corporate hedging.

As the survey by Bank for International Settlements is conducted every third year one can also get a sense of how the structure of the market has developed over the last decade. Evidence presented in the charts below shows that foreign exchange swaps and spot trading have grown significantly in terms of value over the last decade. Looking at growth rates one can see that the growth has been fairly equal across instruments.

Chart1.4.1-2: Instruments in global currency markets
USD trillions

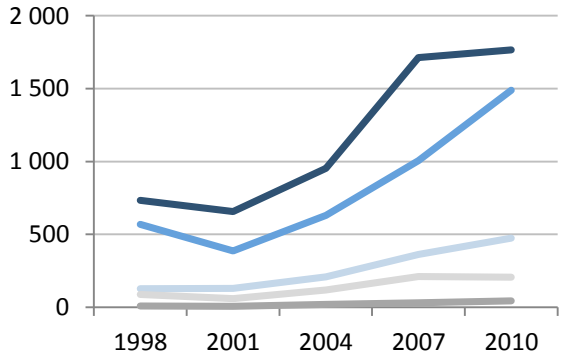
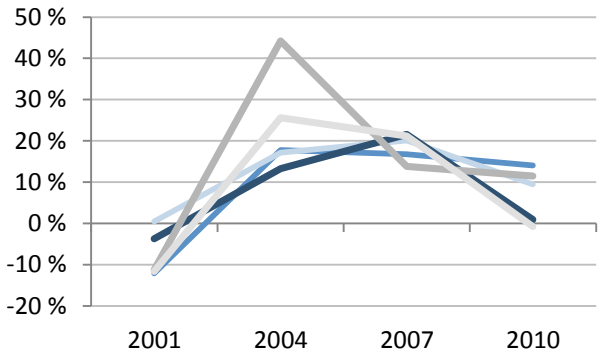
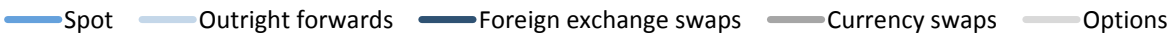


Chart 1.4.1-3: CAGR[3] per instrument
Percentages





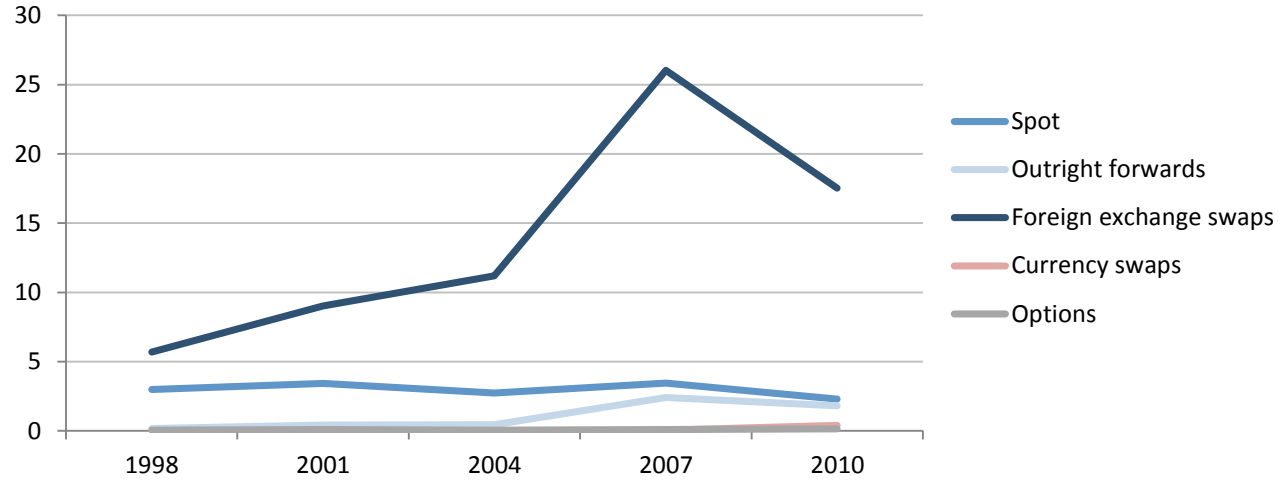
Source: BiS Trennial Central Bank Survey April 2010

1.4.2 Norwegian Currency Markets

The Norwegian currency market seems to have a slightly different structure than the international market. First of all, spot trading seems to be much smaller, in relative terms, in Norway compared to the global market. Further, foreign exchange swaps is by far the most used instrument, even after a significant dip following the recent credit crisis. The table below show the development in different instruments over the last decade.

[3] Compound Annual Growth Rate

Chart 1.4.2-1: Instruments traded in Norwegian currency markets
USD Billions



Source: Norges Bank: Aktiviteten I det norske valuta- og derivatmarkedet i april 2010

When it comes to trade counterparties we can see below that non-financial customers have a slightly bigger part of the total turnover. This is mainly due to the large fall in turnover by reporting dealers. In absolute terms we can see from chart 1.4.2-3 that the turnover of non-financial customers decreased in the 2010 survey, but has increased over the last decade. The turnover actually increased fourfold from 1998 – 2007 before dipping down in 2010, still about three times the 1998 level. We believe this is first of all an effect of globalization with more international trade by Norwegian companies, but also from an increased focus on hedging.

Chart1.4.2-2: Counterparties in Norwegian currency markets
Percentage share of total

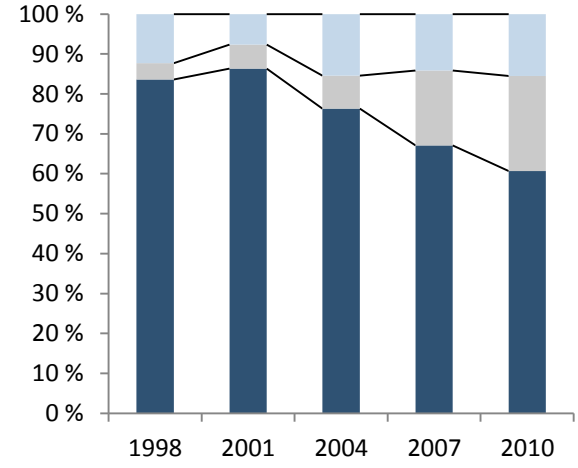
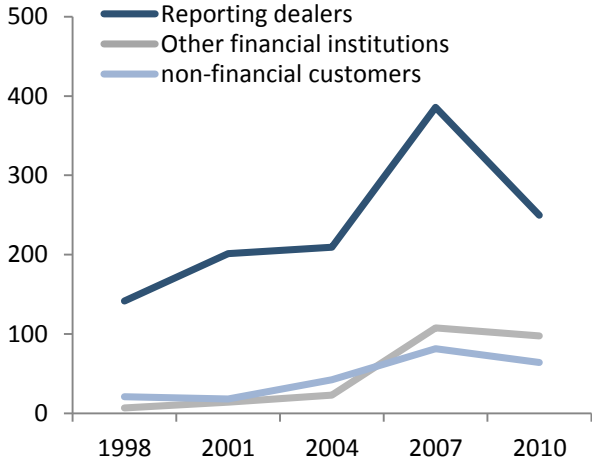


Chart 1.4.2-3: Counterparties in Norwegian currency markets
USD Billions

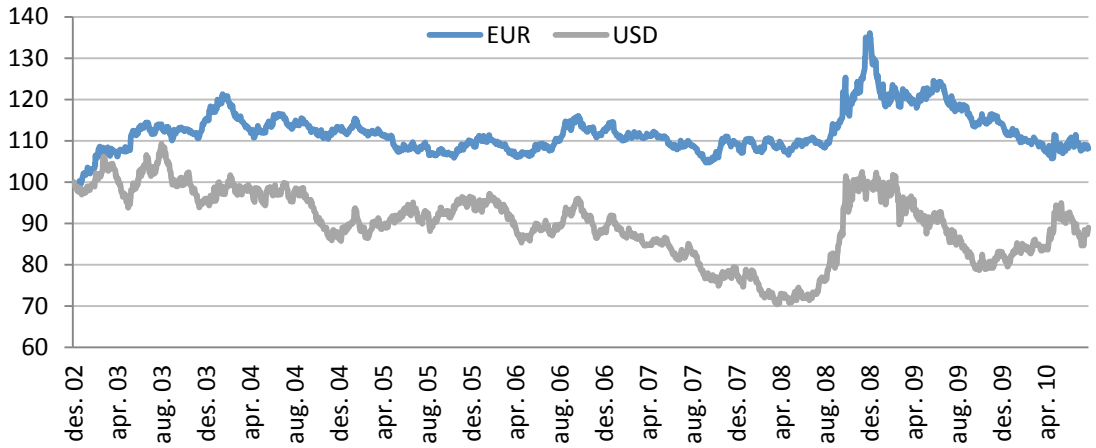


Source: Norges Bank: Aktiviteten I det norske valuta- og derivatmarkedet i april 2010

1.4.3 Exchange Rate Developments

The main currencies traded in the Norwegian market are the Euro (EUR) and the United States Dollar (USD). The development of the Norwegian Krona towards these two major currencies is presented in chart 1.4.3-1 below. We have indexed the development to 100 in the end of 2002 and can see that NOK has depreciated towards the Euro, and appreciated towards the USD over the period. Further we see a significant depreciation of NOK during the second half of 2008. This is due to the credit crisis when fear spread across all markets and investors sought a safe haven for their funds. This is a typical response during market turmoil, and one can often see that especially the USD, but also the EUR, appreciates in such periods.

Chart 1.4.3-1: Development in EUR and USD since 2002
Indexed. Rising index values denotes depreciation

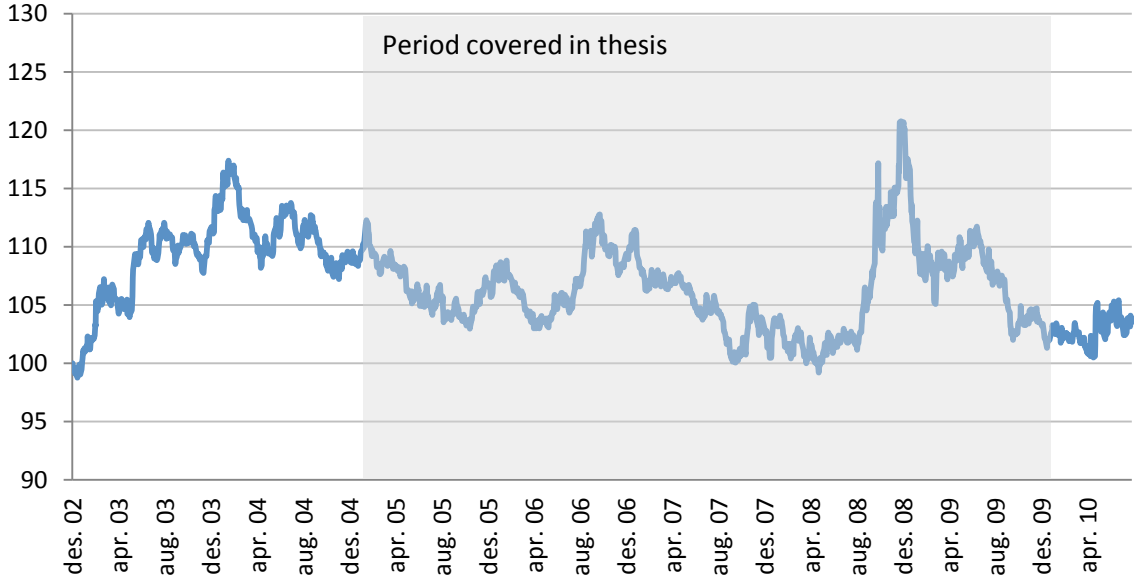


Source: Norges Bank

Norges Bank uses a nominal effective rate based on the exchange rates against the 25 most important trade partners to track the performance of the Norwegian Krona. This index, TWI[4], is weighted as a geometrical average based on the OECD trade weights. The daily development in this index is presented in the chart below.

[4] Trade Weighted Index

Chart 1.4.3-2: Development in TWI last from 2003[5]
Indexed. Rising index values denotes depreciation



Source: Norges Bank

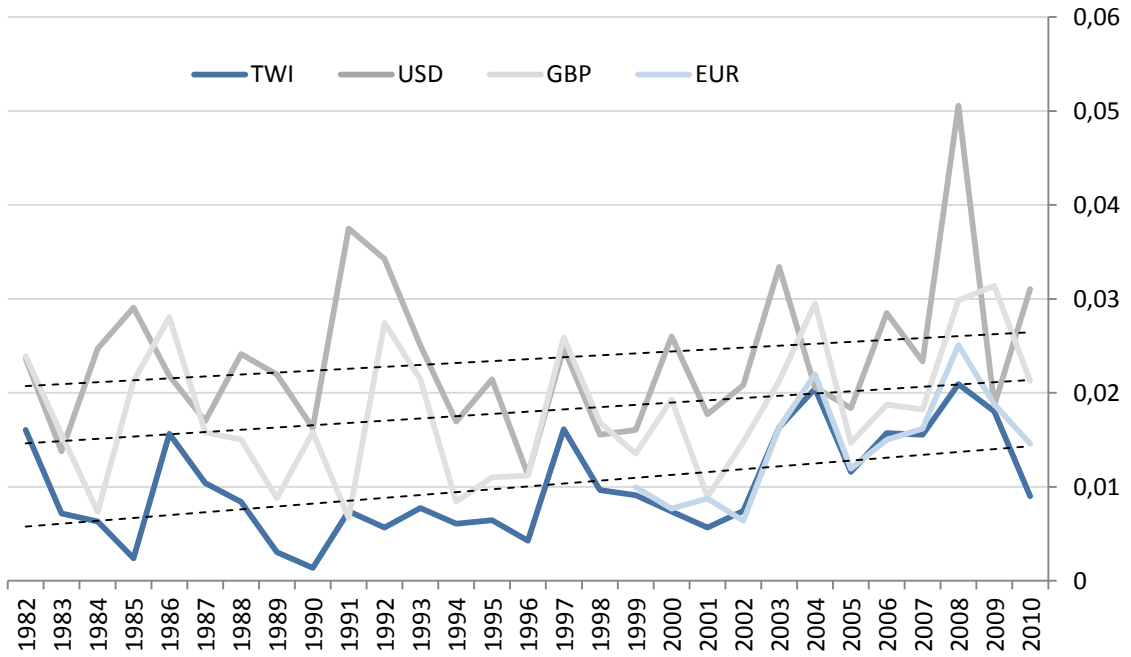
We can see that NOK has appreciated slightly during the focus period of our thesis. As in the EUR and USD chart, there was a significant depreciation during the credit crisis.

1.4.4 Developments in Volatility

As we showed in the charts in section 1.4.1 and 1.4.2 currency markets have grown significantly over the last decade, both in total and for the non-financial institution. First of all we believe this is due to globalization and thus larger mismatches between currencies in revenues and costs. Further, another possible explanation could be that the volatility in this market has increased and hence the companies have become more aware of the increasing risk from cash flows, or assets, in foreign currencies. The chart below shows how the monthly volatility in daily returns has developed over the last 30 years.

[5] Data extracted 23.08.2010

Chart 1.4.4-1: Historical volatility development; monthly volatility of daily return
Standard deviation



Source: Norges Bank

Even though we have experienced periods of high volatility throughout the history we can see that the underlying trend lines in TWI, USD and GBP are clearly upwards sloping which indicates increasing volatility. We have not included the trend line for EUR as it has only been traded for the last decade. However, based on the available data it would have shown a clear upward sloping trend.

2 Theoretical Background

2.1 What is Foreign Currency Exposure?

Companies are affected by fluctuations in currency markets in several ways. Foreign revenues increase or decrease valued in the reporting currency depending on movements in exchange rates. Similarly, input cost from having sub vendors abroad, or buying commodities denominated in foreign currency, can vary significantly from one year to another depending on the development in currency markets. These are factors that directly will influence a company's cash flow, and need to be managed properly. In addition, items on the balance sheet could also potentially loose or gain value following a change in the company's reporting currency. We will in the following provide an outline of the different foreign exchange risks a firm faces, in economic theory often defined as transaction, operating-induced and translation exposure (see for example Homaifar 2004).

2.1.1 Translation Exposure

Homaifar (2004) provides the following definition of translation exposure:

> *Translation exposure defines the unexpected change in exchange rates on the balance sheet of the subsidiary as translated for consolidation purposes into the parent company's currency* (Homaifar 2004: 217)

Naturally, the translation of the subsidiary's balance sheet (and income statement) in a foreign currency could potentially change stockholder's equity. A multinational company that has several subsidiaries located abroad, e.g. production facilities in New Zealand and South America, must translate the balance sheets (and income statement) of these subsidiaries into their reporting currency when consolidating their statements in the financial reports. Any change in the exchange rate related to the currency of the subsidiary from the last translation will produce either an accounting gain or loss, which in turn will be posted to the stockholder's equity.

The translation exposure measures the change in the value of assets-, and/or liabilities, due to changes in currency exchange rates since the last translation. According to IFRS-rules, a company is obliged to report what this translation effect is, in addition to any tax effect that

might arise due to exchange differences (IFRS IAS 21). Usually the income statement of a foreign subsidiary is translated at the weighted average of the exchange rate during the reporting period.

2.1.1.1 Managing Translation Exposure

Translation exposure poses challenges for the company through two channels. Firstly, a sudden decrease in parts of the firm's assets due to unfavourable development in the currency markets is a threat to firm (and shareholder) value. Secondly, it could pose a balance sheet mismatch between assets and liabilities, as most companies have their bank debt allocated in the holding- or parent company. Translation exposure is best avoided using balance sheet hedging, which is explained below.

The problem with mismatch of exposed assets and liabilities is avoided if the company has equal values of assets and liabilities denominated in the foreign currency. A firm that has exposure of 100 million through a large production facility in Brazil could remove net exposure through a bank loan of 100 million in the same currency. Note while this would raise liabilities with 100 million, cash and equivalents would simultaneously increase by 100 million, unless the company transfers the money back into the reporting currency. But, in most cases, creating a match of assets and liabilities in the same foreign currency will minimize the problem related to translation exposure.

2.1.2 Transaction and Operating Exposure

Opposed to translation exposure, transaction exposure is not related to the balance sheet. Transaction exposure is currency effects that have a direct effect on a company's cash flow. Homaifar (2004) describes two different degrees of cash flow exposure to foreign currency, transaction exposure and operating exposure:

> *Transaction exposure is defined as the impact of the unexpected change in the exchange rate on the cash flow arising from all the contractual relationships entered prior to the change in exchange rate at time (t_1) to be settled after the change in exchange rate at time (t_2)* (Homaifar 2004: 224)

Thus, when Norwegian Air Shuttle orders a series of new airplanes to be delivered at a given date from the American manufacturer Boeing, with payment in USD upon delivery, they face

transaction exposure from fluctuations in USD/NOK between the dates of contract agreement and delivery.

Operating exposure is does not differ from transaction exposure depart from the fact that it has a more long-term nature. A typical example of operating exposure is recurring revenues denominated in foreign currencies that are not offset by costs in the same currencies.

2.1.2.1 Managing Transaction and Operating Exposure

In theory, transaction exposure is easier to hedge, as it is by nature transparent. The company has entered into a specific contract and the cash flow related to it is known. There are several hedging strategies that could be useful in this situation, and below is a presentation of these.

Exposure Netting

A natural hedge is obtained by netting cash in- and outflows. A company that has payables of a specific amount in a foreign currency, but also expects income in the same currency during that same period, has a natural hedge. Consequently, one could argue that in order to be naturally hedged, a company should strive to enter contracts in currencies that create a natural hedge. As an example, Norwegian Air Shuttle, who has a higher share of its income in EUR than in USD, should buy their new airplanes from European manufacturer Airbus rather than American manufacturer Boeing, given that the quality and cost of planes are the same from the two manufacturers.

Forward Exchange Contract

A forward exchange contract is one of the most basic financial derivatives. It involves the exchange of one currency for another, at a forward exchange rate determined today for the delivery to take place for cash settlements at an agreed date in the future. Theoretical price of a currency forward is the cost in home currency of obtaining one unit of foreign currency in the future. Thus, to compute the forward price, we must take into account any interest rate differences in the respective countries:

$$F_{0,T} = x_0 e^{(r \text{ - r foreign})T}$$

where F is price of forward, x_0 is the amount in home currency, r is interest rates and T is time to settlement. Consequently, the forward currency rate will exceed the spot rate when domestic risk-free rate is higher than the foreign (McDonald 2006).

A company that has a specific amount of payables in the future and wants to hedge this cash flow can lock the amount today by entering a long forward exchange contract, buying home currency today for the same nominal amount that it will receive in the future. Similarly, a company that has a specific amount of receivables in a foreign currency can lock the transaction today by selling forward exchange contracts for the same amount with delivery in the future.

Money Market Hedge

This alternative is similar to a forward rate contract, but involves lending money, rather than buying forward contracts. A company that has payables in a foreign currency in the future could immediately borrow the nominal amount in the foreign currency. The proceeds will be invested at "risk free" returns until the date of payment. A company that has receivables in a foreign currency would borrow foreign currency and immediately convert it to home currency at the current spot rate. It will then repay its foreign currency debt using the amount received.

The nature of both forward contracts and money market hedging is very similar. In fact, assuming that covered interest parity holds, the outcome of each hedging strategy will be identical. In other words, which strategy is the best could vary from situation to situation, factors like transaction costs, company solidity, bank-relationship, market liquidity etc. could be decisive.

Currency Futures

The main difference between futures and forward contracts are the "margin requirements and daily settlement of the gain or loss on the position" (McDonald 2006: 161). These contractual differences between forwards and futures often lead to pricing differences, though in most cases the costs are similar. One element of futures that perhaps makes them less fit for corporate hedging purposes is the daily marking to market, which often could result in cash outflows before settlement date. Thus, with futures a company will not be in a completely hedged position, as with forward contracts where the standard deviation always is zero. Also, while futures are standardized contracts traded on exchanges, forwards are traded in the OTC market and tailored specifically to each single situation.

Option Hedging

A more costly alternative to futures and forward contracts are currency options. They have the benefit of protecting against loss beneath a certain unfavourable exchange rate, while at the same time not removing the possibility of benefiting from a favourable development in the currency market. An option is a right, but not an obligation, to buy (call option) or sell (put option) an underlying asset to a given price (strike price). There are several variants of options, but we will only discuss plain vanilla options.

A company has three choices when it comes to hedging with options. It could buy protection at the current exchange rate, an at-the-money option, it could buy protection for an exchange rate below the prevailing one (out-of-the-money option). Finally it could also wish to buy protection at an exchange rate that is higher (more favourable) than the spot rate. It is fairly obvious that the option premiums will differ between these alternatives, where an out-of-the-money option will be the least costly (as it holds no value should it expire at the current rate), while an in-the-money option will have the highest premium as the spot rate is higher than the strike price.

Option premiums are sensitive to volatility (historical and/or implied) estimates. Theoretical price of a currency option is found using a modification of the Black-Scholes formula, the Garman-Kohlhagen model:

$$C\left(x_0, K, \sigma, r, T, r_{for\square ign}\right) = x_0 e^{-(rforeign)T} N(d_1) - K e^{-rT} N(d_2)$$

$$d_1 = \frac{\ln\left(\frac{X}{K}\right) + (r - r_{foreign} + \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}$$

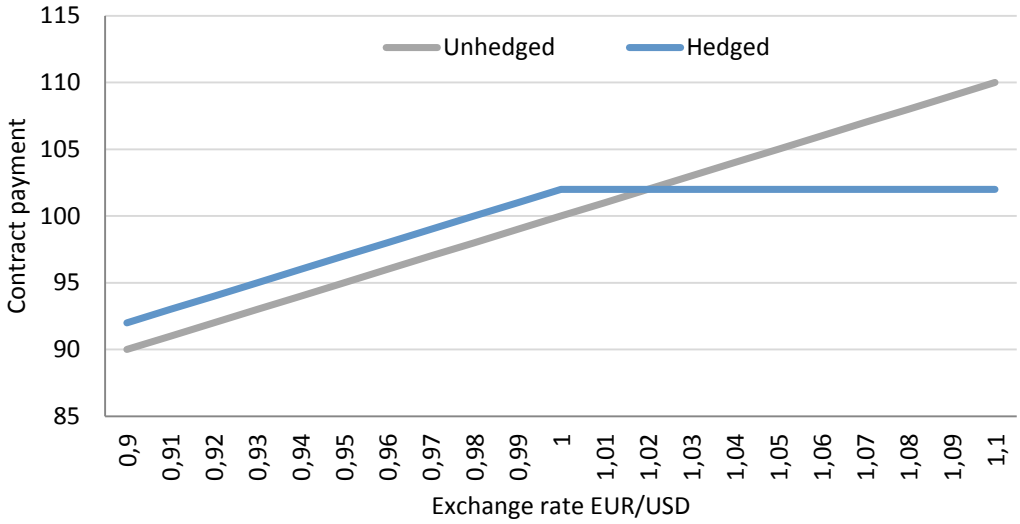
$$d_2 = d_1 - \sigma\sqrt{T}$$

where C is price of a call option, x is the current exchange rate, K is the strike price, σ is the volatility, r is the domestic risk-free rate, T is time to settlement, and $r_{foreign}$ is foreign risk-free rate.

The figure below illustrates how a company can use call options to hedge against unfavourable developments in the currency market after they have entered into an obligation to pay a supplier in a foreign currency. In this case a European company that benefits from strong EUR relative to USD, and has purchased at-the-money call options. The options will

protect against USD appreciations, while at the same time provide the opportunity to benefit from a strong EUR. Note that the minimum payment related to the contract will always be higher when a company is hedged, due to the option premium.

Figure 2.1.2.1-1: Hedging contract-payment with call options



Currency Swaps

Forward contracts, currency loans, futures and options are all hedging tools with a short time horizon, typically one-period/contract tools. These are all contracts that are settled on a specific date, and thus suitable for hedging transaction exposure. However, many transactions occur repeatedly, as companies frequently exchange currencies. So, how can a manager hedge a stream of foreign currency cash flows, as opposed to just one transaction?

Swaps are "multi-period extensions of forward contracts" (Bodie 2008: 831), or as McDonald defines it: "a contract calling for an exchange of payments over time" (McDonald 2006: 247). The company would agree with a counterpart, most of the times a swap dealer, to exchange a fixed amount of foreign currency for given a number of periods. A Norwegian company that has a need for USD to pay suppliers, and has most of its income in NOK, could for example agree to pay a swap dealer a given number of NOK in exchange for the USD it is obliged to pay, at a given exchange rate, for the next five years.

2.1.3 Section Summary: What is Foreign Currency Exposure?

We have now discussed different types of foreign currency exposure, and cash flow hedging methods. We believe that the exposure we have called “operating exposure” is most relevant in our analysis.

2.2 Should a Company Hedge its Currency Risk?

To answer this correctly we first need to clarify what exactly a "hedge" is. Encyclopaedia Britannica provides a good definition of the economic term "hedging":

> "Method of reducing the risk of loss caused by price fluctuation. It consists of the purchase or sale of equal quantities of the same or very similar commodities, approximately simultaneously, in two different markets with the expectation that a future change in price in one market will be offset by an opposite change in the other market" (Encyclopaedia Britannica: Hedging)

This implies that the goal of hedging activity is to reduce the volatility, or variance, of enterprise value. We know that an increase in enterprise value is either a result of increased future cash flow, or reduced cost of capital (WACC) from lower risk when holding the asset. Taking this one step further; if hedging activity is to increase EV it must either be because it increases expected cash flows, or reduces the required rate of return. While it can be argued that some companies do in fact trade with financial derivatives to increase cash flows, particularly financial companies, our thesis only aims to discuss hedging tools as means to reduce risk. Hence, the fundamental question of this thesis is; *should a company aim to reduce cash flow volatility?*

The theoretical answer with foundation in modern portfolio theory, the CAPM and Modigliani & Miller, is negative. But there are certainly arguments in favour as well, and we will discuss these thoroughly, as we consider them to be important for our thesis. Please note that we will only discuss from a theoretical point of view, practical examples from real life as to why hedging activity can ruin whole companies have already been presented. The theoretical discussion, based on Modigliani & Miller, rest on the idea that the currency game is a zero sum game. By this, we mean that the expected return of not hedging cash flows is the same as it is when hedging, not taking transaction costs into account. Consequently, all one can gain from currency hedging is a decrease in cash flow volatility.

2.2.1 Theoretical Arguments against Cash Flow Hedging

The major theoretical arguments against currency hedging, arguments to why firm value does not increase as a result of extensive currency risk management, are all related to standard Corporate Finance theory, both through the Modigliani and Miller theorem, and Modern

Portfolio theory developed by among others Harry Markowitz and Jan Mossin. We begin with arguments derived from Modigliani and Miller, and then proceed with Modern Portfolio theory, where the Capital Asset Prising Model (CAPM) and diversification are the keywords.

2.2.1.1 Modigliani and Miller Theorem and Currency Hedging

Franco Modigliani and Merton Miller published in 1958 what has become somewhat of a starting point for almost any discussion of corporate finance theory (McDonald 2006). They realized that decisions of how to govern a corporation (e.g. how much debt a company should have) could affect the cash flow in several ways, but as long as the total cash flow paid to all stakeholders remained unchanged, the value of all claims, and thus the value of the company, would be the same. Because, as they argued, if financial policy could change enterprise value then there would be profitable arbitrage in the market. The only way financial decisions could affect firm cash flow, and thus firm value, is if they somehow either affect the ability the firm has to operate its business, or if it reduces the incentive the management/owners have to invest in the future.

The theorem, which initially was applied to an analysis of a firm's choice of debt versus equity financing (Grinblatt 1998), can also be used when discussing other elements of corporate finance, such as fixed versus floating interest rate, dividend policy and currency hedging. In theory, none of these should affect firm value as long as Modigliani and Miller's conditions hold. These assumptions are no taxes, perfect capital markets (no difference in borrowing rates) and no transaction costs (Brealey et al. 2008). Let us elaborate:

The irrelevance of the firm's leverage influence on firm value in Modigliani and Miller's theorem can be illustrated by the individual investor who himself can choose his combination of equity and debt to finance his own portfolio. It is of no concern to him whether the company he invests in takes up a lot of debt to increase its operations; if he wants to be more exposed towards that particular company's operations he might as well borrow money from his local bank to buy more shares. One can easily see how this also could be applied to risk management; it is possible for an investor to undo or duplicate any decision the management of the firm makes regarding risk choice. An investor who holds shares in an oil company wants to be exposed to movements in the price of oil. Thus, unless it is a clear strategy communicated to the market, the investor would not want the company to hedge the price it

gets per barrel of oil. If the investor would like to be less exposed to fluctuating oil prices, he would instead place a portion of his portfolio in companies that benefit from falling oil prices, such as a producer of plastic goods.

2.2.1.2 CAPM and Currency Hedging

The capital asset pricing model is a "set of predictions concerning equilibrium expected returns on risky assets" (Bodie 2008: 293). Harry Markowitz was the pioneer of modern portfolio management in 1952, and his ideas inspired Sharpe, Lintner and Mossin to develop the CAPM a decade later. In the model, the risk of an asset is measured by the Beta, which gives the volatility in comparison to the market as a whole.

$$E(r_i) = r_f + \big(E(r_m) - r_f\big)\beta_i$$

where $$\beta_i = \frac{cov\,(r_i, r_m)}{var\,(r_m)}$$

The covariance describes the relationship between two variables (Keller 2005: 115). The significance of the covariance can be shown in an example of a portfolio holding two assets where the variance is given by

$$\sigma_p^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2\rho_{1,2}$$

where w_1 and w_2 are the fractions of the portfolio invested in each asset.

From this we see that if the assets not are perfectly positively correlated (i.e. $-1 \leq \rho_{1,2} < 1$) , putting the two together in a portfolio will be less risky than investing in only one. Every asset in a market has two different types of risk, systematic and unsystematic. The systematic risk is often called market risk. It is the risk of the market as a whole, e.g. macroeconomic factors such as interest rates, energy costs etc.; factors that are likely to affect most assets. Unsystematic risk however, is risk connected to a single asset or company, and can be diversified away by creating a portfolio using the covariance of the assets.

In modern portfolio theory, and the CAPM, no reward or premium is given to an investor who invests in an asset with high unsystematic risk as it could be removed by diversification. And we believe that currency risk is exactly that kind of risk, risk that can be removed by

diversification. Consequently, hedging against currency fluctuations could not change the expected return of an asset.

2.2.1.3 Sub-chapter Summary: Theoretical Arguments against Currency Hedging

As we can see, both these theoretical arguments have basis in the idea of portfolio diversification. The investor is able to compose his risky portfolio according to his degree of risk aversion, and therefore firm hedging cannot add any value to the shareholder. This discussion of who is responsible for diversification, the company or the shareholder, is interesting, but one we do not seek to answer. What is clear, and must be stressed, is that if the company has a clear and communicated strategy that it hedges all its cash flows, then the investor could most certainly look elsewhere if he wants exposure to currency fluctuations.

Theory and practice are not always corresponding to each other, and a discussion of the intuition behind both these arguments is a necessity. First of all; the Modigliani and Miller theorem, does it hold? As we mentioned earlier; their assumptions are based on a market where no frictions or imperfections are present. Such frictions include taxes, transaction costs and financial distress costs, and we will discuss how the presence of these can support arguments of risk management as a source of increased firm value.

2.2.2 Theoretical Arguments in Favour of Cash Flow Hedging

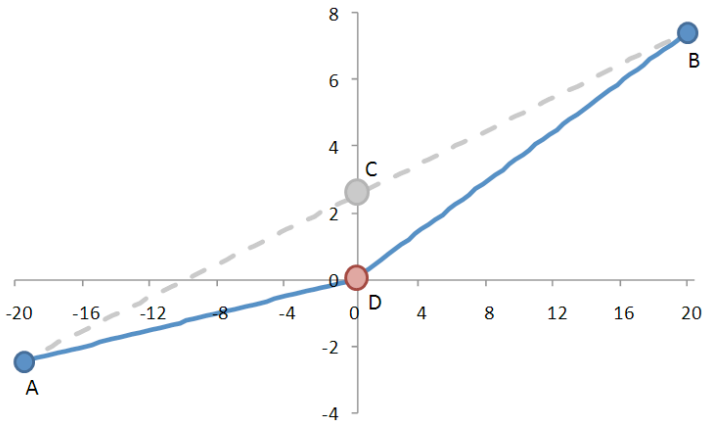
We believe that most of the assumptions Modigliani and Miller used as basis for their theorem can be discussed. Most companies pay taxes (although most shipping companies do not), there are certainly transaction costs, and in most cases these can be higher for a single investor than a large corporation (Grinblatt 1998). There are substantial costs related to the bankruptcy of a company, and finally, there are often problems related to asymmetric information, as corporate executives are more knowledgeable about their risk exposures than the average shareholder.

We will continue with a discussion of how the presence of all these frictions can be used as arguments in favour of increased firm value from cash flow hedging.

2.2.2.1 Taxes and Currency Hedging

Smith and Stultz (1985) argued that if a tax regime is constructed a particular way; it might encourage companies to take positions in financial instruments for hedging purposes. This is valid when firms are facing a convex tax function; i.e. when taxable income is low, the effective marginal tax rate will be low, while as taxable income increases, so does the marginal tax rate. Graham and Smith (1998) later argued that firms that faces such a tax function, and hedge (smoothing their earnings), will experience that the tax increase in circumstances where income would have been low is smaller than the tax reduction in circumstances where income would have been high. Consequently, hedging reduces expected tax cost, and increases expected cash flow (and thus firm value).

Figure 2.2.2.1-1: Convex tax function and expected tax payment[6]
Earnings before tax on X-axis and tax payment on Y-axis.



If a company face a tax function such as the blue line above, there is clearly a tax incentive from hedging. Earning either A or B (both with probability 0.50) gives expected tax payment in point C. If one could hedge the future earnings and earn D with certainty the tax payment would be zero instead of approximately 2.5.

Most companies in our sample are facing a tax schedule with fixed tax rates on domestic operations. Generally, the corporate tax rate in Norway is 28%, although oil explorers and producers may face taxes up to 78%. No matter what tax rate a firm face, all Norwegian companies face linear tax functions. This implies that the tax benefits from hedging will not be present, as the marginal tax rate is not raised as earnings increase. Therefore it has been

[6] In this figure marginal tax rate is higher on gains than losses.

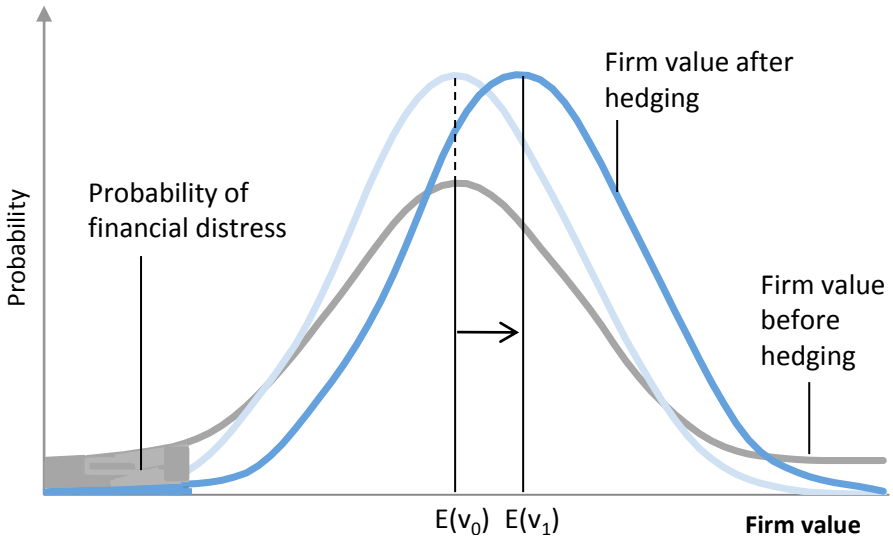
suggested (Davies et al. 2006) that Norwegian companies cannot include tax incentives among the determinants of their foreign currency risk management. However, we believe that it is important to look at standard practice here. A company that experiences a loss does not get a tax refund from the authorities, they are allowed to carry that loss forward and deduct their tax benefit from any future tax payments. But when such losses are carried forward, they are treated in nominal terms, which implies that the real value of tax benefits from losses are actually lower than the nominal value at the time the loss occurs. Hence, the effective tax rate on losses (benefit) is lower than the effective tax rate on earnings (liability). This creates in fact a convex tax function for Norwegian companies, where the degree of convexity would depend on the time (i.e. number of years) until the company makes a profit and is allowed to take advantage of the tax benefits carried forward. The longer the time, the more convex the tax function would be and the more would the company gain from hedging their foreign currency cash flows.

2.2.2.2 Bankruptcy Costs and Currency Hedging

Financial distress and bankruptcy can be costly to both equity and debt holders. These costs can arise from conflicts between debt holders and equity holders, e.g. the cost of lawyers and external accountants. For example, it has been estimated that the bankruptcy costs related to the collapse of Enron surpassed one billion USD.

Corporate finance theory often defines the cost of bankruptcy as the probability of default multiplied by the loss to stakeholders given default (See for example Grinblatt 1998). The loss to stakeholders is clearly independent of any risk management strategy, however the probability of default can certainly be controlled and reduced by reducing cash flow volatility. Less probability of default could then in turn lead to higher cash flows, as both suppliers and customers are more likely to appreciate a firm where the likelihood of financial distress and bankruptcy is low. So, by hedging its risk, a firm can reduce its bankruptcy costs, and possibly increase firm value. The figure below illustrates this;

Figure 2.2.2.2-1: Possible effect of hedging on firm value



It is worth to mention that there could be cases where hedging would not reduce the probability of default sufficiently, neither will it increase cash flows and value. If the cost of hedging is sufficiently high, combined with it resulting in a very small variance reduction in cash flows, we could possibly see that hedging in fact increases the probability of default. However, we do not believe that such a situation will occur frequently. Nevertheless; if the hedging process is very costly, then hedging might not be worthwhile, especially for firms where bankruptcy costs are already low.

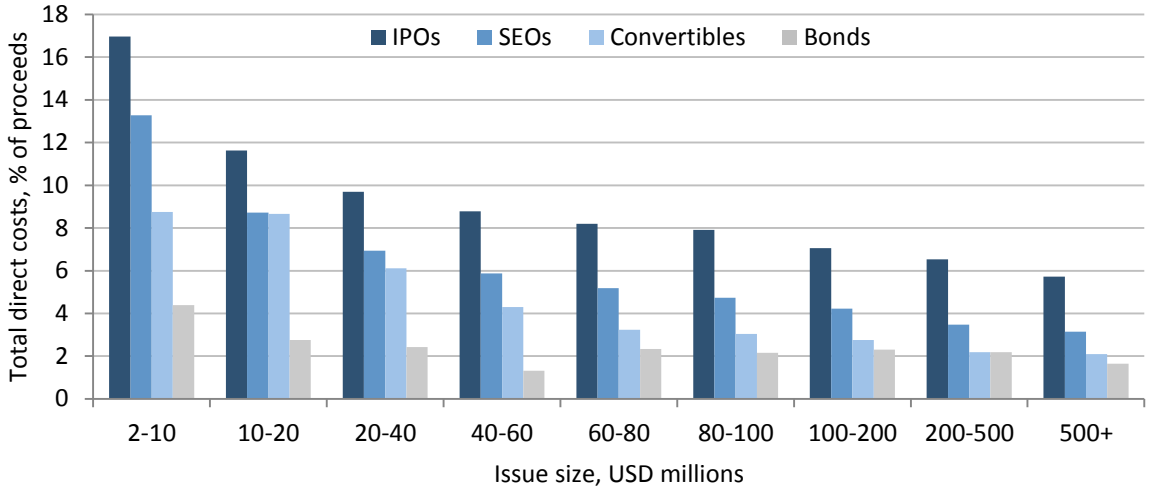
Another matter closely related to this is the fact that reduced probability of default can help increase a firm's debt capacity. Increased debt will in turn mean increased tax shield, and potentially increased cash flows. Miller and Modigliani state that there is no source of financing that is cheaper than another; the cost of using debt versus equity is the same. Clearly this is another condition that in the modern financial markets does not hold. Using hedging-means to decrease volatility and probability of default can possibly lower the cost of external financing, or even suppress the need for it in the first place. However, this is not relevant for all firms as Norwegian firms seldom utilize its' debt capacity.

2.2.2.3 Under- and Overinvestment and Currency Hedging

Textbooks in corporate finance suggest that firms see internally generated capital, cash from operations, as the cheapest source of capital (see for example Grinblatt 2002). There are several reasons to this, which we will not discuss, including taxes and transaction costs. For

example, when using external financing, by either issuing equity or debt, there are fees attached to hiring an underwriter, and one often has to sell the company at a discount. These transaction costs vary, but Lee et al. (1996) have found the following costs for different types of issues dependent upon the issue size;

Chart 2.2.2.3-1: Total direct costs as a percentage of gross proceeds



Source: Lee et al. (1996): The costs of raising capital

where IPOs are initial public offerings, SEOs are seasoned equity offerings and convertibles and bonds are different debt structures. The results were found by examining approximately 4500 issues conducted in the US market between 1990 and 1994.

Empirical evidence also suggests that the level of capital expenditures of a corporation is closely related to its generated cash flows. Firms have a tendency to invest heavily when cash flows are high, and underinvest when cash flows decrease. From this, we can derive that using hedging activity to reduce volatility (variance) of operating cash flows, can help smoothen capital expenditures and increase firm value due to avoidance of under- and overinvestment.

Lewent and Kearney (1990) support this view with their article on how Merck & Co., a large pharmaceutical corporation, implemented and carried out a currency risk strategy. We find the following excerpt particularly interesting:

> *The key factors that would support hedging against exchange volatility are the following two: (1) the large proportion of the company's overseas earnings and cash flows; and (2)*

> ***the potential effect of cash flow volatility on our ability to execute our strategic plan – particularly to make the investments in R&D that furnish the basis for future growth*** *(Lewent and Kearney 1990, Journal of Applied Corporate Finance p.19-28)*

The management of Merck & Co. regards internal cash flow from operations as such an important source of capital that to reduce the volatility becomes a top priority. Lewent and Kearney argued that it is particularly interesting that a firm like Merck are so focused on this, as that company had easy access to debt markets and were able to borrow funds at one of the lowest corporate borrowing rates available. If they express this concern, then firms with weaker credit ratings must have even greater concerns, and decreasing cash flow volatility must be of even greater importance.

Grinblatt (1998) states that this argument is particularly relevant for firms that find it costly to delay or alter their investment plans. We believe that this is extra relevant for the Norwegian market, with a large share of the companies operating in either shipping or oil related business. The prices of oil tankers and rigs are extremely volatile, which further increases the importance of being able to invest when attractive investment opportunities are present.

2.2.2.4 Sub-chapter Summary: Theoretical Arguments in Favour of Hedging

As we can see from the arguments discussed, reducing cash flow volatility can increase firm value in several ways. What seems to be a denominator for all of them is that they decrease firm specific risk, and increase debt capacity. Lower average tax burden could result in higher cash flow, which in turn could increases firm value and debt capacity. Lower variation in cash flow indications to reduced bankruptcy costs, and thus higher firm value. Furthermore, it can reduce the problem of over- and under-investments, as capital expenditures are closely related to internal cash flows.

2.3 Additional Factors to Consider When Developing a Hedging Strategy

In section 2.1 we have discussed the main factors, as net exposure and balance sheet risk that need to be assessed when developing a hedging strategy. Risk averse companies might chose to hedge all translation, operation and transaction risk. For given quantities this should be easy and could be done by selling or purchasing forward contracts whose total amount corresponds to what the company is to pay or receive in the future. However, it is not always optimal to buy perfect hedges, nor do the companies know with certainty what quantities to hedge. The purpose of this chapter is to present theories and examples of what factors a company should take into consideration when developing a hedging strategy.

Even though hedging seems to be a good theoretical idea, in absence of the Miller and Modigliani conditions, it might not always be such a good idea in practice. And even if it is, it might not have the expected effect. We believe this is due to the fact that theory often assumes *ceteris paribus*. In real life there is certainly correlation between exchange rates and other variables affecting a company's revenues and balance sheet risk[7].

2.3.1 Quantity Uncertainty

A factor clearly increasing the complexity of hedging is quantity uncertainty. Both prices of input and output might affect the quantity produced by a firm. When such occurs, the optimal hedge (based on expected quantity) might even increase risk. In general, risk could be minimized by entering into forward contracts whose total amount is derived through the following formulas:

$$Hedged\ revenue = R(H) = (S * Q) + H * (S - F)$$

where H is the quantity entered into forward contracts on, S is the price, Q is the quantity and F is the forward price. When the quantity is uncertain the following equation denotes the variability in revenue;

$$\sigma^2_{R(H)} = \sigma^2_{SQ} + H^2\sigma^2_s + 2H\rho_{SQ,S}\sigma_{SQ}\sigma_S$$

[7] For example, NOK/USD and crude oil price with correlation -0,89 last 12 months (01.12.2010)

where σ_{SQ} is the standard deviation of the revenue and $\rho_{SQ,S}$ is the covariance between revenue and sales price. With the use of derivation and the formulas above one can derive the H that minimizes the variance of hedged revenue through the following formula;

$$H = -\frac{\rho_{SQ,S} * \sigma_{SQ}}{\sigma_S}$$

Hence, variance minimizing hedge ratio is the negative of the coefficient from a regression of unhedged revenue on price (McDonald 2006: 118). That said, it might not be optimal for all companies to hedge the variance-minimizing amount. Some might actually seek a particular exposure and other may have strong enough cash flow and interest coverage to not need to worry about currency fluctuations. If so, it is not necessarily optimal to use hedging derivatives as these might induce costs to the company.

2.3.2 Quantity Uncertainty and Non-Linear Hedging Instruments

Above we have discussed how to minimize variance with both quantity and price risk. Gay et al. (2003) took this a step further and provide a great article on how to balance the hedging portfolio between linear and non-linear derivatives[8]. They concluded that, in general, the optimal hedging portfolio consists of solely linear contracts. However, as the levels of quantity and price risk increase, the portfolio should be weighted more towards non-linear contracts to avoid overhedging.

The overhedging problem occurs when the corporation has sold too many forward contracts as the quantity risk makes realized output deviate from expected output. An example would be if the firm hedges its revenue and prices rise, then revenue will be hurt by lower volumes and loss on forward contracts will more than offset the gain from higher prices as the firm has hedged more contracts than the realized volumes. In such situations hedging will actually increase risk as the price quantity correlation is negative and a natural hedge. To avoid costs of overhedging the company should substitute linear contracts (forwards) with non-linear instruments (e.g. purchasing puts). An increase in prices, under this strategy, will make puts finish out-of-the-money and rising prices will offset loss in volumes. To which extent the loss in volumes is offset depends on the correlation between volumes and price. In a scenario with decreasing prices the volumes will increase and there will be underhedging as the company

[8] Linear derivatives are typically forward contracts while non-linear derivatives could be derivatives such as options and swaps.

only has hedged for the expected volumes. However, such a scenario will be beneficiary for the company.

The degree of substitution between linear and non-linear derivatives depends on the correlation between output and prices. Negative correlation reduces overall demand for hedging, but increases the risk for overhedging and thus increases the relative demand for non-linear hedging derivatives. A positive correlation increases demand for hedging. However, prices are likely to be low when volumes are low so that overhedging leads to the gains on forward contracts that exceed the loss from lower prices.

2.3.3 Additional Factors

An actual example (Copeland and Joshi 1996) illustrates that correlation might be a problem, even between the different exposures within the firm (i.e. translation, transaction and operational risk). In the middle of 1980s a European airline decided to purchase several aircrafts from the American manufacturer Boeing. The company put itself in a short US dollar position which it hedged buying forward contracts on roughly the same amount. Hence, strengthening dollar would make the company loose on its Boeing contracts, but earn an offsetting amount on the forward contracts. Unfortunately, the company had cash flows positively correlated with the US dollar due to earnings on transoceanic routes[9]. Hence, the correlation actually created a natural hedged which led to overhedging when using forward contracts. Weakening US dollar would lead to lower revenues, but also cheaper aircrafts. The dollar peaked February 1985, and fell 40% by the end of the year. Consequently, the company suffered a large loss in operating cash flow and a large loss on the forward contracts.

Copeland and Joshi also argued that foreign exchange rates are only a minor contributor to total risk, except for during extreme events such as the Mexican Peso collapse in 1995. In such situations hedging programs would not be able to cope with the risk associated. This implies that, from their point of view, eliminating the foreign exchange exposure would hardly have any effect on the total risk faced by the firm.

Independent of what hedging strategy the company decides to pursue, we believe the most important factor is communication. Choosing a “wrong” hedging strategy, from the investor’s

[9] Weaker dollar implies to lower demand and lower prices in order to keep up volumes. In sum, revenues fall when dollar weakens.

point of view, is not necessarily a problem, neither value destructive, as long as it is communicated properly. As hedging instruments are available to the individual investor one can, at least in theory, obtain the preferred exposure independent of the company's hedging policy. The problem arises when the company does not communicate properly and investors obtain an exposure that deviates from his or her preferences.

Another question arising when developing a hedging a strategy is how to define an effective hedging program. We strongly believe that an effective hedging program is not necessarily one that attempts to eliminate all risk. It is rather one that seek two manage risk in a way that makes it acceptable for the company. This should be done by balancing the costs of hedging against the benefits and hence derive an equilibrium with a desired hedging ratio.

2.4 Does Hedging Add Firm Value From a Theoretical Point of View?

2.4.1 Introduction

The purpose of this chapter is to assess the value creation of the possible hedging motives discussed earlier in this chapter (e.g. tax, distress costs and debt capacity). In section 2.1.2.1 we provided an explanation of the different instruments used for hedging purposes. Common for all these is that they can be characterized as derivatives; instruments that derive its value from the value of another asset. From a theoretical point of view, a corporation's equity and debt derive its value from the asset value of the firm. Hence, equity and debt can be characterized as derivatives and could hence be valued as derivatives.

To illustrate how debt and equity can be priced as derivatives we use a hypothetical non-dividend paying firm with a simple capital structure consisting of assets (A) on one side of the balance, and equity (E) and debt (D) on the other side. Then let t be a variable that denotes which year we are in, so that t=1 is the end of year 1 and so on. All of the firm's debt matures in T and has a face value of D*.

Equity holders are subordinate to debt holders when it comes to how the firm's profit is shared. When D* is to be repaid at time T, the asset values have to be higher than the debt principal to make the equity valuable. In other words, to make $E_t > 0$ the following inequality has to hold $A_T > D^*$. If not, the equity holders will declare the company bankrupt and permit debt holders to take possession of the firm's assets. This means that the equity of a firm can be valued as an option with A_t as the underlying asset, D* as the strike price and T as time to expiration. Hence, the value of the equity at time T is;

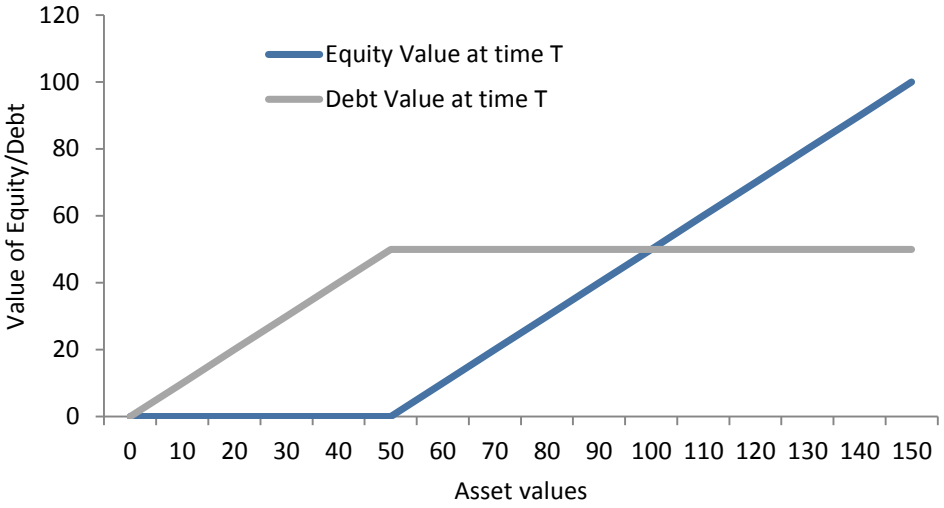
$$E_T = \max(0, A_T - D^*)$$

This equation is equal to the cash flow at expiration for a call option. Analogous one can also think of the debt as an option. If the assets are worth more than the debt at time T, the debt holders get the whole principal repaid. However, if the assets are worth less, the firm goes bankrupt and the debt holders take possession of the assets. This means that the debt can be valued as an option with A_t as the underlying asset, D* as the strike and T as time to expiration. The debt holders will always receive either A_T or D*, depending on which is the smallest. Thus the cash flow is;

$$D_T = \min(D^*, A_T)$$
$$D_T = D^* + \min(0, A_T - D^*)$$

This is equal to the principal of the debt, D*, plus the value of a written put option with strike price D*. The payout on the equity and debt options at time T is shown below;

Figure 2.4.1-1: Equity and debt payout at time T



We can see from the chart above that the equity is only valuable when the asset values are above 50, which is the debt principal. Similarly, the debt is valued at its principal as long as the asset values are higher than the debt principal.

As the cash flows from owing a corporation's equity and debt can be replicated by cash flows from call and put options, we should also be able to value them as options. There are multiple ways to value options, but the most commonly used is the Black-Scholes model. The Garman-Kohlhagen version of this model is discussed in section 2.1.2.1. As we use a slightly different version in this section we have provided the Black-Scholes formulas below;

$$C(S, K, \sigma, r, T, \delta) = Se^{-\delta T}N(d_1) - Ke^{-rT}N(d_2)$$
$$P(S, K, \sigma, r, T, \delta) = Ke^{-\delta T}N(d_1) - Se^{-rT}N(d_2)$$

where,

$$d_1 = \frac{\ln(S/K) + (r - \delta + 1/2\,\sigma^2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

For further explanation on the model we refer to section 2.1.2.1. The variables have been given the following interpretation in our example:

Table 2.4.1-2: Variable interpretation

Variable	Description	Equivalent in our example
S	Current price of underlying asset	A_0 – Asset values in year 0
K	Strike price	D* - Debt principal
σ	Volatility of underlying asset	St. dev. of asset values
r	Risk-free interest rate	-
T	Time to expiration	Number of years until debt matures
δ	Dividend yield on underlying asset	N/A (Non-dividend paying firm)

To illustrate this valuation approach, we use a numeric example throughout the rest of this chapter. The purpose of this is to give a theoretical explanation of how hedging might affect values for the firm, and more specifically the equity and debt holders separately. We give the variables above the following values:

Table 2.4.1-3: Variable values

Variable	Value at t=0
A	100
D*	50
σ	30%[10]
r	5%
T	5 years
δ	0[11]

and rewrite the Black-Scholes equations with the use of our variables;

$$Equity\ value = E(A, D^*, \sigma, r, T, \delta) = AN(d_1) - D^* e^{-rT} N(d_2)$$

$$Debt\ Value = D(A, D^*, \sigma, r, T, \delta) = D^* e^{-rT} N(-d_2) - AN(-d_1)$$

[10] Which is fairly in line with our sample with an average of 28%, and a median of 25%, over the period

[11] Non-dividend paying firm

$$d_1 = \frac{\ln(A/D^*) + (r + 1/2\,\sigma^2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

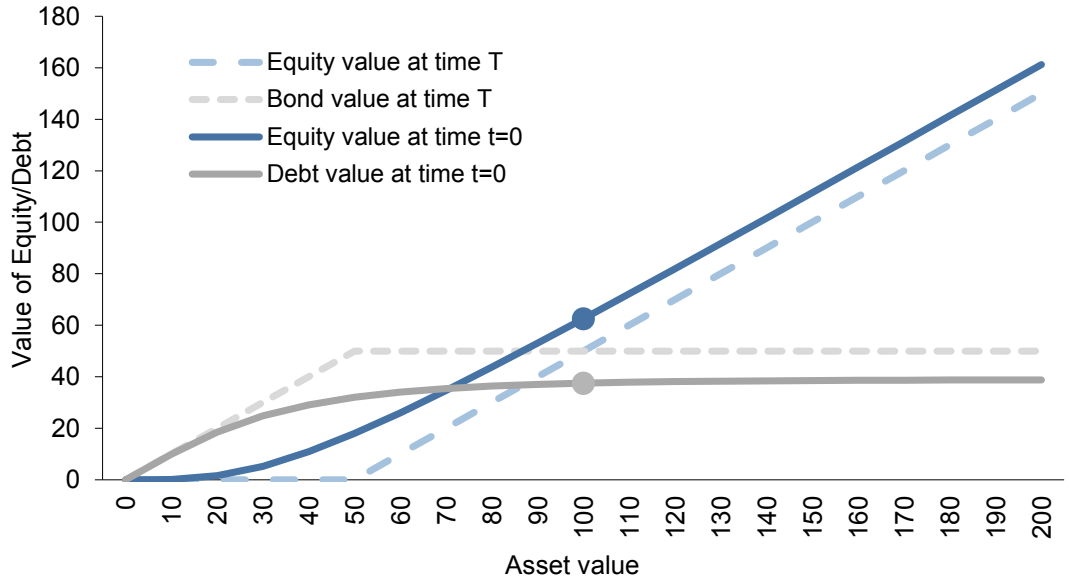
Using the values above we calculate the following initial values of debt and equity:

Table 2.4.1-4: Option values

Value of	Value
Equity	62.52
Debt	37.48

The following graph denotes the equity and debt values for different asset values at both time T and t=0:

Figure 2.4.1-2: Option values at time t and T



where the dotted lines denote the values of equity and debt at the time the debt matures, T. The solid lines represent the values at time t=0, and the circles denote the values in table 2.4.1-4 above.

So the question is; how can hedging add value to the firm given this valuation method? We will in the following try to explain how hedging affect the different inputs and thus value of

equity and debt. In the Black-Scholes equations used above the following variables are included;

Table 3.4.1-4: Black and Scholes variables

Variable	Description
S	Current price of underlying asset
K	Strike price
σ	Volatility of underlying asset
r	Risk-free interest rate
T	Time to expiration

Please note that some of the assumptions to be made on the variables above might seem non-realistic. However, we believe the assumptions made serve well in assessing the value creation. Also, we have included a paragraph at the end of this section that shortly discusses limitations in our approach.

2.4.2 How Does Hedging Affect the Different Black and Scholes Variables?

2.4.2.1 Strike Price

The strike price is in this occasion the face value, or principal, of the debt. For simplicity we assume that all debt is in domestic currency. This excludes currency effects on the principal, which thus gets a volatility of zero. Hence, the strike is fixed and independent of whether the firm engages in hedging activities. Alternatively, if using foreign debt, one can use swap options to model the values given a volatile debt principal. We will not examine this in our thesis as we believe the purpose of this chapter is well-addressed using only domestic debt.

2.4.2.2 Risk-free Interest Rate

The risk-free interest rate is the theoretical rate of return on an investment with zero risk, including the risk of default. Obviously, there is no such asset. Even those assets regarded as the safest, often 3 month US Treasury Bills, carry a very small, but not necessarily completely negligible, amount of risk. However, engaging in hedging activities will not affect this variable.

2.4.2.3 Time to Expiration

There is no reason why hedging should affect number of years until the debt matures, so this variable is independent of hedging and therefore kept constant.

2.4.2.4 *Volatility of Underlying Asset*

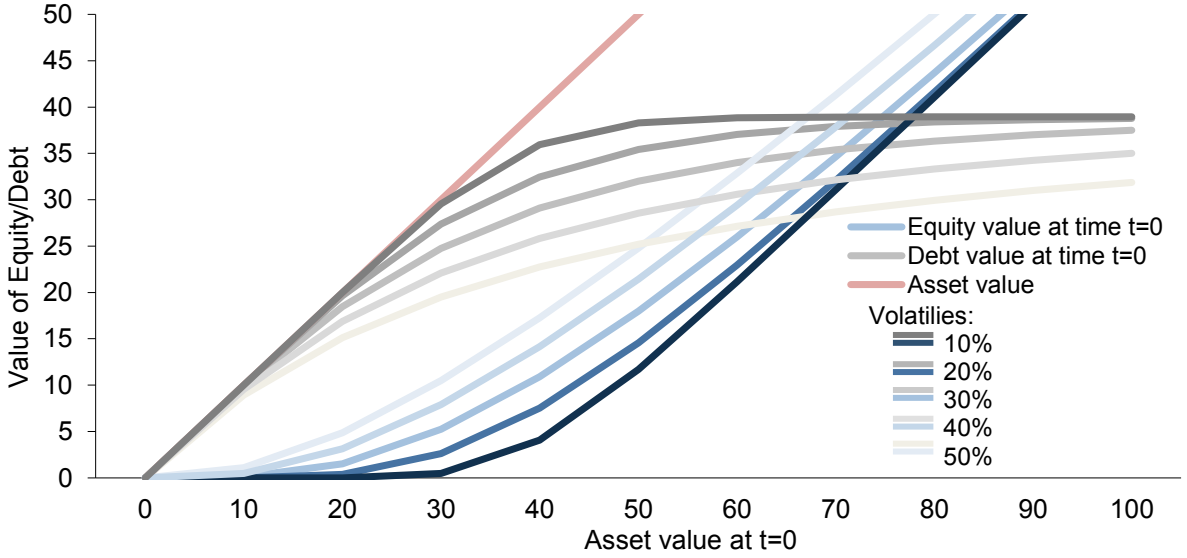
The most obvious purpose of hedging is to reduce cash flow volatility. High cash flow volatility might give rise to problems like high distress costs and low debt capacity. Currency hedges, and other, are used to reduce firm's exposure to currency fluctuations and volatile input or output markets. In this thesis we are mostly focused on the effect from using currency derivatives. However, all sorts of derivatives reducing cash flow volatility are of interest when examining the effects on a theoretical basis using option theory.

At a fundamental level the value of the firm's assets equals the present value of future cash flows generated by the assets[12];

$$Asset\ value = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t}$$

Using the equation above one can conclude that reducing the cash flow volatility will also reduce the asset value volatility. The amount of which the volatility is reduced will vary to a large extent, so finding the proper volatility reduction from a theoretical point of view is impossible. However, it is clear that the volatility will decrease. The chart below to show how a reduction in volatility affects values of debt and equity for different asset values at time t=0. Please note that all other variables are kept constant, even those we know will change from reduced volatility (e.g. debt capacity, distress costs etc.)

Figure 2.4.2.4-1: Effects from changing volatility on equity and debt values



[12] N is the number of years the firm produces cash flow, CF_t is the firm's cash flow in year t, r is the discount rate

From the chart above we can see how the value at time t=0 changes for different asset volatilities. Reducing the volatility does not affect the asset value. However, even if the sum not changes, both debt holders and equity holders are affected from the volatility change. Reducing the volatility will reduce the equity value and increase the debt value. The only effect from the reduced volatility will thus be a shift of values from equity to debt holders.

By looking at the chart above we conclude that the reduction in volatility does not directly add value to the firm. So, the reduced volatility is not, in itself, an incentive to hedge. However, there might be other effects arising from reduced volatility, which increases the asset value. These will be further examined later in this chapter.

2.4.2.5 Current Price of Underlying Asset

Total firm value can be expressed as the value of assets plus the value of tax benefits from debt, less the value of potential default costs and costs of debt issuance (Leland 1998). The current price of the underlying asset is in this occasion the firm value in t=0. As mentioned earlier in this thesis there is multiple ways that this might change from hedging. We will in the following use our numeric example to explain how different factors determining firm value are affected from hedging.

Tax

As discussed in section 2.2.2.1, there might be tax incentives for hedging despite the linear tax function in Norway. The reason is that present value effects actually create a convex tax function. By using the same hypothetical company we estimate the effect of a lower tax rate on losses. The assets of our company are valued at 100 in t=0. Using a WACC of 10%, and growth 2.8%, we estimate the expected future cash flows to be 7.2[13]. As asset values reflect the future cash flows of a firm the asset volatility must be related to the cash flow volatility. In order to estimate cash flow volatility we have used operating income volatility as a proxy and found that this was about 70% higher than asset value volatility in our sample. Hence, cash flow volatility is estimated to be 50%[14] before hedging. Finding a proper reduction in

[13] Assuming depreciation equals capital expenditure. We believe this is a fair assumption as this makes the company able to maintain its current size.
[14] Corresponding to the assumed asset volatility of 30% from table 2.4.1-3.

volatility is hard, but we believe our of 25% volatility post hedging is fair. The variables used in the following are summarized below:

Table 2.4.2.5-1: Variables used in tax computation

Variable	Description	Value
$\boldsymbol{A}$	Asset value at t=0	100
$\boldsymbol{t}$	Tax Rate	0.28
$\boldsymbol{\sigma_{w/o}}$	Volatility of earnings without hedging	50%
$\boldsymbol{\sigma_{w}}$	Volatility of earnings with hedging	25%
$\boldsymbol{WACC}$	Discount rate	10 %
$\boldsymbol{EBT}$	Expected earnings before tax	10

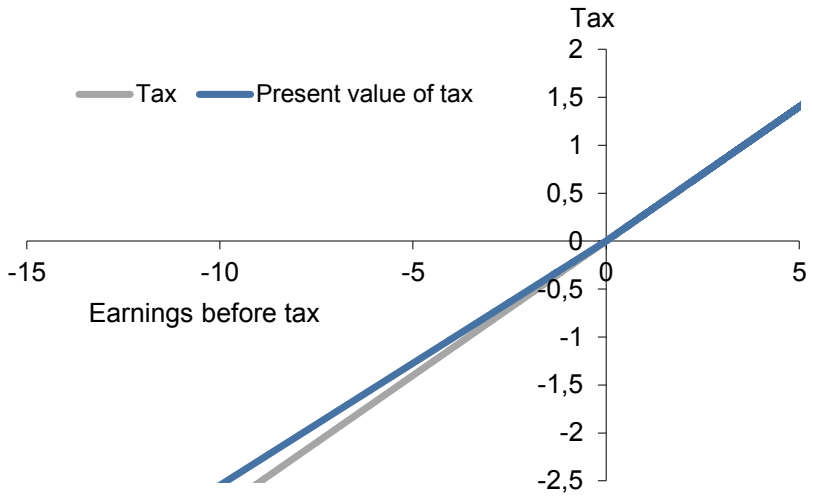
Let's further assume that the hypothetical company is able to deliver positive earnings the year following a loss. This implies that to find the present value of losses one should discount the nominal value one year. This further implies that the tax rate on losses actually is:

$$Tax\ rate\ on\ losses = \frac{Tax\ Rate}{1 + WACC}$$

$$Tax\ rate\ on\ losses = \frac{28\%}{1 + 10\%} = 25.45\%$$

which give rise to the following tax curve:

Figure 2.4.2.5-1: Convex tax curve due to present value effects[15]



Hence there might be a hedging incentive from lower tax payments[16].

[15] Please note that we have zoomed in around zero in order to make the convexity visible.

[16] See section 2.2.2.1 for further explanation

In the following we have assumed that the earnings are normally distributed and used Monte Carlo Simulations on earnings before tax to examine whether tax benefits arise from hedging. We have calculated earnings before tax, and the corresponding tax, for 15 000 simulations. The distribution of tax payments is shown in the chart below. We have also conducted a T-test to test for differences in the two means:

Figure 2.4.2.5-2: Distribution of tax payments[18]

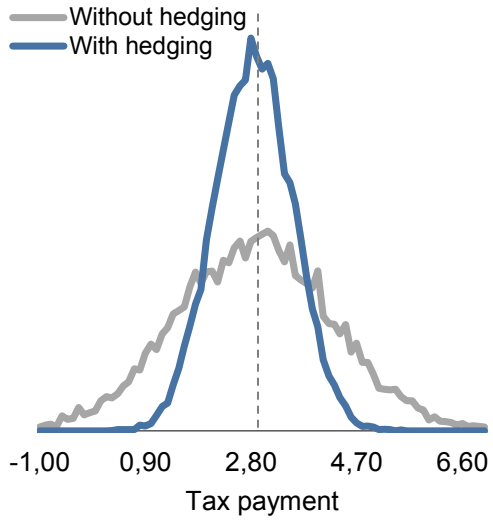


Table 2.4.2.5-2: Two sample T for Tax with and without hedging[17]

Samples	N	Mean	Step
1. Tax without hedging	15000	2.800	1.400
2. Tax with hedging	15000	2.795	0.704

Estimate for difference (1 - 2)	0.0085
95% CI for difference	(-0.0166; 0.0336)

T-test of difference = 0 (vs not = 0):

T-value	0.67
P-value	0.505

From the distribution of tax payments above we see that the amount paid in tax is less volatile after hedging. Further, the test indicates that average tax payment with hedging is smaller than without hedging. However, the results are unfortunately not significant. As theory suggests that tax incentives are present, we believe it is possible to obtain statistically significant results by using higher pre-hedging volatility or a higher WACC. However, we believe our assumptions are fair and conclude that we do not have any indications of Norwegian companies facing tax incentives for hedging.

Distress Costs

Distress costs in relation to hedging have been discussed in section 2.2.2.2. When a firm declares bankruptcy it has to bear both legal and administrative costs from liquidation or

[17] Please see appendix 10.9.1 for explanation on the statistical method
[18] Number of observations on Y axis

reorganization. The expected bankruptcy costs can be expressed as the loss given default multiplied by the probability of default. Hence, our definition of financial distress costs is:

$$Financial\ distess\ costs = loss\ given\ de\square fault * probability\ of\ default$$
$$FDC = LGD * P(D)$$

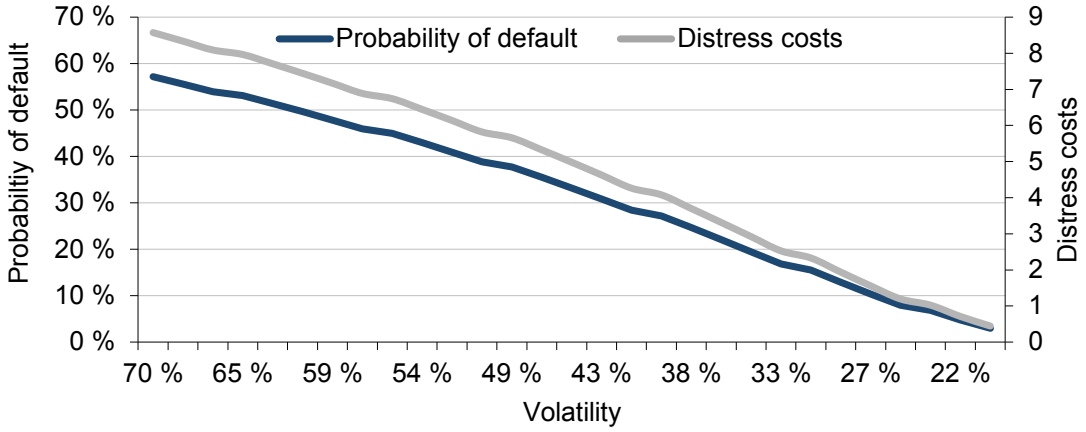
Jakubík and Seidler (2008) define loss given default as the percentage of the debt principal lost from default. In their sample the average LGD over the period 2000 – 2008 is 30%. With our hypothetical firm's debt value of 50 this implies an expected loss given default of 15. This LGD has been used throughout the rest of this section.

The Merton Default Model, introduced 1974, is a way to predict the probability of default. This model is closely related to the Black-Scholes option pricing model. This model is still broadly in use and is the basis for credit risk analyses at the rating agency Moody's. In Merton's model the probability of default is calculated the following way:

$$Prob(A_T < D^* | A_t) = N\left[-\frac{\ln\left(\frac{A_t}{D^*}\right) + \left(r - \delta - {}^1\!/_2\,\sigma^2\right)T}{\sigma\sqrt{T}}\right]$$
$$Prob(A_T < D^* | A_t) = N(-d_1)$$

where D1 is the "distance to default" and measures the number of standard deviations that is required for a shock to induce bankruptcy. Next we calculate the loss given default for our hypothetical company based on the variables used earlier and a set of different volatilities;

Figure 2.4.2.5-3: Probability of default and distress costs[19]



Given the assumptions above we can see that distress costs and probability of default both decrease with volatility reductions. This suggests that hedging reduces financial distress costs and thus increases the firm value. The magnitude depends on how much the hedging can decrease volatility.

As above we assume that volatility is reduced from 50% to 25% through hedging activities. This will reduce the distress cost from 5.82 to 1.19, thus increasing firm value with 4.63. This is quite a substantial amount and could definitely be an incentive to hedge. However, Davies et al. found no evidence that foreign exchange hedging is undertaken to reduce bankruptcy costs. This could either relate to our assumption on reduced volatility being too high, firms operating far away from bankruptcy due to low debt levels or that managers do not pay attention to the bankruptcy costs to a large extent.

Increased Debt Capacity

Because interest expenses are tax deductible many firms find debt a more tax-advantageous way of raising funds. However, not all firms are positioned to raise debt, as lenders are unwilling to lend money to firms with volatile cash flows. The reason is obvious, which we also have indicated earlier, that volatile cash flows reduce the market value of the debt as the risk for default increases with volatility. Since hedging reduces the cash flow volatility it implicitly also increases the debt capacity, as more lenders will be willing to lend out money to the firm after engaging in hedging activities.

[19] See appendix 10.1 for VBA subroutine

Since debt has tax advantages, one could argue that more debt should increase firm value. Hence, increased debt capacity could potentially increase firm value, ceteris paribus. Leland (1998) wrote that when the firm is solvent and profitable, debt coupon payments would shield income from taxes, producing a net cash flow benefit of interest rates times' coupon payment[20]. Hence the cash flow from tax benefits is[21]:

$$CF = t * i * D$$

One can then estimate the value creation from increased debt capacity as a result of hedging by multiplying the tax rate by the increased interest payment. The increased cash flow is then:

$$\text{Increased CF} = t * i * \Delta D$$

We have assumed a debt increase of 30 following the engagement in hedging activities. Further, the firm pays interest rate of 6% and a tax rate of 28%. This gives the following increased cash flow as a result of increased debt capacity:

$$\text{Increased CF} = \Delta CF = t * i * \Delta D = 28\% * 6\% * 30 = 0.504$$

Valuing this at WACC 10% without growth (holding the same absolute debt level in perpetuity), gives an increased asset value of $\frac{\Delta CF}{WACC} = \frac{0.504}{10\%} = 5.04$. This is above 5% of the initial asset value and quite a substantial increase in firm value.

Even though increased debt creates positive value in terms of lower taxes it will also increase the bankruptcy costs. To assess this properly we hold volatility constant at "post-hedging" level and increase D* to 80;

Table 2.4.2.5-3: Increased distress costs following increased debt level

Input		**Output**	
At	100	**Before hedging**	
Volatility	30 %	P(D)	35.57%
T (years)	5	FDC	5.34
D* before	50	**After hedging**	
D* after	80	P(D)	14.22%
r	5 %	FDC	2.13
		Change in FDC	**3.21**

[20] Present value effects as described above in this section are not taken into account. However, these were shown to be almost negligible

[21] where i is the interest rate, t is tax and D is debt principal

We can see from this that, given our assumptions, the tax gain from increased debt capacity is almost offset by the change in financial distress costs from increased leverage.

In order to properly value the effect of increased debt capacity one has to take into account the cost of restructuring the balance. When increasing the leverage from 50% to 80% the firm will need to pay out equity as extraordinary dividend and take on more debt either in the form of bonds or bank loans. This process will undoubtedly induce costs to the firm. However, given the costs presented in section 2.2.23, we believe the process is value creative under our assumptions.

Looking at our sample we find that most firms do not borrow to its debt capacity. This makes the actual gains lower. In our sample the hedgers have a debt to enterprise value of 28.3%, while non-hedgers have 19.1%. If using this difference as the increase in debt one would find that the benefits are close to negligible and hence most likely not a strong incentive to hedge.

2.4.3 Sub-chapter Summary: Does Hedging Add Firm Value From a Theoretical Point of View?

When examining the different firm value determinants possibly affected by hedging we found that A_t, asset value at time t=0, is the only variable that might increase the value of the entire firm. We further looked into the different factors that might change the asset values. The impact of each factor is summarized in the table below:

Table 2.4.3-1: Summary

Variable	Impact
Tax	0, or negligible
Distress costs	4.6
Increased debt capacity	1.8
Total theoretical increase in firm value from hedging	**6.4**

This indicates that hedging is beneficial for firm value under our assumptions. However, there is one important factor that we have not taken into account in the calculations above. Hedging will certainly induce costs to the firm, and these are further discussed in section 2.5.

Our results in this section are strongly dependent upon our assumptions. In this example one could argue that we have used nonrealistic assumptions on debt levels and volatility reduction. Copeland and Joshi (1996) found that volatility does not necessarily decrease from

engaging in hedging activities. Among their sample only 10% of the companies were successful in reducing cash flow volatility more than 10%. Also, based on our sample, debt levels are not likely to increase as much as we have assumed. However, we have chosen our assumptions with the purpose of providing a theoretical framework that indicates value creative effects from hedging. One could argue that these assumptions do not properly reflect the situation Norwegian companies' face. In order to provide an assessment based upon more "realistic" assumptions the rest of the thesis is based on a more practical approach.

2.5 Costs of Hedging

Earlier in this chapter we have addressed the potential benefits arising from hedging, but paid little attention to the cost of obtaining these. As we think of it, the costs of hedging can be split into two determinants; the cost of running a hedging program/strategy and transaction costs.

First of all the running of a hedging strategy/program is likely to induce labor (and/or advisory) costs to the firm. Such costs are hard to estimate on a general basis and we have unfortunately not been able to find any relevant literature on the subject.

The second determinant of hedging costs is the transaction costs. As with the first determinant we have not been able to find any literature on this. However, we know that traditional pricing formulas, as those presented in section 2.1, are used on a spot rate, which is the interbank rate plus a spread. The size of the spread is dependent upon several factors such as size of transaction and client relationships. We have tried, but not been successful in, obtaining the size of these spreads. Such information seems to be confidential and highly dependent on whom the client is. However, if the forward price is calculated on the basis of the spot you would get if exchanging money today, trading in forward markets should not be more expensive than trading in the spot market. Also, another source of transaction cost is the commission paid to the bank for conducting the transaction. This commission is also varying from client to client and highly confidential.

In addition to the costs above one could argue that there is a third source of costs that fall into neither of the two categories. This is the counterparty risk that has shown to be relevant during the recent credit crisis. As forward contracts in most case are settled on maturity date there is a risk that your counterparty might declare bankruptcy and not pay the potential gains you might have had from holding the forward contracts.

Despite the fact that we have not been able to obtain supporting literature we are certain that hedging induce costs to the firm.

2.6 Summary: Theoretical Background

Throughout this chapter we have presented a set of different theories that is of interest when examining currency hedging from a corporate perspective. We believe these theories, and the numerical example; serve well in presenting the theoretical effects and motives of hedging.

As indicated in this chapter one cannot conclude on whether currency hedging increase firm value on the basis of the theories presented. On one hand one could argue that hedging does not add value in perfect markets due to the two following reasons:

- Hedging is a zero-sum game: Hedging does not eliminate risk but rather pass it on to someone else. In perfect markets the price of passing the risk on to someone else should be set so that both parties have net present value zero in the transaction. Hence, it cannot increase firm value.
- Investors' ability to duplicate or eliminate corporations' transactions: In perfect markets, as under the Miller and Modigliani conditions, the investor can do the same transactions as the company at the same cost. Hence, investors can easily obtain the preferred exposure and would not pay a premium for companies engaging in hedging activities.

On the other hand it could be other factors determining firm value that is positively affected from hedging. As shown in section 2.4 hedging might decrease financial distress costs. Also, as written in section 2.2.2.3, agency costs could be reduced from cash flow smoothing. In addition to this, if one believes in absence of the Miller and Modigliani conditions, there are other factors such as tax benefits and increased debt capacity that might contribute positively.

Clearly, theory does not tell with certainty whether hedging is beneficial for firm value. Hence, we are left with an empirical question that we have addressed in chapter 5. The question is thus whether the gains are substantial enough to offset the costs following the engagement in hedging activities.

3 Prior Research on the Subject

Whether currency hedging actually has an influence on firm value has been investigated thoroughly in several international studies, however Norwegian research on the subject is more limited. A study by Norges Bank from 2004 has provided us with great insight on the matter, but other than that, little updated material is available. We will first present international findings and research, before we proceed with studies related to the Norwegian market and our sample.

3.1 International Studies

An important study on our subject is Allayannis and Weston "The Use of Foreign Currency Derivatives and Firm Market Value" (1998). They examined the use of foreign currency derivatives by a sample of 720 large U.S. non-financial firms between 1990 and 1995, and its potential impact on firm value. They concluded with a positive relationship between the value of a firm, and the use of foreign currency derivatives. The average hedging premium was 5.7% of firm value. Thus, according to them, the decision to hedge cash flows with currency derivatives is value increasing. Allayannis and Weston used, as we also will in our empirical analysis, Tobin's Q[22] as a measure of firm value. Furthermore, they concluded that the more multinational a firm is - the higher is this hedging premium.

Allayannis, Lel and Miller (2009) further examined the relationship of currency hedging and firm value in 39 countries. They tested whether the use of foreign currency derivatives was associated with a higher valuation for firms that have strong internal or external corporate governance. They found strong evidence that corporate governance adds value through hedging, and that hedging firms with strong corporate governance is valued at a premium. They further concluded that currency risk management is valuable only if it is also paired with strong corporate governance.

Contrary to what one might consider being intuitive; it has been argued that using financial derivatives will not reduce foreign exchange risk. Among others, Copeland and Joshi (1996), claimed that derivatives do not reduce risk. They examined a sample of 198 companies and used 10 years of data and found that only one of the companies reduced its cash flow volatility

[22] Enterprise value divided by the sum of book values of equity and debt

with more than 20% as a result of hedging activity. Furthermore, only 20 out of the 198 would have reduced the volatility by more than 10%. They presented bold statements such as *sometimes a hedge is totally unnecessary* and *even the most superbly designed and executed programs seem not to reduce cash flow volatility significantly.* Nevertheless, they did not believe that management should simply abandon all hedging measures and let the currency market take control:

> *Hedging individual transactions may not work, but overall foreign exchange exposure at the company cash flow level can and should be managed. But don't look to derivatives for the answer… relocating plants and adjusting pricing often provides the best hedge against foreign exchange risk (Copeland and Joshi, McKinsey Quarterly 1996)*[23]

A more recent study by Hagelin and Pramborg (2002) concluded the opposite; that firms that hedge in fact do have lower exchange rate exposure than firms that do not. They then argue that it follows that firm's hedging activity may increase firm value. Their results could at first look trivial; that a firm's foreign exchange exposure increases with the level of inherent exposure, defined as the gap between revenues and costs denominated in a foreign currency. Hedging transaction exposures reduces risk more effectively than by hedging translation exposure (terms defined in section 2.1).

Pramborg (2003) used survey data from a total of 451 firm years, all listed on Stockholm Stock Exchange and considered by the author to be representative for the Swedish economy. As in Allayannis and Weston (1998), Tobin's Q is considered to be an efficient measure of firm value by Pramborg. His results supported the findings of Allayannis and Weston, but provided additional information as well. It is suggested that geographically diversified firms that hedge are valued at a premium. Whether this is due to hedging activity or geographical diversification is not answered, which the author claimed supports the argument that "firms engaging in international operations could increase profitability and be higher valued since they can exploit market imperfections" (Pramborg 2003).

[23] A definition of different types of foreign exchange risks, and different hedging methods are provided in chapter 2

Clark and Judge (2009) compared the effect on firm value of different hedging strategies. They collected data on type of exposure (long- or short-term) and type of instrument used (forwards, options, swaps or foreign currency debt). First, they found that what type of instrument used depended on what type of exposure the firm faced. Forwards and options are more used to hedge short-term exposure, while foreign currency debt and swaps are mainly used to hedge exposure with a longer term. Furthermore, they concluded that the use of foreign currency derivatives increase firm value in the region of 14%, however there is no hedging premium associated with the use of foreign currency debt, except when this is combined with the use of derivatives. Also, on a general basis, foreign currency swaps tend to generate more value than the short-term derivatives.

Chiang and Lin (2005) had many of the same findings as Clark and Judge four years later, in their study of foreign exposure among Taiwanese firms. Taiwan is a particularly export-focused economy, and thus well suited for an investigation. They found that the use of foreign currency derivatives is very effective, as opposed to the use of foreign debt. This is in line with Clark and Judge, however Chiang and Lin also found that the use of foreign currency debt in fact increase exchange rate exposure. Their studies contradict previous studies in the conclusion that foreign currency derivatives and debt are actually used as complements, rather than substitutes.

While the studies differ in their conclusions on how successful derivatives are in reducing currency exposure, it seems like they agree in that currency hedging adds firm value. Even though they present a wide range of how much it increase value, they all have a positive sign to the coefficient.

3.2 Norwegian Studies

Norges Bank's "Valutasikring i norske selskaper"[24] (2004) has also been of great inspiration to this thesis. We have been given access to their raw material (a sanitised version), where 214 Norwegian companies responded to a questionnaire of their currency risk strategy. The survey showed that around one third of the companies had less than 25% of their revenues and costs denominated in a foreign currency. This indicates a fairly high degree of natural hedging given that costs and revenues are denominated in the same currency. Furthermore, two thirds of companies that regard themselves as exposed to currency fluctuations claimed that they had a small or no share of their fixed assets denominated in foreign currencies. Hence, translation exposure is low, only 16% of the firms stated that they had more than half of their assets exposed to currency fluctuations. Most companies with assets in a foreign currency also had a large portion of their debt in other currencies than NOK. 91% of the sample companies use some kind of currency hedging. They also seem to seek an estimate of their exposure, for example through calculating a Value at Risk estimate.

Norges Bank's study is in line with some of the international ones we have already mentioned; they found that the use of derivatives is mostly used for hedging short-term exposure, and that larger firms are more eager users of currency derivatives. Of the around 9% of the sample firms that do not have any kind of currency hedging, around half state that their exposure is not significant enough to justify the use of hedging, or that they believe their financial situation is sufficiently strong to handle fluctuations in the currency markets.

Descriptive charts on the use of hedging derivatives and exposure among the respondents in Norges Bank's survey has been included below:

[24] English title: "Currency hedging among Norwegian companies"

Chart 3.2-1: Use and purpose of using currency derivatives, share of respondents on Y-axis

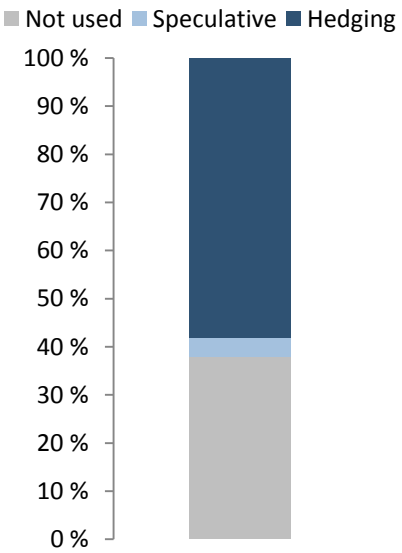


Chart 3.2-2: Revenue and costs in foreign currency, share of respondents on X-axis

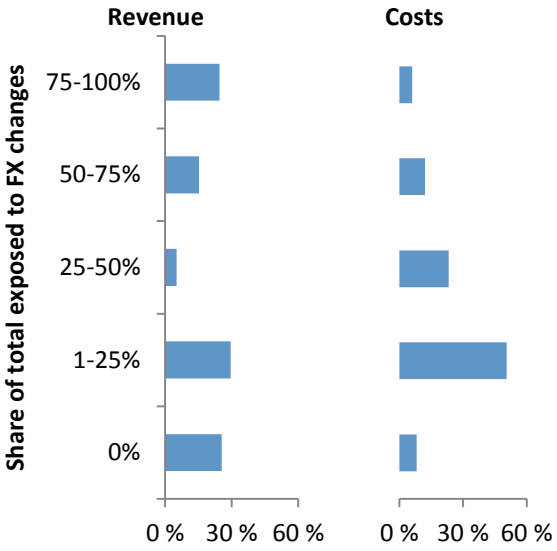


Chart 3.2-3: Balance sheet in foreign currency, share of respondents on X-axis

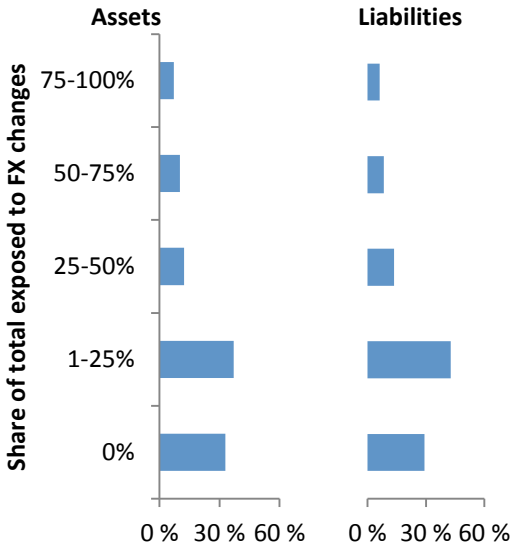
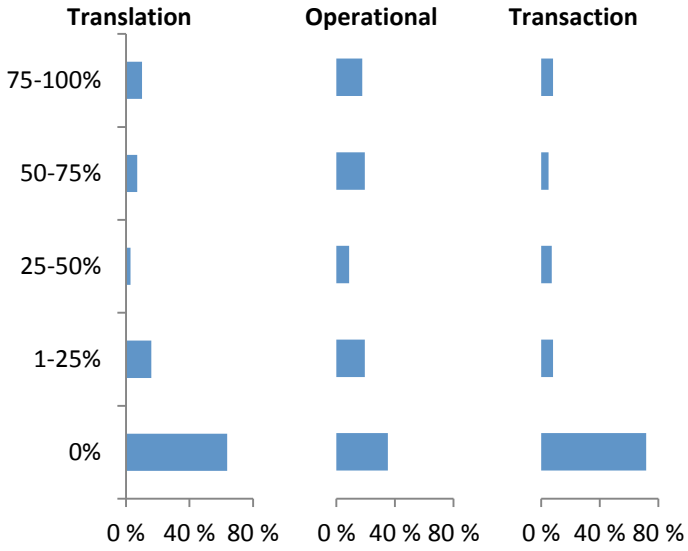


Chart 3.2-4: Fraction of exposure hedged, share of respondents[25] on X-axis



Source: Norges Bank.

The charts above show that almost 60% of the sample companies use currency derivatives for hedging purposes, while on a small fraction, about 4%, use such derivatives for speculative purposes. Also, it seems that a substantial part of both costs and revenue is denominated in

[25] All sorts of hedging (e.g. operational hedging, derivative hedging etc.)

foreign currencies. Further, balance sheet risk seems limited and the respondents seem to care most about the operational exposure.

Davies, Eckberg and Marshall investigated the "Determinants of Norwegian Exporter's Foreign Exchange Risk Management" in 2006. They used the same method as we have chosen for our study, extensive reading of financial reports. They found that 70% of Norwegian exporters hedge foreign exchange risk, and that the larger firms have broader and more extensive hedging strategies than the smaller. Matching costs and revenues and currency forward contracts are the most extensively used hedging techniques. The study sought to uncover firm's motives for foreign exchange hedging, and found evidence for underinvestment-motives[26] and managerial risk aversion. They thereby concluded that there is a relationship between manager's degree of risk aversion and currency hedging activity, and that cash flow stability in order to avoid lack of funds for capital expenditures is an important motive for hedging. Finally, Davies et al. found no evidence that foreign exchange hedging is undertaken to reduce bankruptcy costs or avoid the need for costly external financing. They believe that the ownership structure of Norwegian firms and the institutional features of the Norwegian capital market perhaps could be an explanation to this.

Finally, we would like to mention Eriksen and Wedøe's MSc thesis from Norges Handelshøyskole: "How are the largest non-financial companies in Norway managing their foreign exchange exposure?" (2010). Through a survey distributed to 438 Norwegian companies[27], they sought to discover how Norwegian companies manage their foreign exchange exposure. Among their results was that the main motivation for currency hedging is to reduce cash flow variation, and that short-term derivatives are more common than longer term. Natural hedging is very common, and those companies who only use operational hedging techniques have subsidiaries in more countries than those only using financial derivatives.

We have not been able to find any prior research that empirically examines the value creation, or destruction, from the use of currency derivatives among Norwegian companies. However,

[26] See chapter 2.2.2.3.
[27] With a response rate of 40.2%

prior research indicates that Norwegian companies are significantly exposed to currency fluctuations.

4 Sample Description

We have based our analysis on publicly available material. We considered conducting a questionnaire, and send it to all the companies listed on Oslo Stock Exchange. However, due to time limitations and the uncertainty of what such a questionnaire actually would yield, we decided to gather information from the companies' annual reports. Hedging strategies could be sensitive information, and we believe that many companies would have been reluctant to share their information. Therefore, in order to avoid having data that would have been hard to compare, we opted for this solution.

4.1 Introduction

We began our sample selection process with a list of all the companies on Oslo Stock Exchange. However, to be included in our regression analysis all companies needed to meet the following selection criteria:

1. Financial reports for at least two of the years 2005 - 2009 available
2. Sufficient information available in reports to make a reasonable conclusion of the company's hedging strategy
3. No company could be a subsidiary of another firm in the sample[28]
4. No company should operate in the financial industry
5. Market capitalisation larger than NOK 100 million[29]

We have chosen to exclude all financial firms because we find it hard to compare their derivative use with other companies not belonging to that industry. Financial firms are likely to use derivatives for portfolio hedging and/or speculation, which cannot be compared with the derivative use among non-financial companies. This seems to be the norm in similar analyses we have come across.

This process reduced the number of companies to 63, and a table describing the final sample selection is shown below:

[28] Lerøy Seafood is a separate legal entity, but owned 63% by Austevoll Seafood. We have adjusted for this in Austevoll's figures before conducting our tests.
[29] As of date of retrieval, 27.08.2010

Table 4.1-1: Final sample description

	Number of observations per year				
	2005	2006	2007	2008	2009
Div	3	6	6	6	6
Cyclical Industries	8	8	8	8	8
Shipping	8	9	9	10	10
Oil Service	9	10	12	13	13
Fish Farming	4	6	8	9	9
E&P	5	8	9	10	10
Consumer Goods	7	7	7	7	7
Total	**44**	**54**	**59**	**63**	**63**

As we can see, the industry with the most companies in our sample is oil service, followed by E&P and shipping.

4.2 Data Selection and Gathering

As a measure of firm value we have chosen the Tobin's Q ratio. The ratio was developed by James Tobin in 1969, and is defined as the relationship between the market value of a company, and the book value (i.e. replacement value) of the assets:

$$\textbf{Tobin's Q} = \frac{(\text{Equity Market Value} + \text{Liabilities Book Value})}{(\text{Equity Book Value} + \text{Liabilities Book Value})}$$

If we assume that the market value of liabilities equal its book value, the ratio would be equal to enterprise value divided by book value of total assets. This ratio has been used by many, among them Davies et. al (2006), when they conducted a similar analysis. Market value of equity has been calculated as average market capitalisation throughout the year, while book values have been calculated as average of in- and outgoing values from the annual accounts.

Other key financial ratios, such as leverage, current ratio, Return on Equity (RoE), revenue growth etc., has been extracted using Datastream. A list of all financial figures/ratios that has been extracted is attached in appendix 10.4.

The final, and most important, piece of information needed for our analysis is the companies' hedging strategies. This has been found through extensive reading of annual reports. As the information provided is of various quality and extent, we have been forced to make a few simplifying assumptions. First of all, a firm has been classified as a foreign exchange hedger if it uses any of the following external currency derivatives: swaps, futures, forwards or options, and/or if it has a substantial portion of its debt denominated in a foreign currency. We do admit that to simply classify a firm as a hedger based on these parameters could be misleading and lead to incorrect estimation of the hedging activity of a firm. In order to get a better understanding of the actual hedging activity of a firm, we must take a look at the exposure. A firm that has 90% of its revenues denominated in other currency than NOK is not necessarily an active currency hedger if it possesses a couple of foreign exchange forward contracts. So, for each company we have investigated, we have calculated their currency split of both revenues and assets. Most corporations exhibits this in their annual reports, and if not we have excluded that observation when constructing our model.

We realize that in order to calculate the net operating exposure of a firm, we would also need to find the currency split of costs. We have tried to do this, but quickly realized that our results were too fragile to be of any value. Only a small portion of our sample firms provides this information in their annual accounts. Nevertheless, we do not feel that this poses a threat to our results. Our thesis is not aiming to map the foreign exposure of all firms, but simply to see whether firms that hedges their foreign currency cash flows trade at a premium versus those who do not. Thus, to calculate the exact exposure is not a target in itself. We do believe that a firm that hedges through matching costs with revenues also have other sort of hedging strategies as well. For example, it is unlikely that such a firm would not have a significant portion of its fixed assets located in a foreign country, or a portion of its debt in a foreign currency. In such case the company would be classified as a currency hedger in our analysis, which also is what we are looking to find: does the firm hedge its foreign exchange exposure, or not.

Also, we have tried to identify the total notional amount of outstanding currency derivatives. With the use of this we calculated a ratio seeking to explain to which extent a firm hedges; total notional amount of outstanding currency derivatives divided by total revenue denominated in foreign currency. Unfortunately, a lot of observations are missing this value as many companies do not disclose such information.

4.3 Chapter Summary

Below is a table summarising our data on the use of foreign currency derivatives among Norwegian companies:

Table 4.3-1: Use of foreign currency derivatives among Norwegian companies (2009)[30]

	Div	Cyclical Ind.	Shipping	Oil Service	Fish Farming	E&P	Consumer Goods	Total
Number of companies	6	8	10	13	9	10	7	63
Number of companies using:								
Derivatives Hedging	**5**	**7**	**9**	**10**	**8**	**8**	**7**	**54**
Forwards	5	6	8	9	8	5	6	47
Options	1	2	5	1	0	1	0	10
Swaps	3	3	6	1	0	5	3	21
FC Debt	2	7	6	8	7	6	5	41

Hence, more companies are using derivatives than foreign currency debt. Also, we see that forwards are, by far, the most used derivative in our sample. Of the 63 companies this thesis cover, as many as 54 uses one or more types of derivatives. Forwards are the most widely used with 47 of the companies, while only 10 use options for hedging currency risk.

[30] Please note that companies not disclosing such information was assigned 0 and hence assumed to not use the particular derivative/instrument.

5 Analysis I: "Does Hedging Increase Firm Value?"

5.1 Chapter Introduction

The purpose of this chapter is to try to answer the question about whether hedging is rewarded in terms of higher firm value. In order to test for this we have conducted a multiple linear regression analysis. The chapter begins with a presentation of the basic statistical theory behind the analysis. Later, we will present our constructed model, the results, and an interpretation including a discussion of our results

5.2 Method: Simple and Multiple Regression Analysis

Regression analysis is a tool used to predict the value of one variable on the basis of other variables. The idea is to develop a mathematical equation, which in turn is used to describe the relationship between the dependent variable (the variable to be forecasted) and a set of other variables, believed to be related to the dependent one. A regression line can be written as follows:

$$\mathbf{Y} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \varepsilon$$

where

Y	=	Dependent variable
x_1, x_k	=	Independent variables
β_0	=	y-intercept
β_1, β_k	=	Coefficients of the independent variables
ε	=	Error variable

In other words, β_1 is the change in Y as a result of a one-unit change in x_i. The error variable, ε, represents the part of Y that is not explained by the independent variable(s).

The regression is based on the *least squares method* in order to estimate the parameters β_0 and $\beta_i \cdots \beta_k$. Because these parameters represent the coefficients of a straight line, their estimators are based on drawing a straight line through the sample data, represented by the following equation:

$$\hat{y} = b_0 + b_1x_1 + \ldots + b_nx_n$$

The line shown above is called the *least squares line*, or the *regression line*. In this line b_0 is the y-intercept, b_1 is the slope of the line, and $\hat{y}$ is the predicted value of dependent variable. The least squares method produces a straight line that minimizes the sum of the squared differences between the actual observed values and the predicted line. In other words, the coefficients b_i are calculated so that the sum of squared deviations is minimized.

All variables can normally be split into three different groups of scales. These are *nominal, ordinal, and interval data*. Nominal variables have no natural ranking; for example an industry or a geographic location where one cannot say that Oslo is ranked higher than Bergen, but one can assign a number code for both of them. Ordinal variables can be ranked, but they cannot be compared. These are often used when dealing with questionnaires; one can say that "good" is better than "bad", but not how much better. Interval variables can be ranked, and are equally scaled. Interval data are real numbers, such as heights, distance, income etc.

In this thesis, we use nominal and interval data, in addition to several dichotomous variables, also called dummy variables. These are independent variables given the value 0 or 1, depending on whether a characteristic of that variable is present or not. For example; to see whether the fact that an observation is from the year 2006 affects our dependent variable or not, we would include a dummy called *2006* and assign the value 1 if the observation is from 2006, and 0 otherwise.

Each independent variable is followed by a P-value. If the P-value is sufficiently low we can reject a hypothesis that the relationship (β_i) between the dependent variable y and the independent variable x_i equals zero. We have used a confidence interval of 95%, meaning that we reject the hypothesis that an independent variable does not contribute to the model if the P-value is below 0.05. In such case, we can with 95% confidence say that the variable is significant for the entire population.

Every regression analysis is also followed by a measurement called R-squared, the coefficient of determination. This is a percentage, and explains how much of the variation in *y that can be explained by the variation in x* (Keller 2005). If the population is distributed perfectly along a

linear line, R-squared will be 100%. This coefficient is useful when looking at how well the model fits the data and when comparing different regression analyses.

5.2.1 Regression Diagnostics

As mentioned above, the regression analyses are based on the least squares method. There are a few occasions where this could pose a threat to the validity of the results, and we feel it is necessary to mention the assumptions that the method is based upon. The first set of requirements that need to be met in order for the results to be valid are all related to an analysis of the residuals; *the deviations between the actual data points and the fitted line* (Keller 2005).

1. Residuals should be normally distributed, with an expected average of zero
2. All residuals should have equal variance (homoscedasticity)
3. All residuals should be uncorrelated with each other (no autocorrelation)
4. Are there observations that are inaccurate or do not belong to the target population? Observations that deviate a lot from the rest of the population could reduce the validity of the model, and therefore one should check if they belong to the sample material, and if they do; consider excluding them when constructing the model (Keller 2005).

In addition, as we deal with multiple independent variables, there is one more important matter that always needs to be checked for. Multicollinearity is a condition that exists when the independent variables are correlated with each other. There are two negative implications of this phenomenon. First, due to the fact that the variability of the coefficients is large, the sample coefficient may be far from the actual population parameter. In some cases, we might even find that that the statistic and the parameter have opposite signs. Secondly, when the coefficients are tested, the t-statistic will be small, thus we will conclude that there is no linear relationship between the independent and the dependent variables. In some cases, this will be wrong. To complicate the model even further, multicollinearity can even lead to a result where none of the independent variables seem to be significant, while the R-squared of the model is relatively high, and the F-test (which is testing the variance of the model) is significant. Thus, the model is valid, while none of the independent variables seem to have a linear relationship with the dependent one.

In order to test for multicollinearity in the regression one can examine the correlation structure of the independent variables. A simple way to do this in Minitab is to calculate the variance inflation factors (VIF). This is a measure of how much the variance of an estimated regression coefficient increases given that your independent variables are correlated. VIF=1 implies no multicollinearity, whereas a VIF between 1 and 5 indicates moderately correlated variables. VIFs above 5 indicate that the regression coefficients are poorly estimated and might be useless.

To get around the problem of multicollinearity in regressions one might choose to use one of the two possible solutions:

- Remove highly correlated variables (**one** of them) from the regression model. As these often only supply redundant information the removal will not necessarily result in substantial reduction for R^2.
- Another possibility is to use other types of analyses as Partial Least Squares Regression (PLS) or Principal Components Analysis. Both of these methods reduce the number of independent variables to a smaller set of uncorrelated predictors.

5.3 Model: Regression Analysis I

We have constructed a multiple linear regression model using the statistical software Minitab. The dependent variable is Tobin's Q ratio, and we are examining how a hedging strategy influences this ratio. To avoid multicollinearity, we have used a stepwise regression technique, by removing one and one independent variable, until there is no longer any significant correlation among them. We will now present the independent variables chosen, along with our opinion of how they should affect the dependent variable.

5.3.1 Independent Variables in Regression Analysis I

In the process of developing our model we have defined a set of interval- and dichotomous variables. Below is a description of them, as well as an explanation as to why we have chosen to include them.

Dichotomous variables

Table 5.3.1-1: Hedging instruments

Variable	Interpretation
Hedging	1 if the company uses any sort of currency hedging strategy, 0 if not.
FC Debt	1 if the company uses FC debt, 0 if not.
Swaps	1 if the company uses FC swaps, 0 if not.
Options	1 if the company uses FC options, 0 if not.
Futures	1 if the company uses FC futures, 0 if not.

The reason why we created all these dummy variables listed above, is to see whether one of these strategies could be more favourable than another. For a description of the derivatives, see chapter 2.1.

Table 5.3.1-2: Foreign revenue

Variable	Interpretation
0-25% FR	1 if 0-25% of total revenue is in other than reporting currency, 0 if not.
25-50% FR	1 if 25-50% of total revenue is in other than reporting currency, 0 if not.
50-75% FR	1 if 50-75% of total revenue is in other than reporting currency, 0 if not.
75-100% FR	1 if 75-100% of total revenue is in other than reporting currency, 0 if not.

The dummy variables in the table above are created in order to see whether the hedging strategies may be more efficient if a firm has a larger share of its revenue denominated in a foreign currency, as this could imply a more active management of FX risk. In addition, more

frequent purchasing of financial derivatives might perhaps lead to a better relationship with the investment banks, which in turn could mean both better advice as well as lower costs.

Table 5.3.1-3: Foreign revenue

Variable	Interpretation
2005	1 if the observation is from 2005, 0 if not.
2006	1 if the observation is from 2006, 0 if not.
2007	1 if the observation is from 2007, 0 if not.
2008	1 if the observation is from 2008, 0 if not.
2009	1 if the observation is from 2009, 0 if not.

We have included the year-dummies to isolate the effect time have on firm value. The stock market rose strongly up until 2008, so we believe that Tobin's Q observations from 2006 and 2007 (and 2009) are higher than those from 2008.

Table 5.3.1-4: Industries

Variable	Interpretation
Cyclical Industries	1 if the observation is related to a firm in a cyclical industry, 0 if not.
Shipping	1 if the observation is related to a firm in the shipping industry, 0 if not.
Oil Service	1 if the observation is related to a firm in the oil service industry, 0 if not.
Fish Farming	1 if the observation is related to a firm in the fish farming industry, 0 if not.
E&P	1 if the observation is related to a firm in the oil exploration and production industry, 0 if not.
Consumer Goods	1 if the observation is related to a firm in the consumer goods industry, 0 if not.
Div	1 if the observation is related to any other industry than the ones mentioned above, 0 if not.

The industry-dummies are created in order to isolate any effect that differences in stock market development will have on our observations. For example, the oil price doubled during 2007, and this caused the shares of companies in oil-related industries to rise faster than those of other firms.

Interval variables

We have used several interval variables throughout the work with this thesis. Below is an explanation of each of the interval variables included in our final model.

Derivatives/FR
This variable is created by dividing the notional amount of all outstanding currency derivatives (at year end), by the total amount of foreign currency revenue for that year. A larger fraction would imply a more active hedging strategy.

Current ratio
Current assets divided by current liabilities. Included to isolate any effect that differences in liquidity among firms might have on the Tobin's Q ratio.

Quick ratio
Current assets less inventories, divided by current liabilities. The ratio measures the same as current ratio, the liquidity of a firm; hence we found that these are highly correlated. Quick ratio has therefore been excluded in the stepwise process.

Net debt/EV
Net debt (interest bearing debt less cash and equivalents) divided by enterprise value. A measure of how leveraged a firm is. Included to isolate any effect the type of funding might have on firm value.

YoY revenue growth
Growth in revenues year over year. Included to isolate any effect differences in growth may have on the Tobin's Q ratio.

Tax rate
Tax rate is calculated as the median tax rate over the five-years of observations. This is done as tax rates vary to a large extent in our data. This is probably due effects we cannot extract and hence we have used the median as a proxy for what tax rate the firm face. Tax rate has been used to extract the effect differences in tax rate could have on the Tobin's Q ratio. We believe this is relevant due to the Norwegian tax system where oil E&P companies (who make up a significant fraction of our sample) face a marginal tax rate of 78%.

logAvgMC - mean
This variable is calculated by first taking the average market capitalisation of a firm during a year. Second we calculate the natural logarithm of that number, and subtract the mean natural logarithm of all observations. We used the natural logarithms because this makes it easier to see a clear linear relationship between Tobin's Q ratio and the market capitalisation (dependent and independent variable), and thus not violate the assumptions behind our model and the least squares method. The reason why we subtract the mean of all observations

is simply to divide our sample into two categories: "larger than average" and "smaller than average". We use mean of all averages rather than mean of each industry, as we want to control for differences across all industries on Oslo Stock Exchange.

ROE% - mean

Return on equity is defined as net income divided by market capitalisation at beginning of the year. We subtract the mean of all ROE-observations for the same reasons as above; establishing two categories where one group outperform the other on ROE-margin.

5.4 Results: Regression Analysis I

Conducting a manual stepwise regression analysis left the following model:

Table 5.4-1: Regression I: "Does hedging increase firm value?"

Independent variables	Coeff	SE Coef	P-value	VIF
YoY Revenue Growth	-0.019	0.009	0.030	1.220
Current Ratio	0.262	0.048	0.000	1.277
log Average market cap - mean	0.113	0.037	0.003	1.360
Tax Rate	-0.755	0.281	0.008	1.397
Dummy-variables				
Hedging	-0.474	0.1577	0.003	1.299
Industry				
Cyclical Industries	-0.537	0.224	0.017	2.461
Fish Farming	-0.543	0.233	0.021	2.340
E&P	-0,436	0.226	0.055	2.251
Consumer Goods	-0.374	0.231	0.107	2.357
Shipping	-0.855	0.236	0.000	2.849
Oil Service	0.134	0.218	0.538	2.840
Year variables				
2006	0.404	0.176	0.022	1.817
2007	0.596	0.174	0.001	1.925
2008	0.141	0.174	0.417	1.962
2009	-0.177	0.175	0.312	1.951
Constant	1.499	0.264	0.000	
N	260			
R-squared	0.35			
P-value of analysis of variance	0.00			

Firstly, as our focus is on whether hedging increases firm value (Tobin's Q ratio) or not, it is interesting to see that our model shows that it does not. The dummy variable indicating whether a firm hedges or not has a negative coefficient (-0.474), and is significant on a 99% confidence interval. Secondly, all the hedging strategy dummies have been excluded in the stepwise regression process, as they had no statistical significance what so ever. They were

also highly correlated, as it is common to use more than one hedging instrument. Furthermore, they were naturally closely correlated to the hedging-dummy, and therefore removing them does not pose a threat to our model, but instead increasing its robustness due to reduced multicollinearity. We tried running the model without the *Hedging*-dummy, but keeping all the different instrument-dummies, but these remained not significant.

Further, it is also interesting to see that the dummy-variables indicating how large percentage of total revenues that are denominated in other currencies than the reporting currency are removed. They had no statistical significance, and we can assume that firm value is not affected by the geographic origin of revenue streams.

The independent variable we created that measured to which extent a firm hedge, *Derivative/Foreign Revenue,* has also been removed due to lack of significance. It seems that what portion of the foreign revenue that is hedged has no influence on firm value.

Our thesis does not aim to answer what factors that determine firm value. Hence, we do not find it necessary to discuss the other independent variables in our model thoroughly. They are simply included to extract other effects not related to cash flow hedging. Nevertheless, we observe that more liquid firms (higher current ratio), and also large firms tend to have a higher Tobin's Q ratio. On the other side, a higher tax rate is clearly negative; while high revenue growth also seems to have a marginal negative impact on Tobin's Q. Leverage seems to have no influence on firm value, in line with Miller and Modigliani's theory. Hence, the *Net Debt/EV*-variable has been removed during the regression process. More surprisingly perhaps, *ROE%* has also been removed. It appears that differences in return on equity have no impact on the Tobin's Q ratio, which in our opinion is a bit surprising. However, this effect is perhaps captured by the different industry dummies, as the return over the period deviates significantly. We stress though, that it is not the purpose of this thesis to investigate this further.

From the industry-dummies, the *Div*-variable has been removed due to perfect correlation as the other industry dummies are interpreted relatively to the observations with this characteristic (firms classified in the *Div. category)*. We can see that they all have negative coefficients, except for *Oil Service*, which is not statistically significant. From the year-

dummies, we learn that all the years except for 2009 have positive coefficients, relative to *2005*, which has been removed. We know that the stock market experienced strong growth up until mid 2008, when the financial crisis struck the economy.

5.4.1 Validity of Regression Model I

The MINITAB-print is included in the appendix 10.6.1. Through our stepwise regression process we have excluded a lot of variables, and those that end up constituting our model are not very correlated. The variance inflation factors (VIF) are all well below 5. Except for the industry variables, all independent variables have VIFs below 2. Not surprisingly, there is a moderate degree of multicollinearity between the industry variables. However, based on the VIF tests, we do not believe this reduces the validity of our results.

Another assumption behind linear regression is related to the plot of residuals, which are supposed to follow the normal distribution with an expected average of zero. These plots are shown in the appendix 10.6.2. Even though these not seem completely perfect we believe they indicate a satisfying degree of normality.

5.5 Conclusions: Regression Analysis I

We wanted to see whether hedging activity would increase firm value; the latter measured using the Tobin's Q ratio. We must conclude with the opposite, that firm value in fact seems to decrease when a firm hedge its foreign currency cash flows. In fact, when looking at the estimated coefficient for the *Hedging*-variable at -0.474, we believe our results are somewhat surprising. The average Tobin's Q observation from our sample is 1.18, which means that those who hedge will have a 40% lower Tobin's Q, *ceteris paribus*. We believe that this is a lot, and certainly more than expected. However, looking at the other variables does smooth the picture somewhat. We see that larger firms have a significantly higher Tobin's Q than smaller. Adjusting for the fact that there is a correlation between larger firms and the tendency to hedge reduces some of the negative effect of hedging. We have tried creating a variable containing both larger firms and hedging, but this does not improve our model. Similarly we wanted to see whether hedging was favourable in 2008, when the currency market was extremely volatile and the NOK depreciated substantially. This was done through creating a dichotomous variable with value 1 if the observation was *both* of a company that hedge, and from 2008. However, we did not get any significant results from this either.

We have conducted several variants of this regression analysis. We have tried excluding all but one industry, to see whether there are any internal differences. Only one industry points itself out, namely the *oil service* industry. When only including the sample observations belonging to this industry, the *hedging*-coefficients becomes significantly more negative, which means that firms in the oil service industry who are hedging their cash flows underperform those who do not. Similarly, we have tried testing for only one year at the time, and we find that the hedging coefficient is significantly more negative for the observations from 2007. We suspect that both this, and the fact that oil service companies are punished when hedging their cash flow, is related to the price of crude oil, which doubled during 2007. When running the regression model of a sample consisting of only oil service companies, and only observations from 2007, we get the most significant negative *Hedging*-coefficient. We believe that a possible explanation for this would be that risk averse oil service companies would have a tendency to enter into longer contract engagements. When the crude oil price doubles over a year, the revenues of the companies in the oil service industry will also increase, as the rates probably increase Companies that are already tied up in long term

contracts will not benefit as much as those with most of their equipment available in the spot market. We assume that there is correlation between the tendency to enter long contract engagements, and the tendency to hedge against fluctuating currency rates. This could possibly be an explanation for our findings.

When looking at the different variables that were excluded from the model due to lack of significance, we see that the different types of derivatives have no impact on firm value. Thus, we cannot conclude that any derivative is more value creating (or destructive) than others.

In the summary of chapter 2 we asked the question of whether the benefits from hedging are substantial enough to offset the costs. Based on the analysis provided in this chapter our answer is no. As the coefficient is negative, hedging seems to be value destructive, which means that the costs of hedging offset the benefits.

5.5.1 Regression I Results Compared With Economic Theory

In chapter 2, we presented classic economic theory related to whether a company should reduce its cash flow variance through the use of hedging measures. Both the traditional Modigliani and Miller view, as well as modern portfolio theory was discussed. We concluded that the theoretical point of view was that hedging could not add any value to the firm, as the investor himself could diversify his portfolio. This should imply a *Hedging*-coefficient of zero. However, our analysis concludes that hedging in fact reduces firm value. One could perhaps assume that this is due to transaction costs, net of taxes. However, if we accept that conclusion, then we should also find that the more derivatives a firm uses, the more this should reduce firm value. And this is not a result of our model. Hence, we believe we can exclude the transaction costs as the sole reason to why hedging seems to reduce firm value. Consequently, we feel that our results do not reflect economic theory. In chapter 2 we discussed several market frictions that violate the assumptions behind the traditional economic theory, but all of these should actually make hedging favourable to the firm, and not decrease its value.

5.5.2 Regression I Results Compared With Other Studies

Our results are not in line with what previous research has found. Allyannis and Weston found a hedging premium of 5.7% on average, which is completely the opposite of what we

find. Furthermore, Pramborg (2003) also concluded that firms that hedge have a higher Tobin's Q ratio.

We believe that a possible explanation to the deviations of our results could relate to our sample. We have selected data from 2005 up until year-end 2009. Stock prices increased rapidly up until mid 2008, and as we have used average market capitalisation throughout the year, and not the market capitalisation at December 31st, the only time we have a decrease in market cap is from 2008 to 2009. We believe this could influence the results, that those firms who hedge have grown less rapidly, and that during our period this actually causes hedging to affect firm value negatively.

6 Analysis II: "What Characterizes a Firm That Hedge?"

6.1 Chapter Introduction

The purpose of this chapter is to investigate whether there are any characteristics that make one firm more likely to hedge than another. In order to do so, we have conducted a binary logistic regression analysis. Again, we will begin by presenting the basic statistical theory behind the model, before presenting the results we obtain and a short discussion on those towards the end of the chapter.

6.2 Method: Logistic Regression Analysis

One of the requirements of linear regression is that the dependent variable must be interval data. When the dependent variable is nominal, we use logistic regression (Keller 2005). We wanted to see whether any characteristics could make a company more likely to hedge against currency fluctuations. Logistic regression is used to estimate the probability that a particular outcome will occur, and is thus ideal for such a task. The statistical technique behind logistic regression is called *maximum likelihood estimation*, and below is a presentation of how we can use this tool for our purpose.

The dependent variable in logistic regression is known as the *odds ratio*, and described as follows:

$$\text{Odds ratio} = \frac{\text{Probability of event}}{1 - \text{Probability of event}}$$

One can see that this can be rewritten so that we obtain the probability of an event to occur:

$$\text{Probability} = \frac{\text{Odds ratio}}{\text{Odds ratio} + 1}$$

Other than this, logistic regression is similar to linear regression, with the following equation being estimated:

$$\ln(\hat{y}) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \varepsilon$$

with the following interpretation of the variables

Table 6.2-1: Logistic regression variables

Variables	Description
$\hat{y}$	Odds ratio
ln(y)	Natural logarithm of the odds ratio
x_1, x_k	Independent variables
β_0, β_k	Coefficients of the independent variables
ε	Error variable

From this, we see that the estimated odds ratio of the regression can be calculated from $\ln(\hat{y})$, so that

$$\hat{y} = e^{\ln(\hat{y})}$$

Hence, the estimated probability of the event when taking all independent variables into account can be written as

$$\text{Estimated probability of event} = \frac{\hat{y}}{\hat{y}+1}$$

On a general basis, it is easy to see that when a coefficient is positive, it will contribute positively to the probability of an event.

We will not discuss the theory behind logistic regression any further, mainly due to the fact that we will not be using the results for prediction purposes. Our interest lies in the coefficients of the independent variables; it suffices to know that the higher this coefficient is the more likely is an observation with that variable's characteristic to also fit the description of the dependent variable (Keller 2005).

6.3 Model: Regression Analysis II

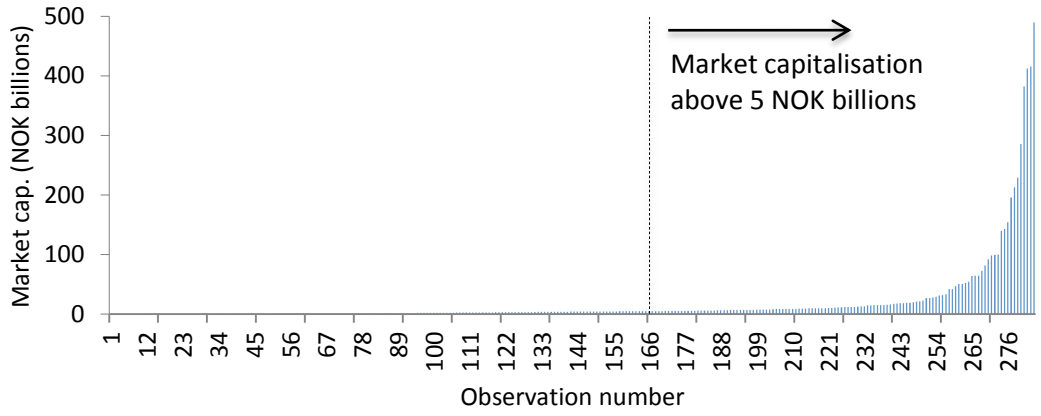
We have a set of interval- and dichotomous variables used to develop our model. The dependent variable is the *Hedging*-dummy, where the value 1 is assigned to an observation where the company uses any sort of hedging measure. As many of the variables were included in Regression I, and thus presented in section 5.3, we will only list the ones who are exclusive to this second analysis.

Dichotomous variables

MC>5mrd

We have encoded most of the independent variables from the previous regression model into either dummy-variables, or a continuous target variable in the 0 to 1 range, representing either a probability value or a proportion. This simplifies the interpretation of the model, and increases its stability (Keller 2005). Therefore we have replaced the *logAvgMC - mean* variable from the previous analysis, with a dummy with value 1 if the market capitalisation is above 5 billion NOK, and 0 if not. The graph below shows the market capitalisation distribution for 260 observations. The average is 19.5 NOK billion, while the median is 4.2. We have settled on 5 billion as a threshold;

Figure 6.3-1: Market capitalisation, plot of observations



FR50%+

We have classified the observations in two categories regarding foreign currency revenues. If an observation is related to a company with more than 50% of its revenue in other than the reporting currency, this variable is assigned the value 1, and 0 if not.

Continuous variables

Ownership

From our theoretical discussion, we have learned that the shareholder might as well diversify his own portfolio, rather than see the companies he invests in try to reduce the cash flow variance. We want to see whether differences in ownership structure affect the probability of hedging, and have therefore created an ownership variable denoting the number of shareholders holding more than 5% of the company. This will give us an idea of the degree of diversification the shareholders of the company have. We believe that the higher number of owners that hold more than five 5%, the less likely will the firm be to hedge. This is simply due to our assumption that the higher number of large owners, the smaller share will each large owner have, and therefore probably be more diversified on his own.

6.4 Results: Regression Analysis II

Conducting a logistic regression analysis gives the following results:

Table 6.4-1: Regression II "What characteristics make a firm more likely to hedge?"

Independent variables	Coeff	P-value	Odds Ratio
MC>5mrd	1.677	0.010	5.35
Tax Rate	0.064	0.000	1.07
Net debt/EV	0.021	0.003	1.02
Ownership	-0.447	0.045	0.64
Dummy-variables			
FR50%+	2.679	0.017	14.58
Industry			
Cyclical Industries	1.876	0.178	6.53
Fish Farming	20.291	0.997	6.49E+08
E&P	0.161	0.905	3.34
Consumer Goods	3.103	0.042	22.26
Shipping	3.164	0.032	23.66
Oil Service	1.884	0.157	6.58
Year variables			
2006	1.007	0.185	2.74
2007	1.083	0.152	2.95
2008	2.113	0.022	8.27
2009	1.790	0.033	5.99
Constant	-2.143	0.179	
N	238		
Log-Likelihood	-54.469		
P-value test that all slopes are zero	0.00		

Again, we are more interested in the way the different variables contribute to whether a firm hedges or not, rather than the exact probabilities.

From our analysis we can clearly see that larger firms (those with market cap above NOK 5bn) are more likely to hedge than those below. Furthermore, it does not come as a surprise that

those companies with a larger share of their revenue denominated in a foreign currency are more likely to use foreign exchange derivatives. We can also see a slight tendency that those with higher tax rate and leverage are more likely to hedge. It is also interesting to see that firms with more large owners are less likely to hedge. This is also the only variable that reduces the probability that a firm hedges.

Looking at the industry-variables, which are all presented as relative to the *Div*-variable, we can conclude that shipping and consumer goods firms are more likely to hedge than other. Their coefficients are significant on a 5% significance level, while no of the other industry-dummies are near significant on even a 10% level.

The year-variables are not even significant on a 10% significance level. However, we can see a slight tendency that an observation from 2008 and 2009 is more likely to be hedging than earlier observations[31].

[31] All the year-dummies are relative to 2005

6.5 Conclusions: Regression Analysis II

We have used a logistic regression model to check whether any firm characteristics could make a company more likely to hedge their foreign currency cash flows. The dependent variable is a dichotomous variable with value either 1 or 0, depending on whether an observation is of a hedger or not.

We find that observations from 2008 and 2009 are more likely to be of firms that hedge, and this is in line with what we would have predicted. The derivatives market has grown explosively over our sample period, and more firms have begun to take measures against currency fluctuations. Looking at the different industries, only shipping and consumer goods companies have a significant positive coefficient. To observe that consumer goods companies hedge, is not very surprising. Companies like Rieber & Son and Orkla have production facilities and sales in a broad range of currencies. Shipping companies however, is more surprising, as this is an industry where the dollar is dominating as functional currency, and therefore currency fluctuations should not pose too great a threat to the operations. We suspect that this finding is due to substantial use of dollar denominated debt in the Norwegian companies, or the use of forward contracts when engaging in shipbuilding contracts with yards in Korea or China.

It does not come as a huge surprise that the higher share of total revenue a company has in foreign currency, the more likely is it to hedge. Furthermore, the larger firms are also more likely to be hedging, and this is also as expected. Larger firms will often have separate risk management departments and possibly more purchasing power against investment banks. Hence, there seems to be economies of scale in currency hedging that can explain the fact that large firms hedge more. A higher tax rate equals a higher probability of currency hedging, and this is natural, as a high tax rate would also mean a higher tax refund from the extra cost. Higher leverage increases probability of hedging, and this is in line with economic theory, which we will discuss in a moment.

Finally, we also observe that a higher number of large shareholders reduce the probability of the firm being a hedger. We believe that this enables us to conclude that more diversified investors will be less interested in companies that take currency hedging measures. This

demands of course, that we accept our assumption that a low number of large shareholders would suggest that a greater proportion of their wealth is invested in that firm.

It is also interesting to observe the variables that are excluded from our model as they are of no significance. Liquidity ratios, return on equity and revenue growth have no influence on the likelihood of being a hedger. Nor does the Tobin's Q ratio, and we believe that this strengthen our results from Regression I. This is because it enables us to conclude that Tobin's Q ratio does not influence hedging decisions, but those firms who choose to hedge have a higher ratio than those who do not.

6.5.1 Regression II: Results Compared With Economic Theory

We believe that this regression analysis is much more in line with what one could expect having economic theory in mind. Higher levered firms are more likely to hedge. Higher leverage equals higher probability of default, and using hedging to reduce cash flow volatility is therefore appropriate. Higher tax rate also means higher tax shield, thus it is logical that this variable increases the probability of hedging. These factors are also discussed, on a theoretical basis, in section 2.2.2.1.

We also saw that if the shareholders are more diversified, the firm is less likely to hedge. This is also in line with Modigliani and Miller theory, that the investor himself should diversify his portfolio. When there are only one or two large owners, these will often be very exposed to that single firm and the industry it operates in. Consequently, the owner will prefer that the management reduce its cash flow volatility and risk through hedging. In addition, many smaller Norwegian companies are family owned, with the family-members being present in both management and board of directors. Hence, they have great influence to decide upon strategic and operational matters.

Both the Tobin's Q ratio and return on equity have no significant influence on the probability of whether a firm hedges or not. This supports the Miller and Modigliani/Modern portfolio theory idea that variance reduction and unsystematic risk has no influence on shareholder value, but is unfortunately in breach with our results from regression I.

6.5.2 Regression II Results Compared With Other Studies

Davies et al. conducted a similar study in 2006, looking at what factors determined Norwegian exporters hedging strategy. Their findings are similar to ours on many accounts. Higher taxes increase probability, as does fewer large shareholders. Higher market capitalisation is also contributing positively to the likelihood of being a foreign exchange hedger, as well as higher leverage. The more foreign revenues a firm has, the more will it hedge, and this is also in line with our findings. However, Davies et al. also suggested that higher current ratio implies a more active hedger, which we cannot indicate from our model.

Hagelin (2003) had the same conclusions as both Davies et al., and ourselves, and we conclude that our model supports previous research. Our sample material, however, is more extensive than both Davies et al. and Hagelin, which were based and observations from a single year, 2001 and 1996 respectively.

7 Analysis III: "Does Hedging Reduce Currency Exposure?"

7.1 Chapter Introduction

We have conducted an analysis that seeks to answer whether hedging actually reduces the exposure to currency fluctuations. This is done by examining the sensitivity in firm value to changes in the Norwegian Krona. For simplicity we have chosen to use Norges Bank's Trade Weighted Index (TWI) as a proxy for the development in the Norwegian Krona (NOK). Please see section 1.4.3 for further explanation of this index.

Opposed to what we have done earlier in the thesis we use equity value, and not Tobin's Q, to measure value creation in the companies. Hence, we are examining the relationship between share price developments and changes in the value of NOK. As written earlier in this thesis many Norwegian companies are highly exposed to fluctuations in exchange rates as they have both cash flows and assets/liabilities in foreign currencies. From this follows that the value of the firm, here measured by the equity value, will change as NOK appreciates or depreciates. The analyses presented throughout this chapter will look closer into whether the value of the companies that hedge is less sensitive to changes in NOK.

7.2 Method: Analysis of Variance (ANOVA)

ANOVA is a procedure that tests whether the mean of two or more populations differ. The name of the test is derived from the way the calculations are performed as it analyses the variance in the two. For each of the populations one draw an independent sample and calculate the means, $\bar{x}_j$, and variances, s_j. The corresponding mean and variance of the populations is then μ_j and σ^2_j. The test then determines whether there is sufficient statistical evidence to reject the null hypothesis. Consequently, one will always have the two following hypotheses:

$$H_0 = \text{The means of the populations tested are equal}$$

$$H_0 = \mu_1 + \mu_2 + \ldots\ldots + \mu_j$$

$$H_1 = \text{At least two of the tested means differ}$$

To calculate the test statistics one will first need to measure the proximity of the sample means to each other. This is called the sum of squares for treatments, denoted SST:

$$\mathrm{SST} = \sum_{j=1}^{k} \mathrm{n_j}\,(\bar{x}_\mathrm{j} - \bar{\bar{\mathrm{x}}})^2$$

Where $\bar{\bar{\mathrm{x}}}$ is the mean of all observations across samples. If large differences exist between the sample means, at least some of the means deviates considerably from the mean of all observations, producing a high value of SST. So the question is then how high this value must be in order to reject the null hypothesis. In order to address this one use the within-treatments variation, the sum of squares for error (SSE);

$$\mathrm{SSE} = \sum_{i=1}^{n_1}(\mathrm{x_{i1}} - \bar{\mathrm{x}}_1)^2 + \sum_{i=1}^{n_2}(\mathrm{x_{i2}} - \bar{\mathrm{x}}_2)^2 + \cdots + \sum_{i=1}^{n_i}(\mathrm{x_{ik}} - \bar{\mathrm{x}}_\mathrm{k})^2$$

$$\mathrm{SSE} = \sum_{\mathrm{j=1}}^{\mathrm{k}} \sum_{\mathrm{i=1}}^{\mathrm{n_j}} (\mathrm{x_{ij}} - \bar{\mathrm{x}}_\mathrm{j})^2$$

where k is the number of samples and i is the number of observations within each sample. Hence, SSE is a measure of the total variation within all samples. Next we compute the mean squares in order to able to calculate the test statistics;

$$\mathrm{MST} = \frac{\mathrm{SST}}{\mathrm{k}-1}$$

$$\mathrm{MSE} = \frac{\mathrm{SSE}}{\mathrm{n}-\mathrm{k}}$$

where n is the total sample size. Finally, we are able to compute the test statistic;

$$\mathrm{F} = \frac{\mathrm{MST}}{\mathrm{MSE}}$$

F is distributed with k-1 and n-k degrees of freedom given that the response variable tested is normally distributed. Hence, if the following inequality holds one can reject the null hypothesis.

$$\mathrm{F} > \mathrm{F}_{\alpha,\mathrm{k}-1,\mathrm{n}-\mathrm{k}}$$

Where α is the significance level with the corresponding confidence interval 1- α.

7.3 Model: Analysis III

The first and most obvious factor that affects the stock price of a single company is the market return. In the theoretical discussion in section 2.2.1.2 we have provided the CAPM equation. This can be regarded as a regression equation risk free rate is the constant and β_i is the regression coefficient to the independent variable market return. As a particular company's share performance is closely related to the market, and the market return is correlated to TWI, we have chosen to use only the error variable one gets from doing a regression on TWI with OSEBX return as the independent variable. Hence, we did the following regression:

$$TWIreturn = Constant + OSEBXreturn * \beta_1 + \epsilon(TWI)$$

As ϵ(TWI) is the error variable in the regression equitation above it is completely uncorrelated to OSEBXreturn. Hence, ϵ(TWI) captures all variability in TWI that is not explained by the market. Even though this equation seeks to explain TWIreturn with OSEBXreturn we believe the relationship is more the other way around; changes in TWI affect the market return. However, the equation still serves well for our purpose; to calculate the TWI variability that is not correlated with the market return.

Table 7.3-1: Regression III "Does hedging reduce currency exposure?"

Independent variables	Coeff	SE Coef	P-value
OSEBX return	-0.053201	0.00658	0.000
Constant	0.000006	0.00057	0.810
N	1455		
R-squared	0.043		
P-value of analysis of variance	0.000		

Despite the low R-squared we note that the P-value of the coefficient is below the 5 percent alpha used throughout the thesis and thus statistically significant. Next we use the regression equation to calculate a series of error variables. This series has the following characteristics:

Table 7.3-2: Descriptive statistics of ϵ(TWI)

N	Mean	SE Mean	St Dev	Min	Median	Max
1455	0.0000	0.000122	0.004666	-0.039636	-0.000041	0.026067

As expected the mean is zero as the series is the residuals from the linear regression line. Further, the plot and normality test in appendix 10.8.3 shows little or no skewness and normally distributed residuals, which ensures validity of the tests conducted below.

Dumas (1978) and Adler and Dumas (1984) both defined foreign exchange exposure as the sensitivity in firm value from changes in exchange rate. Jorion (1990) developed this further and created a model based on market return and foreign exchange changes:

$$Return_i = Constant + \ MARKETreturn * \beta_{i1} + FXreturn * \beta_{i2} + \epsilon(Return_i)$$

where FXreturn is the change in the domestic currency, which in this thesis relates to TWI.

Griffin and Stulz (2001) argued that the inclusion of a market return represents the case where the market explicitly induces changes in foreign exchange rates. Our view on this is the other way around, namely that changes in foreign exchange rates determines market returns. If so, Hagelin and Pramborg (2002) argued that the market index should not be included. We disagree with their view and have developed a model that deals with both market return and foreign exchange changes in what we believe is a proper manner.

The major shortcoming to the model above is that changes in exchange rates affect the market as a whole which leads to a statistically significant correlation (-0,207) between FXreturn and MARKETreturn. This creates some degree of multicollinearity which might give coefficients that is hard to interpret. In order to adjust for this effect we seek to only examine sensitivity to the exchange rate changes that do not affect the market as a whole.

Consequently, we develop a model that includes this as well as the market return. The variable MARKETreturn is included in order to capture the systematic risk assigned to the companies. In CAPM, explained in section 2.2.1.2, all unsystematic risk is captured by the error variable. We believe that the currency fluctuation that not directly affects market return, ϵ(TWI), is part of the unsystematic risk. Hence, we incorporate the time series ϵ(TWI), described above, as the second factor in our model. The model used in this analysis is thus[32];

[32] $Return_i$ is the daily return in a particular share, $MARKETreturn$ is the OSEBX return.

$$Return_i = Constant + MARKETreturn * \beta_{i1} + \epsilon(TWI) * \beta_{i2} + \epsilon(Return_i)$$

where i denotes the particular share. For our analysis the variable of interest in this equation is β_{i2}. This is a measure of how sensitive a company is to fluctuations in exchange rates that do not affect the market as a whole. In order to test whether those who hedge are less sensitive we conducted one regression for each company covered in the thesis. The results are provided in the table in appendix 0.

Our analyses are based on daily returns. As prior research by Guay (1999), Wong (2000) and Allayannis and Ofek (2001) we first conducted the analysis using monthly returns. However, our belief is that the changes in foreign exchange rates with market influence materialize immediately, and hence daily returns should be used in order to adjust for these effects properly.

After calculating the betas we need to adjust these for leverage in order to make them comparable. Hence, to test for whether the sensitivities differ among hedgers and non-hedgers we first calculate the asset betas using the following formula;

$$\beta_{Asset} = \frac{\beta_{i2}}{1 + (1 - tax\ rate)\left(\frac{Debt}{Equity}\right)}$$

and next calculate the absolute value of these in order to be able to compare companies with opposite exposures to exchange rates (i.e. exporters and importers).

7.4 Results: Analysis III

We will in the following present three ANOVA tests that examine whether the currency exposure differs between hedgers and non-hedgers, as well as between the different types of derivatives.

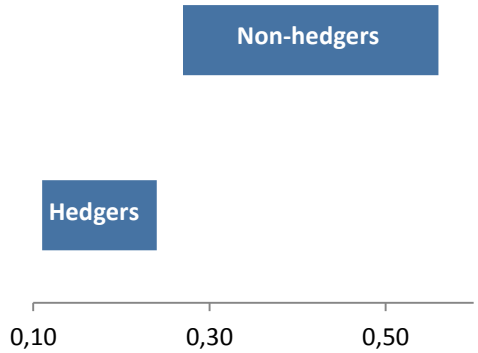
First we assign 1 to the companies that hedge more than half of the period, and 0 to others. We then test for whether these two groups have different exposure to currency fluctuations:

Table 7.4-1: Oneway ANOVA, β_{Asset} vs. Hedging

Level	N	Mean	StDev
0	10	0.4114	0.4585
1	54	0.1662	0.1423

R-squared	0.146
P-value	0.002
Pooled StDev	0.219

Chart 8.4-1: Confidence intervals[33]



The test shows that means significantly (p-value less than 5%) differ and consequently that the confidence intervals does not overlap each other. Hence, we can conclude that our test indicate that hedging reduce the exposure to currency fluctuations.

We have also conducted an analysis to check for whether the number of derivative types used affect the exposure reduction. This is done by assigning 1 to those who used a particular derivate more than half of the period. Hence, we will have 4 groups of observations, one with those who did not hedge and separate groups for those who used one, two or three derivatives throughout the period. The purpose of this test is to check for whether a more comprehensive hedging strategy (i.e. one that includes multiple types of derivatives) reduces the exposure more than a less comprehensive strategy. The test for differences in means give the following results;

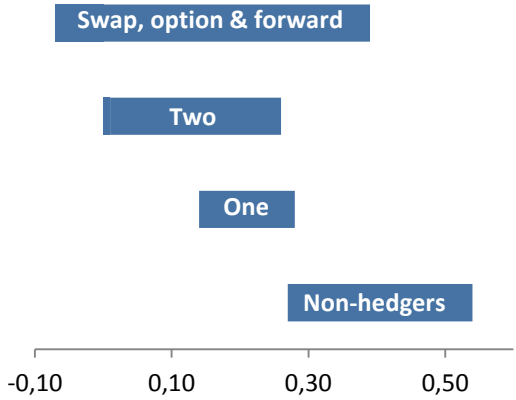
[33] Please see appendix 10.9.2 for an explanation on the statistical method

Table 7.4-2: Oneway ANOVA, β_A vs. # of derivatives

Level	N	Mean	StDev
0	10	0.3995	0.4676
1	33	0.1947	0.1487
2	16	0.1300	0.1344
3	5	0.1185	0.0660

R-squared	0.1466
P-value	0.022
Pooled StDev	0.222

Chart 7.4-2: Confidence intervals[34]



As the P-value is less than our significance level of 5% we reject the null hypothesis and conclude that there is statistical evidence to infer than at least two of the means differ. From chart 7.4-2 we can see that the confidence interval for non-hedgers and those who use two hedging instruments not overlap and thereby the two means differ. We cannot conclude on a 5% significance level that those who use only one hedging derivative are less sensitive to changes in exchange rates. The same goes for those who use all three instruments and the reason is that we do not have sufficient data. Unfortunately, too few observations widen confidence intervals and increase P-values above significance level, which makes us unable to draw statistically significant conclusions.

The last analysis we have done in this section is to check for whether the three different instruments differ in the magnitude of which they reduce exposure. Assigning one to those who only use forwards, two to those who only use options and lastly three to those who only use swaps does this. As in the two prior tests we have used an ANOVA test along with confidence intervals to test for whether the means differ:

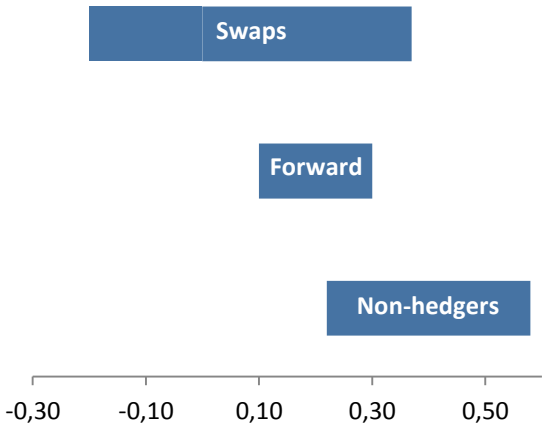
[34] Please see appendix 10.9.2 for an explanation on the statistical method

Table 7.4-3: Oneway ANOVA, vs. derivative types

Level	N	Mean	StDev
0	10	0.3995	0.4676
1	29	0.2094	0.1509
3	4	0.0876	0.0765

R-squared	0.1248
P-value	0.0690
Pooled StDev	0.2561

Chart 7.4-3: Confidence intervals[35]



As this test has a P-value above our significance level we cannot reject the null hypothesis. Hence, we do not have sufficient statistical evidence to infer that the derivatives differ in the magnitude to which they reduce the exposure. As a lot of companies use multiple types of derivatives this test has been conducted on limited data material. Actually, in our sample, there were no companies using solely options, and only four companies using solely swaps.

[35] Please see appendix 10.9.2 for an explanation on the statistical method

7.5 Conclusions: Analysis III

When we presented our tests in section 7.4 we concluded that hedgers are less exposed to currency fluctuation. We also conducted two tests in order to check for whether the magnitude of which exposure is reduced differs between the instruments and the number of instruments used. This chapter will provide a brief discussion on these results and address how these relate to prior research.

The first test conducted on this topic shows that the firms using hedging derivatives are less exposed to fluctuations in exchange rates. The exposure has been measured as how sensitive the value of a firm is to changes in foreign exchange rates, which is in line with the definition presented by Dumas (1978) and Adler and Dumas (1984). Our understanding is that many corporations use foreign exchange derivatives with the purpose of reducing cash flow volatility. Given that corporations are valued as the present value of future cash flows, reducing the cash flow volatility will also reduce the firm value volatility. Hence, it makes sense that those companies who hedge are less exposed if hedging derivatives are successful in reducing cash flow volatility.

Our conclusion that hedging reduces exposure is in line with the research presented by Hagelin and Pramborg (2002). They found that the use of currency derivatives and/or foreign debt is successful in reducing exposure. Besides the Hagelin and Pramborg (2002) article there is little evidence on the field. He and Ng (1998) has done a study on Japanese multinationals that first of all indicates exposure to currency fluctuations, but also that those who where predicted to hedge were less exposed to currency fluctuations than comparables. Another research conducted by Nydahl (1999) examined 47 Swedish firms and found that those who hedged translation exposure were less exposed to exchange rate fluctuations. Allayannis and Ofek (2001) have also conducted a similar study on S&P 500 firms, which concluded the same; derivatives reduce foreign exchange risk. All of these three studies clearly agree with us and suggest that the use of derivatives reduce foreign exchange exposure. Contrary, Copeland and Joshi (1996) argued that derivatives do not reduce foreign exchange risk due correlation with other factors affecting a firm's cash flow. However, they examine the effect on cash flow volatility while we are examining the effect on firm value.

Even though, in theory, this should not make a difference it might be a source for the deviating conclusions.

The second test we did was to check for whether the magnitude of exposure reduction differs depending on the number of derivative classes used. Our conclusion was that those who use two derivatives are significantly less exposed than non-hedgers. For those who use only one of three, or all of the three, derivative classes we are not able to infer that the mean exposure differ. This is due to lack of sufficient data material. Hence, we do not have any indications of more comprehensive hedging strategies being more successful in reducing exposure. Unfortunately, we have not been able to find any relevant literature on this subject.

The third test under this topic was to which extent we can infer that the different derivatives differ in the magnitude of exposure reduction. In this test we also suffer in absence of sufficient data material. This is due to the fact that only about half of the companies use solely one of the derivatives. Hence, our small set of observations widens confidence intervals and makes us unable to draw statistically significant conclusions. Based on the means and confidence intervals we can get indications of swaps reducing exposure more than forwards. However, this is only based on four observations and is far from statistically significant. Similar as with the last test we have not been able to find any literature that is comparable in method and objective.

In addition to these three tests we have tested whether those who hold foreign debt are less exposed to currency fluctuations. As this test was not significant, and did not give any interesting indications, we have chosen leave this out of our thesis. However, we can think of several reasons why this test did not yield interesting results. First of all it is rather net assets in foreign currency that is interesting. A company holding no assets or liabilities in foreign currency has the same exposure as a company holding equal amounts of assets and liabilities in the same foreign currency. Also, swaps can to some extent substitute the need for foreign debt and/or the company might choose to use other form of hedging, both of which might have disturbed the results.

Even though the three last tests did not yield any significant and interesting results we believe the first test contributes to theory in indicating that Norwegian companies reduce their

foreign currency exposure by using derivatives. Further, we believe this method is unique in comparison with earlier research as we compare “cleaner” foreign exchange exposures due to the fact that we calculate and use the error variable from the regression of TWI versus OSEBXreturn.

8 Limitations

This chapter will briefly discuss shortcomings and limitations to our analyses. First we present a general part where we discuss limitations in our data material and then a part where we go more in detail on the different analyses conducted.

8.1 Data Material

The gathering process and sources of data material have been discussed in section 4.2 and an overview is included in appendix 10.4.

The main limitation to the data material used in regression I and II is the short time period. Our study is conducted on the basis of up to five years with yearly observations, dependent on the number of years with available data. Extending the data period would make conclusions more credible as one will cover a longer period with both appreciations and depreciations in the Norwegian Krona. However, even though the NOK has appreciated slightly over the period, there have been multiple periods of both appreciations and depreciations within our time range.

As some companies do not disclose information on hedging policies and/or notional amounts on debt and derivatives we have some missing values in our data. The same is for foreign revenue and foreign debt. Such missing values decrease the number of observations used in regressions and hence make results less significant.

A clear limitation to our analyses is that we have not been able calculate the net exposures correctly. As for net operational exposure we have used foreign revenue as a proxy. This is not entirely correct as a company with equal amounts of revenue and costs in the same foreign currency will have a zero net operational exposure. The same goes for net translation exposure where a company not would be exposed if it has equal amounts of assets and liabilities in the same foreign currency. Unfortunately, due to the fact that companies seldom disclose such information we have not been able to calculate the net exposures. However, we have been able to find foreign revenue and liabilities on most companies and have used this as a proxy for respectively the operational and the translation exposure.

A solution to the limitations presented in the last two paragraphs could be to conduct an extensive survey among all the companies covered. As discussed in chapter 4 we see two problems in such an approach, time constraints from our side and unwillingness to disclose relevant information.

8.2 Regression I: "Does Hedging Increase Firm Value?"

Our first analysis has an R-squared of 35%. This means that 35% of variations in the response variable can be explained by the model. Hence, there are about 65% of the variations that is not explained by our model. This is clearly a limitation and implies that coefficients could be biased. If the coefficients included are correlated with factors outside the model that explain a large share of those 65%, the coefficients might be biased, have the wrong sign or even lose its significance.

Apart from what is discussed under limitations in the sample, and the low R-squared, we do not see any major shortcomings or limitations in our model.

8.3 Regression II: "What Characterizes a Firm That Hedge?"

In our second analysis we determined a set of factors contributing negatively or positively to the likelihood of whether a firm hedge. In such an analysis it is very hard to capture all determinants affect the decision of whether to engage in hedging. Hence, one could argue that a limitation to our analysis is that we do not cover all determinants. However, we believe our analysis is interesting in that it gives an indication of how the different determinants we have defined affect hedging.

8.4 ANOVA: "Does Hedging Reduce Currency Exposure?"

We believe our approach in calculating a measurement of exposure is solid given the data available. However, in developing a perfect measurement of currency exposure there are some improvements we can think of. Ideally one should conduct regressions for each of the companies with multiple independent variables that explain a greater share of the variability than our model does. Doing such makes you able to calculate a measurement of exposure that is less affected by factors not covered in our model.

Another limitation is the lack of firms using solely one type of derivatives. In the last test conducted in this chapter we were not able to conclude due to very few observations.

Extending our data material (i.e. covering more companies) could have been a solution if we had been able to find companies using solely one type of derivatives. However, we believe this would have been hard as our understanding is that very few companies rely on solely options or swaps in currency hedging.

In our calculations we have used TWI, trade weighted index, as a proxy for the development in the Norwegian Krona. Ideally one would wish to determine the exact exposure for each firm and use the developments in the respective currencies. However, our understanding after having read 5-6 annual reports on each company is that very few disclose such information.

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10 Appendices

10.1 VBA Routines from Section 2.4

10.1.1 Computation of Asset Values

```
Sub AssetValues()
Dim AssetValue As Integer
Dim j As Integer

For j = 1 To Range("AssetValue2").Rows.Count

   AssetValue = Range("AssetValue2").Cells(j, 1).Value
   Range("A") = AssetValue
   Range("EquityValue2").Cells(j, 1) = Range("EqVal").Value
   Range("DebtValue2").Cells(j, 1) = Range("DVal").Value

Next j

Range("A") = 100

End Sub
```

10.1.2 Computation of Effect From Volatility Changes

```
Sub VolatilityChanges()
Dim AssetValue As Integer
Dim j As Integer

For j = 1 To Range("AssetValueVol").Rows.Count

   AssetValue = Range("AssetValueVol").Cells(j, 1).Value
   Range("AVol") = AssetValue
   Range("EquityValueVol").Cells(j, 1) = Range("EqValVol").Value
   Range("DebtValueVol").Cells(j, 1) = Range("DValVol").Value

Next j

Range("A") = 100

End Sub
```

10.1.3 Computation of Distress Costs

```
Sub DistressCost()
Dim Vol As Integer
Dim j As Integer

For j = 1 To Range("LGDVol").Rows.Count

   Vol = Range("LGDVol").Cells(j, 1).Value
   Range("Input") = Vol / 100
   Range("WOhedging").Cells(j, 1) = Range("PD").Value

Next j


End Sub
```

10.2 Global Foreign Exchange Market

10.2.1 Instrument, Counterparty and Maturity

Daily averages in April, USD Billions and percentages

Instrument/counterparty/ maturity	1998		2001		2004		2007		2010	
	USDb	%	USDb	%	USDb	%	USDb	%	USDb	%
Spot	**568**	**37**	**386**	**31**	**631**	**33**	**1 005**	**30**	**1 490**	**37**
with reporting dealers	347	61	216	56	310	49	426	42	518	35
with other financial institutions	121	21	111	29	213	34	394	39	755	51
with non-financial customers	99	18	58	15	108	17	184	18	217	15
Outright forwards	**128**	**8**	**130**	**11**	**209**	**11**	**362**	**11**	**475**	**12**
with reporting dealers	49	38	52	40	73	35	96	27	113	24
with other financial institutions	34	27	41	31	80	38	159	44	254	54
with non-financial customers	44	35	37	29	56	27	107	30	108	23
Foreign exchange swaps	**734**	**48**	**656**	**53**	**954**	**49**	**1 714**	**52**	**1 765**	**44**
with reporting dealers	511	70	419	64	573	60	796	46	837	47
with other financial institutions	124	17	177	27	293	31	682	40	758	43
with non-financial customers	98	13	60	9	89	9	236	14	170	10
Currency swaps	**10**	**1**	**7**	**1**	**21**	**1**	**31**	**1**	**43**	**1**
with reporting dealers	5	55	4	53	12	58	12	39	20	47
with other financial institutions	2	23	2	21	5	23	13	41	19	45
with non-financial customers	2	22	2	25	3	14	6	20	4	8
FX options and other products[2]	**87**	**6**	**60**	**5**	**119**	**6**	**212**	**6**	**207**	**5**
with reporting dealers	48	55	28	47	49	41	62	29	60	29
with other financial institutions	18	20	15	26	44	37	91	43	113	55
with non-financial customers	21	24	16	27	21	18	59	28	33	16
	1		**1**		**1**		**3**		**3**	
Total	**527**	**100**	**239**	**100**	**934**	**100**	**324**	**100**	**981**	**100**
with reporting dealers	961	63	719	58	1 018	53	1 392	42	1 548	39
with other financial institutions	299	20	346	28	634	33	1 339	40	1 900	48
with non-financial customers	266	17	174	14	276	14	593	18	533	13

Instrument/counterparty/ maturity	1998		2001		2004		2007		2010	
	USDb	%	USDb	%	USDb	%	USDb	%	USDb	%
Local	698	46	525	42	743	38	1 274	38	1 395	35
Cross-border	828	54	713	58	1 185	61	2 051	62	2 586	65
Outright forwards	**128**	**100**	**130**	**100**	**209**	**100**	**362**	**100**	**475**	**100**
Up to 7 days	65	51	51	39	92	44	154	43	219	46
Over 7 days and up to 1 year	57	45	76	58	111	53	200	55	245	52
Over 1 year	5	4	4	3	5	3	7	2	11	2
							1		**1**	
Foreign exchange swaps	**734**	**100**	**656**	**100**	**954**	**100**	**714**	**100**	**765**	**100**
Up to 7 days	528	72	451	69	700	73	1 329	78	1 304	74
Over 7 days and up to 1 year	192	26	196	30	242	25	365	21	444	25
Over 1 year	10	1	8	1	10	1	18	1	15	1

10.2.2 By Instrument

USD Billions

Instrument	1998	2001	2004	2007	2010
Spot	568 000	386 000	631 000	1 005 000	1 490 000
Outright forwards	128 000	130 000	209 000	362 000	475 000
Foreign exchange swaps	734 000	656 000	954 000	1 714 000	1 765 000
Currency swaps	10 000	7 000	21 000	31 000	43 000
Options	87 000	60 000	119 000	212 000	207 000
Total	**1 527 000**	**1 239 000**	**1 934 000**	**3 324 000**	**3 980 000**

10.3 Norwegian Foreign Exchange Market

10.3.1 By Counterparty

Millions of US Dollars

Counterparty	1998	2001	2004	2007	2010
Reporting dealers	141 368	201 207	209 279	385 625	249 543
- norwegian	13 021	19 242	6 376	3 103	4 914
- foreign	128 347	181 965	202 903	382 522	244 629
Other financial institutions	6 933	14 087	22 713	107 648	97 667
- norwegian		9 880	15 089	43 202	29 032
- foreign		4 207	7 624	64 446	68 635
non-financial customers	20 799	17 859	42 360	81 260	63 942
- norwegian		16 834	35 092	73 326	56 117
- foreign		1 024	7 268	7 934	7 825
Total	**169 100**	**233 152**	**274 352**	**574 533**	**411 152**
- norwegian	37 033	45 956	56 558	119 631	90 063
- foreign	132 067	187 196	217 794	454 902	321 089

10.3.2 By currency

Millions of US Dollars

Currency	1998	2001	2004	2007	2010
NOK	102 025	149 231	202 772	353 115	248 995
USD	140 331	204 358	224 011	489 567	333 222
EUR (DEM before 1999)	58 292	77 880	76 198	145 295	109 462
Other	37 482	34 832	45 720	161 089	130 627
Total	**338 130**	**466 301**	**548 701**	**1 149 066**	**822 306**

10.4 Sources and Data Gathering

Please note that other variables may have been calculated with the use of one, or several, of the variables below.

Parameters used in thesis	Source	Description
Derivatives	Annual reports	Notional amount of currency hedging derivatives
Swap	Annual reports	Dichotomous, 1 if using currency swaps, otherwise 0
Options	Annual reports	Dichotomous, 1 if using currency options, otherwise 0
Forward	Annual reports	Dichotomous, 1 if using currency forwards, otherwise 0
FC Debt %	Annual reports	Percentage of total debt in foreign currencies
Foreign % revenue	Annual reports	Percentage of total revenue in foreign currencies
Foreign % assets	Annual reports	Percentage of total assets in foreign currencies
Reporting currency	Annual reports	NOK, USD or EUR
Net Sales Or Revenues	Datastream	Total sales of the company
Operating Income	Datastream	Total operating income of the company
Return On Equity	Datastream	Return on equity expressed in percentages
Net Margin	Datastream	Net income divided by revenue
Net Debt	Datastream	Total oustanding debt minus cash
Enterprise Value	Datastream	Year end market capitalisation plus book value of debt
Market Capitalisation	Datastream	Year end market capitalisation
Average Market Cap	Calculated	Time weighted average of market cap
Asset Value	Datastream	Year end asset values
Current Ratio	Datastream	Current assets divided by current liabilities
Quick Ratio	Datastream	Current assets minus inventory, divided by current liabilities
Tobins Q	Calculated	Enterprise value divided by book values
Return On Invested Capital	Datastream	Return on invested capital
Operating Profit Margin	Datastream	Operating profit divided by revenues
Pretax Margin	Datastream	Pretax income divided by revenues
Cash Flow/Sales	Datastream	Cash flow divided by sales
Pretax Income	Datastream	Pretac income
Tax rate	Calculated	Tax divided by pretax income
Interest Expense On Debt	Datastream	Interest expense on interest bearing debt
FX derivatives / FX revenue	Calculated	Notional amount of oustanding currency derivatives divided by foreign revenue

Parameters used in thesis	Source	Description
YoY Revenue Growth	Calculated	Revenue growth year over year
Years	-	Dichotomous, 1 if observations is from the particular year, otherwise 0
Industry	-	Dichotomous, 1 if observations is from the particular industry, otherwise 0
Currency rates	Norges Bank	Daily currency rates from 1982 till 25.11.2010
Oil Price	Thomson Reuters	Daily oil price from 2002 till 30.11.2010
Historical share data	Datastream	Historical closing prices. Adjusted for dividends, splits and reverse splits
Shareholder data	Oslo Børs Arena	Top 30 shareholders and both their and total outstanding shares. Average each year 2005-2009
Descriptive data on Norwegian companies	Norges Bank	Background data for Norges Bank's article on currency exposure among Norwegian companies

10.5 Companies, Industries, Reporting Currency and Years per Company

Industry/company	Reporting currency	2005	2006	2007	2008	2009
Div						
Aker	NOK	X	X	X	X	X
Tomra	NOK	X	X	X	X	X
Renewable Energy Corporation	NOK		X	X	X	X
Kverneland	NOK	X	X	X	X	X
Telio	NOK		X	X	X	X
Telenor	NOK	X	X	X	X	X
Cyclical Industries						
Hexagon Composites	NOK	X	X	X	X	X
Yara	NOK	X	X	X	X	X
Norsk Hydro	NOK	X	X	X	X	X
Goodtech	USD	X	X	X	X	X
BWG Homes	NOK		X	X	X	X
Scana	NOK	X	X	X	X	X
Norske Skog	NOK	X	X	X	X	X
Kongsberg	NOK	X	X	X	X	X
Shipping						
Bonheur	NOK	X	X	X	X	X
Eitzen Chemical	USD		X	X	X	X
Stolt-Nielsen	USD	X	X	X	X	X
Green Reefers	USD	X	X	X	X	X
Belships	USD	X	X	X	X	X
Bergen Group	NOK				X	X
Farstad Shipping	NOK	X	X	X	X	X
DOF	NOK	X	X	X	X	X
Camillo Eitzen & Co	USD	X	X	X	X	X
Golar LNG	USD	X	X	X	X	X
Frontline	USD	X	X	X	X	X
Siem Offshore	USD		X	X	X	X
Wilh. Wilhelmsen	NOK					X
Oil Service						
TTS Group	NOK	X	X	X	X	X
Subsea 7	USD	X	X	X	X	X
Acergy	USD	X	X	X	X	X
Aker Solutions	NOK	X	X	X	X	X
Seadrill	USD	X	X	X	X	X
Electromagnetic Geoservices	USD			X	X	X
Prosafe	USD	X	X	X	X	X

Industry/company	Reporting currency	2005	2006	2007	2008	2009
Prosafe Production	USD			X	X	X
Reservoir Exploration Technology	USD			X	X	X
Songa Offshore	USD		X	X	X	X
Petroleum Geo Services		X	X	X	X	X
TGS-Nopec Geophysical Company		X	X	X	X	X
Fish Farming						
Marine Harvest	NOK	X	X	X	X	X
Austevoll Seafood	NOK		X	X	X	X
Lerøy Seafood Group	NOK	X	X	X	X	X
Cermaq	NOK	X	X	X	X	X
Salmar	NOK			X	X	X
Grieg Seafood	NOK			X	X	X
Norway Pelagic	NOK				X	X
Aker Seafoods	NOK	X	X	X	X	X
Marine Farms	NOK		X	X	X	X
E&P						
Rocksource	NOK	X	X	X	X	X
PA Resources	NOK	X	X	X	X	X
Fred. Olsen Energy	NOK			X	X	X
DNO International	NOK	X	X	X	X	X
Statoil	NOK	X	X	X	X	X
BW Offshore	USD		X	X	X	X
Norse Energy Corporation	USD	X	X	X	X	X
Consumer Goods						
Rieber & Søn	NOK	X	X	X	X	X
Ekornes	NOK	X	X	X	X	X
Hurtigruten	NOK	X	X	X	X	X
Orkla	NOK	X	X	X	X	X
Kverneland	EUR	X	X	X	X	X
Norwegian Air Shuttle	NOK	X	X	X	X	X
Royal Caribbean Cruises	USD	X	X	X	X	X

10.6 Regression I: "Does Hedging Increase Firm Value?"

10.6.1 Regression model: Minitab Print

Regression Analysis: TOBINS Q avg versus Hedging; CURRENT RATIO; ...

```
The regression equation is
TOBINS Q avg = 1,50 - 0,474 Hedging + 0,261 CURRENT RATIO + 0,404
2006
               + 0,596 2007 + 0,141 2008 - 0,177 2009
               - 0,537 Cyclical Industries - 0,854 Shipping +
0,134 Oil Service
               - 0,543 Fish Farming - 0,436 E&P - 0,374 Consumer
Goods
               + 0,113 logAvgMC - mean - 0,0191 YoY revenue growth
               - 0,755 Tax rate


260 cases used, 24 cases contain missing values


Predictor                Coef   SE Coef      T      P    VIF
Constant               1,4983    0,2638   5,68  0,000
Hedging               -0,4739    0,1577  -3,01  0,003  1,299
CURRENT RATIO         0,26148   0,04818   5,43  0,000  1,277
2006                   0,4040    0,1758   2,30  0,022  1,817
2007                   0,5963    0,1735   3,44  0,001  1,925
2008                   0,1414    0,1740   0,81  0,417  1,962
2009                  -0,1768    0,1746  -1,01  0,312  1,951
Cyclical Industries   -0,5374    0,2235  -2,40  0,017  2,461
Shipping              -0,8545    0,2357  -3,62  0,000  2,849
Oil Service            0,1344    0,2181   0,62  0,538  2,840
Fish Farming          -0,5428    0,2332  -2,33  0,021  2,340
E&P                   -0,4359    0,2260  -1,93  0,055  2,251
Consumer Goods        -0,3741    0,2312  -1,62  0,107  2,357
logAvgMC - mean       0,11306   0,03735   3,03  0,003  1,360
YoY revenue growth  -0,019069  0,008748  -2,18  0,030  1,220
Tax rate              -0,7552    0,2809  -2,69  0,008  1,397


S = 0,828745   R-Sq = 34,7%   R-Sq(adj) = 30,7%


Analysis of Variance

Source           DF        SS       MS     F      P
Regression       15   89,1491   5,9433  8,65  0,000
Residual Error  244  167,5837   0,6868
Total           259  256,7328
```

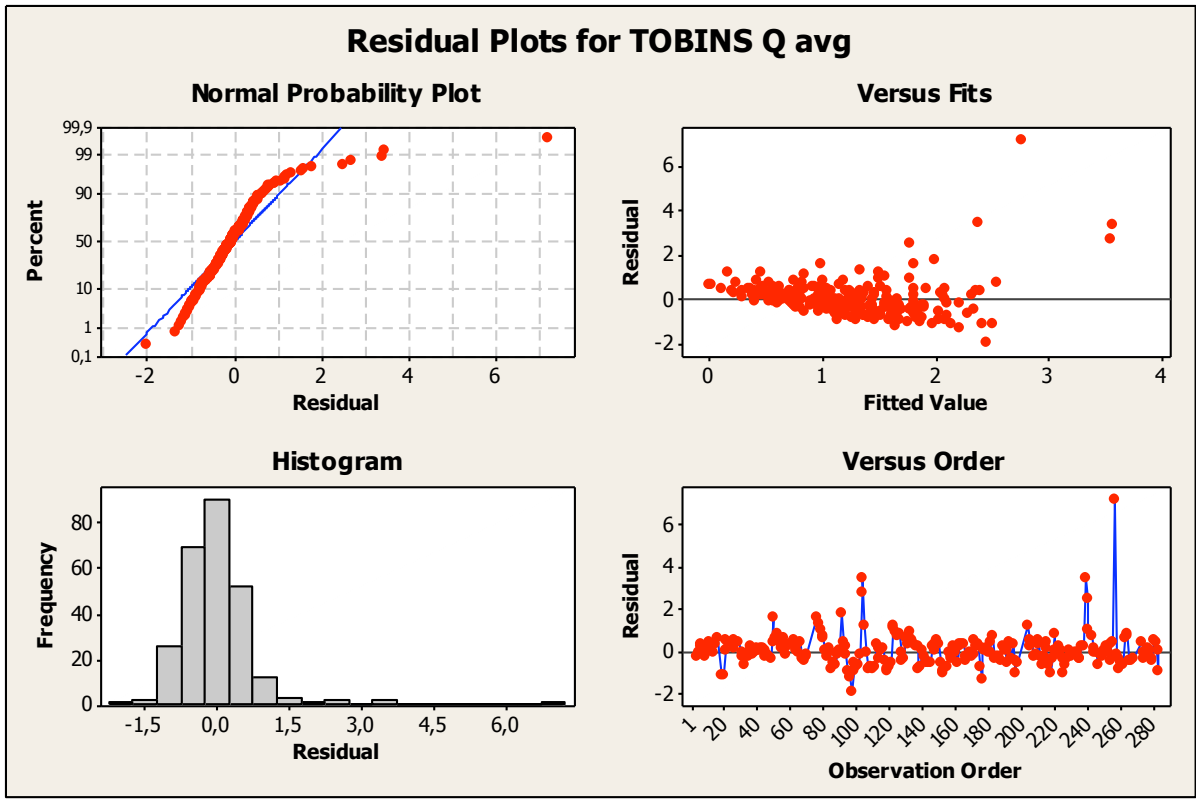
Source	DF	Seq SS
Hedging	1	7,8607
CURRENT RATIO	1	13,8786
2006	1	2,8770
2007	1	19,8256
2008	1	2,8178
2009	1	0,3759
Cyclical Industries	1	1,3102
Shipping	1	9,1370
Oil Service	1	11,6253
Fish Farming	1	1,2136
E&P	1	1,7843
Consumer Goods	1	3,0672
logAvgMC - mean	1	5,4163
YoY revenue growth	1	2,9955
Tax rate	1	4,9640

Unusual Observations

Obs	Hedging	TOBINS Q avg	Fit	SE Fit	Residual	St Resid
18	0,00	0,9354	2,1303	0,6470	-1,1949	-2,31RX
76	1,00	2,6027	0,9842	0,1854	1,6184	2,00R
91	0,00	3,7994	1,9995	0,2311	1,7999	2,26R
97	1,00	0,4361	2,4448	0,2141	-2,0087	-2,51R
103	1,00	6,2788	3,5631	0,3663	2,7157	3,65RX
104	1,00	5,8322	2,3719	0,2097	3,4602	4,32R
195	1,00	1,5044	1,2507	0,3969	0,2536	0,35 X
204	1,00	1,3046	0,1424	0,4964	1,1622	1,75 X
239	0,00	6,9685	3,5748	0,2568	3,3937	4,31R
240	1,00	4,2688	1,7663	0,1693	2,5025	3,08R
257	0,00	9,9890	2,7692	0,1992	7,2198	8,97R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

10.6.2 Residual Plots for Tobins Q avg



10.7 Regression II "What Makes a Firm More Likely to Hedge?"

10.7.1 Regression Model: Minitab Print

Binary Logistic Regression: Hedging versus 2006; 2007; ...

```
* WARNING * Algorithm has not converged after 20 iterations.
* WARNING * Convergence has not been reached for the parameter
estimates
            criterion.
* WARNING * The results may not be reliable.
* WARNING * Try increasing the maximum number of iterations.


Link Function: Logit


Response Information

Variable  Value  Count
Hedging   1        204  (Event)
          0         34
          Total    238

* NOTE * 238 cases were used
* NOTE * 46 cases contained missing values


Logistic Regression Table


95%

CI
Predictor                  Coef    SE Coef      Z      P   Odds
Ratio  Lower
Constant               -2,99017    1,45520  -2,05  0,040
2006                   0,999541   0,767877   1,30  0,193
2,72   0,60
2007                    1,00713   0,755897   1,33  0,183
2,74   0,62
2008                    2,03594   0,915220   2,22  0,026
7,66   1,27
2009                    1,74349   0,837878   2,08  0,037
5,72   1,11
Cyclical Industries     1,74389    1,35452   1,29  0,198
5,72   0,40
Shipping                3,04528    1,45030   2,10  0,036
21,02   1,22
Oil Service             1,65332    1,30680   1,27  0,206
5,22   0,40
```

Fish Farming	20,1046	5355,21	0,00	0,997	5,38656E+08	0,00
E&P	-0,0555989	1,34592	-0,04	0,967	0,95	0,07
Consumer Goods	2,73266	1,45890	1,87	0,061	15,37	0,88
FR50%+	2,65996	1,12003	2,37	0,018	14,30	1,59
MC>5mrd	1,75355	0,653709	2,68	0,007	5,78	1,60
Tax rate	0,0672283	0,0175116	3,84	0,000	1,07	1,03
NET DEBT/EV	0,0228507	0,0072565	3,15	0,002	1,02	1,01
median	-1,21702	0,646970	-1,88	0,060	0,30	0,08

Predictor	Upper
Constant	
2006	12,24
2007	12,05
2008	46,05
2009	29,54
Cyclical Industries	81,35
Shipping	360,63
Oil Service	67,67
Fish Farming	*
E&P	13,23
Consumer Goods	268,30
FR50%+	128,41
MC>5mrd	20,80
Tax rate	1,11
NET DEBT/EV	1,04
median	1,05

Log-Likelihood = -54,712
Test that all slopes are zero: G = 85,792, DF = 15, P-Value = 0,000

Goodness-of-Fit Tests

Method	Chi-Square	DF	P
Pearson	164,811	222	0,998
Deviance	109,423	222	1,000
Hosmer-Lemeshow	5,832	8	0,666

Table of Observed and Expected Frequencies:
(See Hosmer-Lemeshow Test for the Pearson Chi-Square Statistic)

					Group					
Value	1	2	3	4	5	6	7	8	9	10
Total										
1										
Obs	8	12	19	23	24	22	24	24	24	24
204										
Exp	6,3	15,4	19,2	21,7	22,9	22,6	23,8	23,9	24,0	24,0
0										
Obs	15	12	5	1	0	1	0	0	0	0
34										
Exp	16,7	8,6	4,8	2,3	1,1	0,4	0,2	0,1	0,0	0,0
Total	23	24	24	24	24	23	24	24	24	24
238										

Measures of Association:
(Between the Response Variable and Predicted Probabilities)

Pairs	Number	Percent	Summary Measures	
Concordant	6476	93,4	Somers' D	0,87
Discordant	450	6,5	Goodman-Kruskal Gamma	0,87
Ties	10	0,1	Kendall's Tau-a	0,21
Total	6936	100,0		

10.8 ANOVA: "Does Hedging Reduce Currency Exposure?"

10.8.1 Regression: TWI versus OSEBX, Minitab Print

Regression Analysis: TWI versus OSEBX

The regression equation is
TWI = - 0,000137 - 0,0085 OSEBX

343 cases used, 2 cases contain missing values

Predictor	Coef	SE Coef	T	P
Constant	-0,0001367	0,0005696	-0,24	0,810
OSEBX	-0,00853	0,01464	-0,58	0,561

S = 0,0105236 R-Sq = 0,1% R-Sq(adj) = 0,0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	0,0000376	0,0000376	0,34	0,561
Residual Error	341	0,0377644	0,0001107		
Total	342	0,0378019			

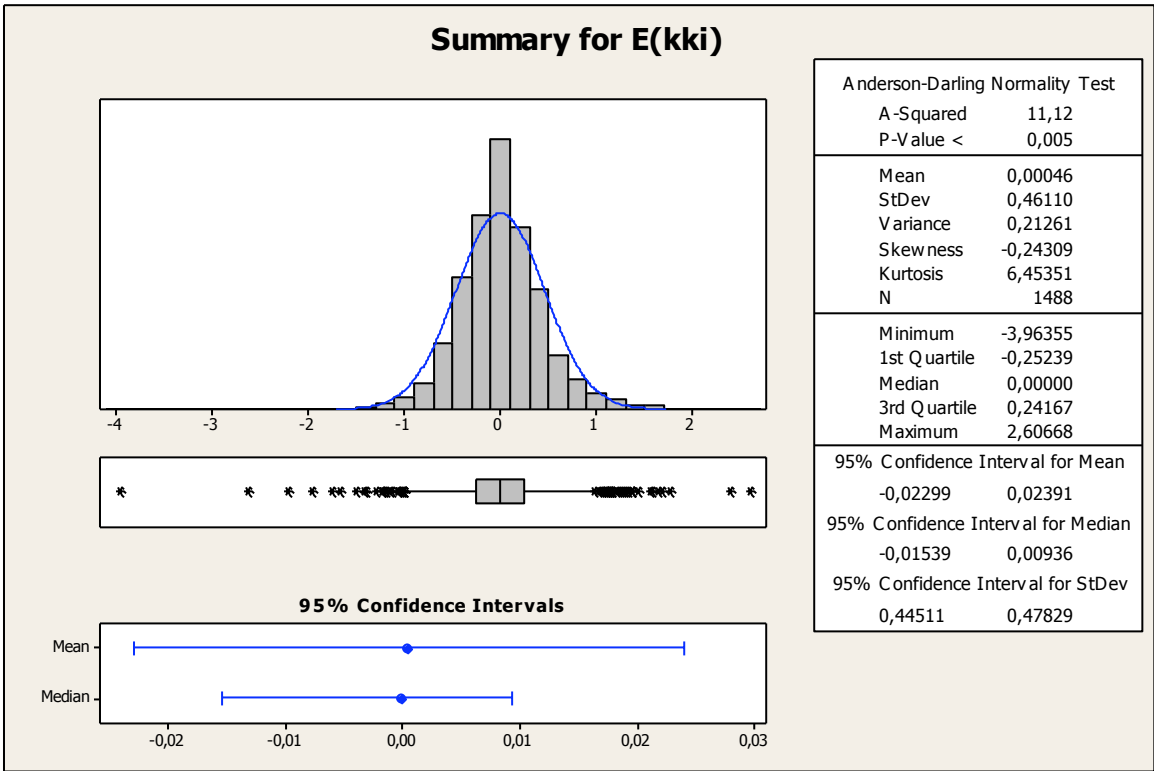
10.8.2 Descriptive Statistics of Error Variable, Minitab Print

Descriptive Statistics: E

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
E	1455	34	0,000000	0,000122	0,004666	-0,039635	-0,002629

Variable	Median	Q3	Maximum
E	-0,000041	0,002497	0,026067

10.8.3 Plot and Normality Test of Error Variable



10.8.4 Does Hedging Reduce Currency Exposure?

One-way ANOVA: Ba versus Hedging

```
Source    DF      SS      MS      F      P
Hedging    1  0,5071  0,5071  10,60  0,002
Error     62  2,9657  0,0478
Total     63  3,4727

S = 0,2187   R-Sq = 14,60%   R-Sq(adj) = 13,22%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level    N    Mean   StDev   -+---------+---------+---------+------
--
0       10  0,4114  0,4585                (----------*-----------)
1       54  0,1662  0,1423    (----*----)
                            -+---------+---------+---------+------
--
                          0,12      0,24      0,36      0,48

Pooled StDev = 0,2187
```

10.8.5 Does the Number of Derivative Types Used Differ in Exposure Reduction?

One-way ANOVA: Ba versus Swap+option+forward

```
Source                DF      SS      MS     F      P
Swap+option+forward    3  0,5092  0,1697  3,44  0,022
Error                 60  2,9635  0,0494
Total                 63  3,4727
S = 0,2222   R-Sq = 14,66%   R-Sq(adj) = 10,40%
```

```
                Individual 95% CIs For Mean Based on
                                Pooled StDev
Level    N    Mean   StDev  -----+---------+---------+---------+---
-
0       10  0,3995  0,4676                        (--------*--------
)
1       33  0,1947  0,1487               (----*----)
2       16  0,1300  0,1344         (------*------)
3        5  0,1185  0,0660   (-----------*-----------)
                             -----+---------+---------+---------+---
-
                                0,00      0,16      0,32      0,48
Pooled StDev = 0,2222
```

10.8.6 Are the Derivatives Differing in the Magnitude of Exposure Reduction?

One-way ANOVA: Ba versus Swap/option/forward

```
Source                DF      SS      MS     F      P
Swap/option/forward    2  0,3741  0,1871  2,85  0,069
Error                 40  2,6228  0,0656
Total                 42  2,9970
S = 0,2561   R-Sq = 12,48%   R-Sq(adj) = 8,11%

                                Individual 95% CIs For Mean Based on
                                Pooled StDev
Level    N    Mean   StDev  ---------+---------+---------+---------
+
0       10  0,3995  0,4676                        (-------*-------)
1       29  0,2094  0,1509                  (---*----)
3        4  0,0876  0,0765   (------------*------------)
                             ---------+---------+---------+---------
+
                                    0,00      0,20      0,40
Pooled StDev = 0,2561
```

10.8.7 Table of Asset Betas to Currency Fluctuations

Company name	Be	Ba	Abs (Ba)	Hedging	Swap	Option	Forward
Aker	0,067	0,061	0,061	1	0	0	1
Tomra	0,338	0,329	0,329	1	0	0	1
Renewable Energy Corporation	0,187	0,179	0,179	1	1	1	1
Kverneland	0,056	0,044	0,044	1	1	0	1
Hexagon Composites	0,141	0,118	0,118	1	1	0	1
Yara	-0,087	-0,077	0,077	1	0	0	1
Norsk Hydro	0,345	0,364	0,364	1	0	0	1
Goodtech	0,234	0,259	0,259	0	0	0	0
Bwg Homes	-0,108	-0,078	0,078	1	0	0	1
Scana	-0,074	-0,064	0,064	1	0	0	1
Norske Skog	0,362	0,245	0,245	1	1	1	1
Kongsberg	0,077	0,077	0,077	1	0	1	1
Telio	0,407	0,496	0,496	0	0	0	0
Telenor	0,357	0,323	0,323	1	1	0	1
Bonheur	-0,034	-0,027	0,027	1	1	1	1
Eitzen Chemical	0,688	0,410	0,410	1	1	1	1
Stolt-Nielsen	0,022	0,016	0,016	1	1	0	1
Green Reefers	0,562	0,353	0,353	0	0	0	0
Belships	0,006	0,010	0,010	1	1	0	0
Bergen Group	-1,102	-0,699	0,699	1	0	0	1
Farstad Shipping	-0,020	-0,014	0,014	1	0	1	1
Dof	-0,470	-0,286	0,286	1	0	0	1
Camillo Eitzen & Co	0,229	0,137	0,137	1	1	0	0
Golar Lng	0,210	0,127	0,127	1	1	0	1
Frontline	0,318	0,216	0,216	0	0	0	0
Siem Offshore	0,133	0,099	0,099	1	0	0	1

Company name	Be	Ba	Abs (Ba)	Hedging	Swap	Option	Forward
Tts Group	-0,612	-0,508	0,508	1	0	0	1
Subsea 7	-0,221	-0,204	0,204	1	1	0	1
Acergy	-0,246	-0,277	0,277	1	0	0	1
Aker Solutions	-0,222	-0,226	0,226	1	0	1	1
Seadrill	-0,424	-0,346	0,346	1	0	0	1
Electromagnetic Geoservices	-0,844	-1,029	1,029	0	0	0	0
Tgs-Nopec Geophysical Company	-0,140	-0,166	0,166	1	1	0	0
Petroleum Geo-Services	-0,130	-0,108	0,108	1	0	0	1
Prosafe	-0,232	-0,197	0,197	1	0	0	1
Prosafe Prod	-0,455	-0,308	0,308	1	0	0	1
Reservoir Exploration Technology	-0,258	-0,187	0,187	0	0	0	0
Songa Offshore	-0,631	-0,456	0,456	1	0	0	1
Marine Harvest	-0,567	-0,445	0,445	1	0	0	1
Austevoll Seafood	-0,348	-0,275	0,275	1	0	0	1
Lerøy Seafood Group	-0,236	-0,200	0,200	1	0	0	1
Cermaq	-0,159	-0,135	0,135	1	0	0	1
Salmar	-0,347	-0,306	0,306	1	0	0	1
Grieg Seafood	-0,097	-0,067	0,067	1	0	0	1
Norway Pelagic	-0,926	-0,699	0,699	1	0	0	1
Aker Seafoods	-0,189	-0,138	0,138	1	0	0	1
Norwegian Energy Company	-0,094	-0,067	0,067	1	1	0	1
Rocksource	-0,051	-0,053	0,053	1	1	0	0
Pa Resources	-0,223	-0,180	0,180	1	1	0	0
Dno International	-0,082	-0,073	0,073	0	0	0	0
Statoil	-	-	0,098	1	1	1	1

Company name	Be	Ba	Abs (Ba)	Hedging	Swap	Option	Forward
	0,102	0,098					
Bw Offshore Limited	0,103	0,075	0,075	1	1	0	1
	-	-					
Fred. Olsen Energy	0,197	0,168	0,168	1	0	0	1
	-	-					
Norse Energy Corp.	0,215	0,170	0,170	0	1	0	0
	-	-					
Rieber & Søn	0,156	0,134	0,134	1	1	0	1
Schibsted	0,003	0,003	0,003	1	1	0	1
	-	-					
Norwegian	0,039	0,041	0,041	1	0	0	1
	-	-					
Hurtigruten	0,470	0,302	0,302	1	0	0	1
Orkla	0,124	0,118	0,118	1	1	0	1
Ekornes	0,551	0,581	0,581	1	0	0	1
Royal Caribbean Cruises	1,060	0,724	0,724	1	1	0	1

10.9 Other Statistical Methods Used

10.9.1 T-test for Mean Differences

The t-test for mean differences is a test of whether the means of two normally distributed populations differ. Several types of t-tests exist, among these the 1 and 2 sample tests which have been used in this thesis. The 1-sample t-test tests whether the mean of a population is equal to a target value and the 2-sample t-test tests whether the difference between the means is equal to a target value.

The 1-sample test has the following test statistic;

$$t = \frac{(\bar{x} - \mu)}{(\frac{s}{\sqrt{n}})}$$

Where $\bar{x}$ is the mean of the sample, n is the number of observations, s is the sample standard deviation and μ is the value tested against (i.e. whether the population mean differ from μ). The 2-sample has test the following test statistic

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - \mu}{\sqrt{(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2})}}$$

Where the subscripts 1 and 2 denotes the two samples. While the 1-sample t statistic is distributed with v = n-1 degrees of freedom the 2-sample test has the following number of freedom degrees;

$$v = \frac{(\left(\frac{s_1^2}{n_1}\right) + \left(\frac{s_2^2}{n_2}\right))^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

For the two tests we have the following alternative hypotheses;

1 sample t-test: H_1 = The population mean differs from μ

2 sample t-test: H_1= The difference in population means differs from μ

Where the following inequality has the hold in order to reject the null hypothesis;

$$t > t_{\alpha,v}$$

10.9.2 Confidence intervals

Confidence intervals are ranges of values, which a mean falls into with a certain probability, 1 minus the alpha level. The confidence interval can take on any probability and widens with decreasing probability. In this thesis we have chosen an alpha level of 5%. Consequently, all confidence intervals are calculated with the probability 95%.

The confidence interval of μ for a given population can be computed with the following formula;

$$\mu = \bar{x} \pm z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$$

where α is the alpha level and 1 – α is the confidence level. $\bar{x}$ is the sample mean and σ is the standard deviation of the population. The interpretation of z can be described with the following formula;

$$P\left(-z_{\frac{\alpha}{2}} < \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{n}}} < z_{\frac{\alpha}{2}}\right) = 1 - \alpha$$

Confidence intervals have been used in the interpretation of the ANOVA tests in section 7.4.