MASTER THESIS IN ECONOMICS/BUSINESS ADMINISTRATION

What risk is the City of Stavanger facing on their financial investments?

In corporation with the City of Stavanger

Written by: Mari Hagvaag Seim

15.06.2009

Universitetet i Stavanger

STAVANGER KOMMUNE

Abstract

Many cities/municipalities in Norway make financial investments, including the city of Stavanger. In 2007 the “Terra-case” was uncovered in the media. Several cities/municipalities in Norway had taken a big financial risk by investing in the American bond market recommended by Terra Securities, and it resulted in big economic losses for the cities/municipalities.

The current recession in the world-economy that occurred in the fall of 2008, affect the cities/municipalities’ willingness to invest.

Important and current risk measurement tools can be used to look at what risk cities/municipalities have taken in the past, and what they can expect in the future. *Value at risk* and *Sharpe ratio* are two risk measurements that can be used, and in this thesis we use these measurements in order to see what risk the city of Stavanger is facing on their financial investments.

We look at previous research and methodology that address the issue and relate them to our research. A thorough analysis of the city of Stavanger’s portfolio from 2006 up to 2008 is explained and showed in the thesis, using *Value at risk* and *Sharpe ratio* as risk measurements. We also compare their portfolio with the portfolio to the city of Haugesund. The comparison enables us to get an accurate picture of the city of Stavanger’s investments.

The analysis shows us that the city of Stavanger has taken minimum risk up to 2008. When comparing the investments with the city of Haugesund, we can confirm it. However, due to the global financial crisis they have taken a substantial bigger risk in 2008.

Strengths and limitations of our risk measurement are uncovered and discussed, and can question our results. If we take some lack in the validity into consideration, we can conclude that the city of Stavanger has taken minimum risk and that they could not have foreseen their financial losses in 2008. The city of Stavanger should continue to avoid risky investments because of their responsibility towards the citizens of Stavanger.

Sammendrag

Mange kommuner i Norge foretar finansielle investeringer, deriblant Stavanger Kommune. I 2007 dukket ”Terra-saken” opp i media. Flere kommuner hadde tatt stor finansiell risiko ved å investere i det amerikanske obligasjonsmarkedet. Dette hadde de gjort etter råd fra Terra Securities, og det førte til store økonomiske tap for kommunene.

Den pågående resesjonen i verdensøkonomien, som høsten 2008 var et faktum, påvirker kommunenes investeringsvalg. Viktige og aktuelle verktøy for å måle risiko, kan bli brukt for å se hvilke risiko kommuner har tatt, og hva de kan forvente i framtida. *Value at Risk* og *Sharpe ratio* er to mål for risiko. I denne oppgaven vil vi bruke disse målene for å se hvilke risiko Stavanger Kommune står overfor med sine finansielle investeringer.

Tidligere forskning og metode blir brukt for å belyse temaet, og for å se det i sammenheng med forskningen som er gjort i denne oppgaven. En grundig analyse av Stavanger sin portefølje fra 2006 til 2008, er forklart og vist, ved å bruke *Value at Risk* og *Sharpe ratio* som risikomål. En sammenligning med Haugesund Kommune sin portefølje er gjort for å få et nyansert bilde av Stavanger Kommune sine investeringer.

Analysen vår viser at Stavanger Kommune har tatt liten risiko fram til 2008. Når vi sammenligner med investeringene i Haugesund Kommune, kan vi bekrefte dette. Imidlertid ser en at de har tatt en vesentlig større risiko i 2008. Dette skyldes i stor grad den globale finanskrisen.

I oppgaven er styrker og svakheter med våre risikomål drøftet og diskutert. På tross av noe begrenset validitet, kan en likevel konkludere med at Stavanger Kommune har tatt lav risiko, og at de ikke kunne ha forutsett de store finansielle tapene som oppstod i 2008. Stavanger Kommune bør også i fremtiden unngå risikofylte investeringer, dette med tanke på at det er fellesskapet(alle innbyggerne i Stavanger Kommune) sine penger de forvalter.

Preface

Writing my master thesis was a time-consuming and educational process. I ran into obstacles on the way, but stayed focused and continued to work hard. My inspiration for the thesis was the subject concerning financial risk, and how the cities/municipalities in the "Terra-case" underestimated the importance of thorough risk analysis before making large financial investments. The current recession in the world's economy was also an inspiration, and I found it interesting to see how the city of Stavanger was affected by it.

There are several people I would like to thank for inspiration, support, information and professional guidance.

I would like to thank Bernt Arne Ødegaard for professional guidance and advice.

I would also like to thank the city of Stavanger with all the guidance and help I needed to chose my subject and find necessary information. A special thank you to Svein Arne Svilosen, who suggested that I could write my master thesis in corporation with them, and Helge Johansen, who helped me get all the financial information I needed to do my calculations.

In addition to the city of Stavanger, I would also like to thank the city of Haugesund for giving med necessary information about their financial investments.

Finally, I would like to thank my family and friends for support and motivation, when I have struggled and needed encouragement.

Table of contents

Attachment: Cd: “Value at Risk and Sharpe ratio”

Introduction

This master thesis will focus on the analysis of the financial risk for the City of Stavanger. The problem description is “*What risk is the City of Stavanger facing on their financial investments?”* which is interesting to look into due to several factors.

A financial scandal was uncovered in 2007 concerning several municipalities/cities in Norway. Due to advice from a Norwegian broker company called Terra Securities, the municipalities/cities invested in the American bond market. This was a considerable risk to take, and led to big losses for the municipalities/cities. In the aftermath of the Terra scandal a discussion began regarding the risks municipalities/cities take on their financial investments. Since municipalities/cities have responsibilities to their citizens, it is important that the risk they take is in line with what money they have at their disposal. It is therefore interesting to look at what risk the City of Stavanger is facing on their financial investments. They were not affected by the financial scandal.

Another factor that makes the problem description interesting to look into is the recession that occurred in the economy in 2008. This led to big fluctuations in the world’s stock exchanges, including the Oslo Stock Exchange, and many companies lost huge amounts of money and some went bankrupt. The City of Stavanger was also affected by the recession, and it is interesting to look at what risk they took in 2008.

The calculations in this thesis measure what risk the city of Stavanger is facing on their financial investments. The risk measures being used are *Value at Risk* and *Sharpe ratio*. Both risk measures are widely used in the financial world. There are strengths and limitations with both measures, and it is important to have a critical view of these measures throughout the thesis. Literature that has discussed these measures, will be presented and discussed in the thesis, and important terms that influence the City of Stavanger’s financial investments will be defined.

The first part of the thesis will look at theory and methodology that address the issue. Data that is used in the analysis is presented and described in the second part of the thesis. The third part consists of an analysis of the empirical results. A presentation of the result will be the first part of the analysis, and the second part will be a discussion of these results. Finally, a conclusion is made to sum up what the thesis consisted of, what was discovered and suggestions for future research.

Part 1: Review of theory and methodology

1.1 The City of Stavanger

In this thesis we will look at what risk the City of Stavanger is facing on their financial investments[1][2]. We will take a risk analysis of their portfolio from 2006, 2007 and 2008. The reason for looking at their portfolio historically is to see what financial development they may have accomplished and what risk they are facing today compared to previous years. Looking at the portfolio for 2008 will be particularly interesting because of the previous recession in the economy. A part of our analysis will be to find out if they have lost on their investments, and whether they took more risk in 2008 compared to previous years.

1.1.2 Financial regulations

It is important to know what financial regulations the CoS needs to follow. Since the city has responsibilities to the inhabitants they need to think long term when investing in securities[3]. At the end of 2008 the CoS had a hearing in Stavanger Chairmanship concerning the new regulation from the Ministry of Local Government and Regional Development. The reasoning for this regulation was the unfortunate financial investments that were discovered in the so-called "Terra case". Several municipalities in Norway made an agreement with Terra Securities to invest with loaned money in the bond market back in 2001. Bond investments in the American credit market were made and in 2007 the municipalities lost their invested money (Takla, 2007). In the after-math of the financial scandal the Ministry of Local Government and Regional Development proposed a regulation for how the financial administration should be for municipalities and counties. The CoS evaluated the regulation in a hearing which concluded that the financial administration should be correlated with the municipalities' own financial knowledge. Emphasis was placed on the need to report to the municipality council would be necessary. It was specified the need to handle risk and how to evaluate it (Saksfremlegg, 2008).

The Local Government Act was established 25th of September in 1992. In this thesis it is necessary to look at the paragraph that deals with the financial administration for municipalities and counties. §52 specifies the rules for financial administration and it is §52.2 that the Ministry of Local Government and Regional development wanted to change. The

[1] City of Stavanger will have the initials CoS throughout the thesis

[2] We refer to Stavanger as a city in this thesis. It is also a municipality and will be referred to that when we look at the Local Government Act.

[3] Securities are claims that a corporation sells on its real assets and on the cash those assets will generate, to obtain necessary money for the real assets, which can be tangible(machinery, factories) and intangible(technical expertise, trademarks) (Brearley, Myers, & Allen, 2006).

ministry may by regulations issue further rules concerning disposition of funds that entails financial risk in this particular paragraph. In §52.1 it says that the municipal council and the county council themselves issue rules for the financial administration of the municipal or county authority. The last section, §52.3, specifies the financial risk:

"Local authorities shall administer their funds in such manner that a satisfactory return may be achieved, without the entailment of any significant financial risk, and with consideration for the fact that the local authority shall have funds to meet its payment obligations when such payments fall due"(Local, 1992, p. §52).

Before the recent change in the §52.2 regulation there was another regulation that was made 5th of March in 2001. The regulation specified which rules municipalities and counties should follow in their financial administration. Low financial risk and high liquidity are key words in this regulation that specifies the importance of placing available liquidity and other means where these factors are followed (AFKommunepartner, 2005).

At the end of 2008 the CoS had a hearing that evaluated the new regulation. There were more specific determinations on how the municipalities prevent themselves for taking substantial financial risk in their financial administration. Routines on how to evaluate financial risk is in the new regulation and the municipality council or county council should make sure that it is followed. The municipality council and the county council have to take into consideration that the economic administration is justifiable and consider how to cover the current liabilities. Municipalities and counties have to base the regulation on their own financial knowledge. Again, as in the regulation from 2001, one should emphasize on low financial risk and high liquidity in the administration of available liquidity (Saksfremlegg, 2008).

1.2 Risk and return

It is important to look at what risk a company takes when investing in different financial assets. The different assets have different risks, and to determine risk we can study *the allocation* of these assets in the portfolio. Financial assets can be stocks and bonds. Level of risk is affected by the return the investor has on its portfolio. Return on the portfolio is affected by the different returns the investor has on his/hers different assets. In other words, the return on the portfolio is the weighted average of return on the individual assets (Brown, Elton, Goetzman, & Gruber, 2007).

1.2.1 Types of risk

Risk can be defined in many ways. In this thesis we will define risk as Johnathan Mun did in his book *"Applied Risk Analysis: Moving Beyond Uncertainty in Business"*:

"Risk is any uncertainty that affects a system in an unknown fashion whereby the ramifications are also unknown but bears with it great fluctuation in value and outcome " (Mun, 2004, p. 27).

It is important to remember that risk has a time horizon, and therefore affects outcomes in the future that are measurable. Scenarios regarding a benchmark are also affected[4] (Mun, 2004). When looking at a portfolio we refer to the risk as *financial risk*. Different types of financial risk exist, and assets may have different kinds of risk at the same time.

The CoS held a hearing in the city council at the end of 2008 and evaluated the new regulation for municipalities and counties financial administration. §4 b) in the new regulation consist of an explanation of the different financial risk that exists. Stavanger and other municipalities need to follow the regulation on how to handle risk, and define the different risk types according to this particular paragraph. In this thesis we therefore define financial risk and the different types of financial risk in the same way. *Financial risk* is the uncertainty of the future value of the investment or the commitment in relation to value at the time of the investment or when entering into the negotiations. *Credit risk* is when the counterpart in a contract does not redeem his/hers liabilities, where as *market risk* is a risk of loss or gain of costs because of changes in the market prices for the assets in the portfolio. *Interest rate risk* represents the risk interest rate has on assets. When the interest rate rises the asset value will as well, and when it goes down the asset value will decline. *Liquidity risk* is the danger that the assets cannot be available for the investor within a short time frame, in which case there will occur a substantial price fall for the assets because of the realization. There is also a risk associated with currency. *Currency risk* represents the risk for loss on positions and loans because of the exchange-fluctuations in the currency-market(Saksfremlegg, 2008).

Finally, two types of risk are associated with the stock market, systematic and unsystematic risk. *Systematic risk* in the stock market, also called general market risk, is associated with the probability that the actual stock market will drop or fall both on short- and long term. *Unsystematic risk* in the stock market, also called firm risk, is associated with the value of the

[4] Benchmark can be used to compare a company's ratios. Usual benchmarks are treasury securities (T-bills) and different rate- and stock indexes (Jørgensen, 2005)

actual investment object the investor is investing in will drop or fall with the value of the market both on short- and long term.

These types of risk are higher if the investor only focuses on investing his/her money on a few assets and the investor will experience substantial financial risk. However, if he/she tries to spread the risk by investing in several different assets, the financial risk will be reduced (Saksfremlegg, 2008). This spread of risk is called diversification in the financial language and can reduce risk.

1.2.2 Markowitz's efficient frontier of risky assets

In the 1950's, American economist Harry Markowitz constructed a portfolio selection model. It is argued that his research has revolutionized the world of finance when it comes to risk and return (Mun, 2004). In his article, *Portfolio Selection*, he looked at how investors should diversify portfolios. He questioned a rule which stated that an investor should diversify and maximize expected return. The rule described that there exists a portfolio that gives a maximum expected return and minimum variance at the same time. The investors were advised to use that kind of portfolio. He meant that the returns from securities are too lacking in correlation, and it is impossible to eliminate all variance with diversification. A portfolio that has a maximum expected return is not always the one with the minimum variance. He simply made another rule that would make the investor choose the optimal portfolio. The rule was called *the E-V rule*, where E is expected return and V is variance, or the expected return-variance of return rule. The expected return-variance of return rule led to an efficient portfolio and using that rule led to diversification of almost all securities[5].

Markowitz illustrated an example to show how effective this rule was. A portfolio with sixty different railway securities would not be as diversified as a portfolio with securities in several different industries. For example a portfolio consisting of some railroad securities, some public utility, mining and various sorts of manufacturing, would be better diversified than only securities in railway securities. He argued that it was generally more likely that firms within an industry would do poorly at the same time than firms in different industries. Another argument he made in his article was that it is not enough to make investments in many securities in order to make the variance small. Securities with high covariances among themselves where not good investments.

[5] Expected return, variance, covariance, correlation and standard deviation will be explained in detail under "Calculation approaches" and is illustrated in appendix A.

To summarize his article it can be said that investors should diversify across industries because they have lower covariances than firms within the same industry. The optimal choice would be to diversify in industries that have completely different economic characteristics (Markowitz, 1952).

In his book from 1959 *"Portfolio Selection: Efficient diversification of investments"* he argued that a good portfolio is more than a long list of good stocks and bonds. He meant that an integrated portfolio that gives the investor outcomes with protections and opportunities, is the optimal choice (Markowtiz, 1959). The portfolio selection model he constructed, known as *Markowitz's Efficient frontier*, identifies the problem with many risky assets and a risk-free asset. His model tried to resolve the portfolio construction problem. The problem consisted of several parts and it is important to identify them in order to resolve the problem. First, we need to look at what the risk-return combinations are in the set of risky assets that are available to us. Secondly, we need to find the portfolio weights that result in the steepest capital allocation line (CAL) in order to identify the optimal portfolio of risky assets[6]. By mixing the risk-free asset with the optimal portfolio, we can choose an appropriate complete portfolio which is the final step to resolve the construction problem.

To determine the risk-return combinations available we can summarize it with a *minimum-variance frontier* for risky assets. It illustrates the lowest possible variance for a given portfolio expected return and is referred to as a frontier. The expected returns, variances and covariances make it possible for us to calculate the global minimum-variance portfolio for any expected return and will show that diversifying investments lead to portfolios with higher expected returns and lower standard deviations. Portfolios that lie on the minimum-variance frontier from the global minimum-variance portfolio are candidates for the optimal portfolio. They will also provide the best risk-return combinations. It is therefore accurate to call the part of the frontier that lie above the global minimum-variance portfolio for an efficient frontier of risky assets[7](Bodie et al., 2005).

After identifying the risk-return combinations available, we need to find the portfolio weights that result in the steepest CAL-line. This involves searching for the highest reward-to-variability ratio. Reward-to-variability ratio is the slope, S, that is equal to the increase in expected return of the complete portfolio per unit of additional standard deviation. The

[6] Capital allocation line (CAL) is a straight line that describes all risk-return combinations available to the investors (Bodie, Kane, & Marcus, 2005, p. 203)
[7] $S = [E(r_c) - r_f]/\sigma_c$

optimal portfolio, P, that is tangent to the efficient frontier is supporting CAL, and CAL dominates all other feasible lines that leads to P being the optimal risky portfolio. The final step is to find the combination that will mix the optimal risky portfolio with a risk-free asset in an appropriate fashion. Markowitz's model identifies the efficient set of portfolios and it is called the efficient frontier of risky assets (Bodie et al., 2005). We can illustrate Markowitz's model graphically. *Figure 1* shows the frontier as a graph of the lowest possible variance that can be attained for given portfolio expected return. It also shows the minimum-variance portfolio for any targeted expected return if we are given the input for expected returns, variances, and covariances.

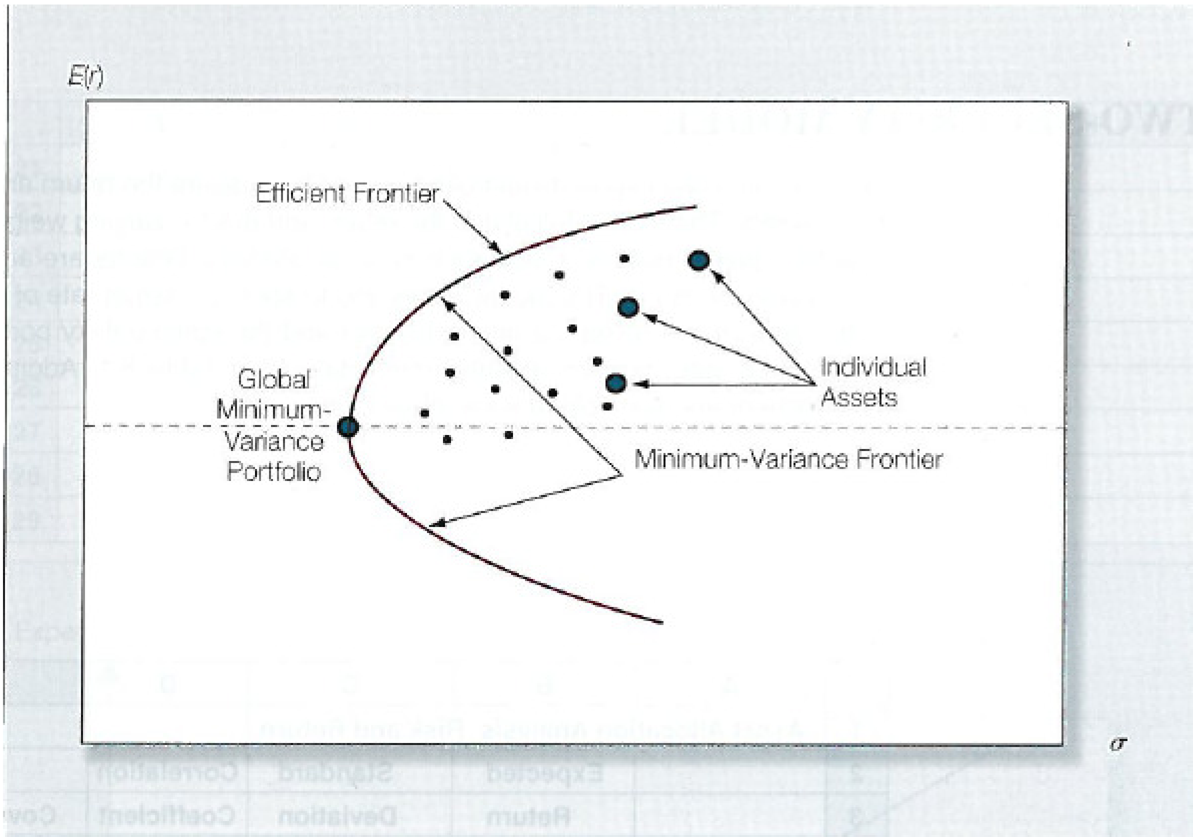


Figure 1 The minimum-variance frontier of risky assets

(Bodie et al., 2005, p. 241)

1.2.3 Trade-off between risk and return

There are some measurements we need to use to find the trade-off between risk and return of the portfolio. It is important to analyze what trade-off that exists between risk and return because the return can increase with an increase in risk. For instance, if we are investing in stocks with high risk, there is a bigger chance that we will achieve high returns, and vice versa if we invest in bonds with almost no risk we will achieve lower returns. We therefore need to know our own risk tolerance when investing in assets for our portfolio.

If we do not take any risk, or have risk aversion, we cannot expect to get a high return. Risk-averse investors want to be on the safe side and will in most cases only consider risk-free prospects or prospects with positive risk premium. Contra the risk-averse investors are the risk-lovers. They are willing to engage in gambles and fair games where they take high risk. Midway between these types of investors are the risk-neutral investors. Expected return is relevant for their choice. Risk-neutral investors look at the expected rates of return to see what risk they want to take (Brown et al., 2007). A graphical representation of the trade-off between risk and return can be useful and is represented in figure 2.

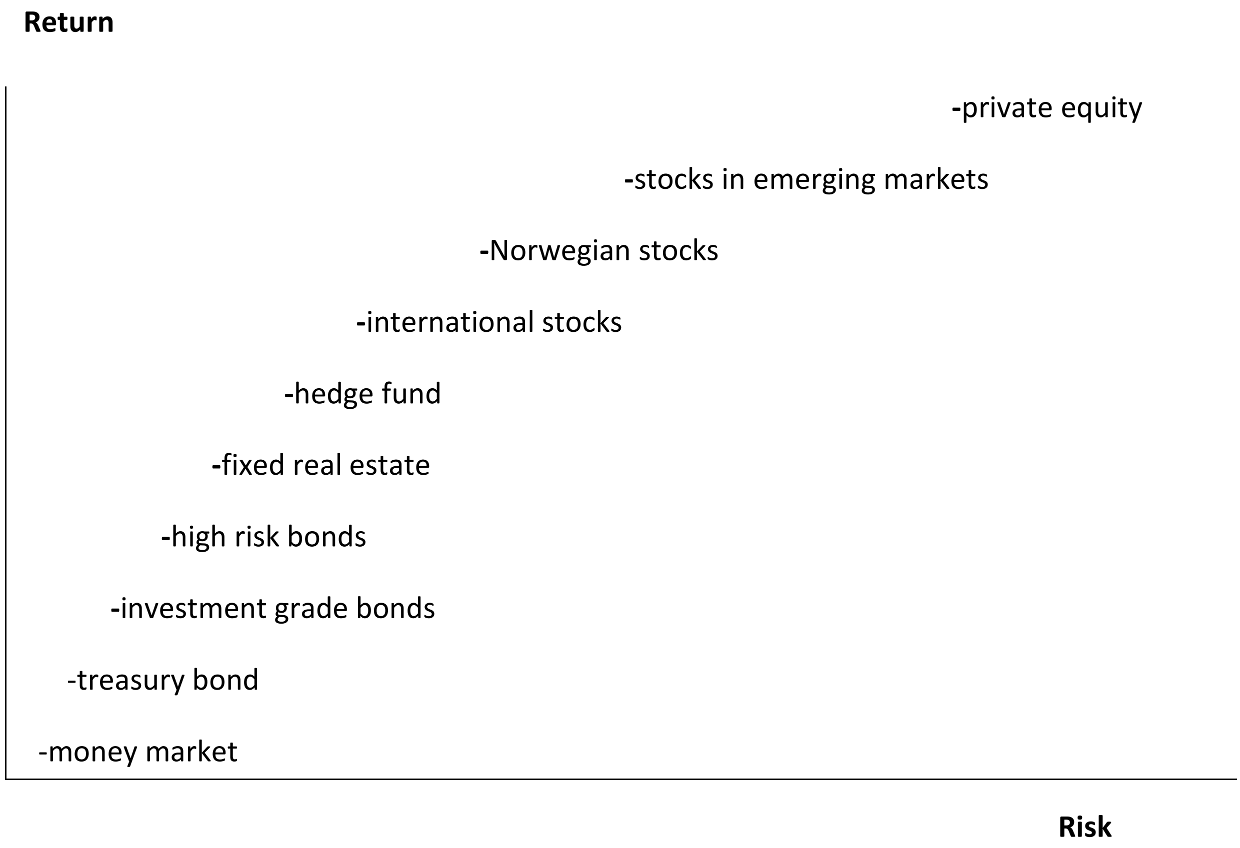


Figure 2 Trade-off between risk and return

(Jørgensen, 2005, p. 84)

1.2.4 Assets

When investors choose their portfolio they choose to invest in assets in different asset classes. Asset classes are different types of securities or financial assets like bonds and stocks (Jørgensen, 2005). Different types of stocks, that are securities, will together entail assets in an asset class. In order to understand exactly what these asset classes are we need to identify them. Since the CoS owns assets that are stocks, stock funds, money-market funds, mutual funds and bonds we need to know what these assets entail.

When we have a stock we own a share in the company. That means that we partly own the company, and that the stock is part of the company's equity. The return is the potential payout dividend and change in the stock-currency minus the costs related to buy/sell or own the stock (Jørgensen, 2005). *Stock funds* separate themselves from *regular stocks* because they do not give us a direct share in a company. With stock funds we buy different stocks in different companies. The Norwegian law of security funds demands spreading of the fund's investments over at least sixteen different issues of stocks or bonds. It is normal to have maximum 5 percent per issue, but the law can allow up to four 10 percent posts. For special index funds it will allow 20 percent in stocks from one issuer. A traditionally managed stock fund will put together a portfolio that lies in the context of those risk frames that are given to the benchmark. In these risk frames the fund will try to look for the best investments. *The Security Funds Association's* standard is defined as a security fund that normally can invest at least 80 percent of the funds' managed capital in stocks. Stock funds are divided into groups that are dependent on which investment universe the means are going to be placed in. It can for example be within a geographic limit or within an industry (Verdipapirfondloven, 1981).

Money-market funds are mutual funds provided for financial institutions by interest-rate regulation (Brearley et al., 2006). *Interest-bearing securities* with maturity under one year are offered here, and they are usually in the form of certifications, bonds with maturity under one year and bank deposits. On short term, these funds will have low interest risk and are often used for shareowners as a supplement for bank deposits.

We can separate the money-market fund into three parts. First, we have a *short-term fund* which means that we invest in short money-market instruments. These funds have a benchmark with low interest-sensitivity and we can separate short-term fund into two groups depending on if there is a credit risk involved or not. The second part is a *long-term fund* that involves investing in long money-market instruments. Here we have the opposite position from short-term funds. Long-term money-market funds have a benchmark with higher interest-sensitivity and these are divided into the same two groups as for short-term funds, depending on if there is a credit risk involved. Finally, we have *international money-market funds* that involve funds that have a benchmark of money-market instruments in foreign currency, or money-market instruments combined with Norwegian and foreign currency (Jørgensen, 2005).

Mutual funds are simply security funds that can invest in both stocks and interest-bearing securities. These funds are often flexible which make it possible for investors to switch their shares in stocks and interest-bearing securities when there is boom/recession in the stock market. In mutual funds there is a division in four parts. *Norwegian mutual funds* are funds that normally invest 80 percent of their managed capital in the Norwegian security market. *International mutual funds* have an international mandate and invest in other countries other than Norway. *Life-maturity funds* are funds where shares in stock are high in the beginning, but decline during their maturity. Bonds and money-market instruments will have bigger part when the portfolio is close to the end. A fourth part of mutual funds also exists, and under this group there are funds that can be classified specifically as for example industry-exposed funds (Jørgensen, 2005).

A bond is an interest bearing security that can be available as a standardized loan in an organized market with a longer maturity than one year (Jørgensen, 2005). There are two parts involved in a bond agreement, the lender and the borrower. The borrower sells a bond to the lender for some amount, and the agreement obligates the issuer to make specified payments to the bondholder on specified dates, longer than one year. When it is an interest payment, we can call it a coupon bond with coupon payments collected over the life of the bond (Bodie et al., 2005).

In the CoS's portfolio there are also assets in stock index bonds. *Indexed bonds* are different than interest bearing bonds. The payments that are done with an indexed bond is tied up to a general price index or it is determined after the price of a commodity (Bodie et al., 2005). For the CoS it is tied up the stock price index. The return on the bond is attached to the stock index (Jørgensen, 2005). However, it is more secure than a normal stock since the return is an agreed amount as we receive with the interest bearing bond.

1.3 Methodology

The method of the analysis is *quantitative* which means that the collected data is expressed in mathematical terms. Qualitative method is the opposite of the quantitative method. It tends to be stated verbally instead of in mathematically terms(Abott & Bordens, 2005). In a statistical analysis a unit refers to one member of a set of entities being studied. Each unit can be described by a set of variables that can be measured quantitatively and classified. Units are separated objects in a population that we wish to describe. We can separate the units between respondents and observations, where observations can be mathematical terms and respondents can be people responding to a specific survey made by the researcher (Johannessen, Kristoffersen, & Tufte, 2004). In the analysis, historical daily data of different indexes from the Oslo Stock Exchange is used to measure the risk for the CoS's portfolio and these are our observations. The daily value of the portfolio is also an observation in the analysis. We have a set of variables that describes each unit, where the indexes are independent variables and the portfolio value is a dependent variable. The indexes are independent variables because they are not affected by what the CoS invest in. However, the CoS's portfolio value is affected by how the fluctuations of the indexes are, and is therefore a dependent variable.

.

1.3.1 Statistical methodology- statistical terms of risk

In order to look at the risk in our analysis we need to know what the statistical terms of risk are. We can divide our analysis into several parts. We have the collection, the presentation, the analysis and the utilization of numerical data to infer and make decisions in the face of uncertainty. The actual population data is unknown. In statistics there are two studies that are used, *descriptive statistics* and *inferential statistics*. Descriptive statistics is where data is summarized and described, whereas inferential statistics is where the population is generalized through a small random sample. Since the population characteristics are unknown, the samples become useful for making predictions or decisions.

We need to know the difference between population and sample. A population is *all* possible observations of interest of a variable, whereas a sample is *a subset* of the population being measured (Mun, 2004). In our research the population is all the Norwegian municipalities that have taken similar financial investments as those taken in the CoS. The CoS as a municipality is our *sample*. This means that we will get a result that demonstrates what risk the CoS is facing on their financial investments. However, it may be quite different for other municipalities in Norway and it must be taken into consideration that the result may not be valid for the whole population in this research. It is necessary to look at observations and how they are divided, without considering if the results can be generalized from sample to population. This means that we are looking at *descriptive statistics* in our research.

1.3.1.1 Statistical distributions

Statistical distributions are used in the research and it is therefore important to know what they are. We can divide the distribution into four moments. The first moment is measuring the center of the distribution (*see appendix B.2.1*). Here the expected rate of return on a particular object is measured. It measures the location of the project's scenarios and possible outcomes on average (Mun, 2004, p. 29) In this part it is usual to include mean (average), median (center of distribution) and mode (most commonly occurring value).

The spread of the distribution is the second moment which becomes a measure of risk (*see appendix B.2.2*). It measures the variability of a variable[8]. This means the potential scenarios of outcomes. We can say that spread of the distribution measures a variable's risks. The risk of a variable can mathematically and statistically be measured through several different statistics. In our research we look at standard deviation and variance which are two of these measures. We can also use range, coefficient of variation and percentiles. Percentiles will be used during the analysis when using Value at risk and historical simulation[9].

The third moment of the distribution is the measurement of skew (*see appendix B.2.3.a and B.2.3.b*). That the distribution has a skew, entails that it is pulled to one side or the other, whereby median moves towards the tail of the distribution. Standard deviation, variance or width can remain constant.

Last we have the measuring of the catastrophic tail events in a distribution (*see appendix B.2.4*). This moment is called kurtosis and measures the sharpness of peaks or thickness in the tails. In other words, it measures the catastrophic losses or gains. Although the returns and risk are identical, there can occur extreme and catastrophic events. Probabilities for these events are higher if there is a high kurtosis distribution (Mun, 2004).

1.3.1.2 Calculation approaches

In the analysis different calculations are used to find *Value at risk and Sharpe ratio*, which are the two risk measurements used in this thesis[10]. Periodic return, expected return, variance and standard deviation are formulas that we need to calculate in order to find *VaR and Sharpe ratio*. *The periodic return* shows the relationship between the price today and the price

---

[8] The variability of a variable is the potentiality that the variable can fall into different regions of the distribution (Mun, 2004, p. 29)

[9] We will explain Value at Risk in later under the section *"The risk measures"*.

[10] We will explain Sharpe ratio later under the section "*The risk measures*".

yesterday. This gives grounds for the calculation of the return (*see appendix A.1.1*). Another calculation approach that is necessary to calculate is the *expected return*. We can define expected return as the average of possible returns weighted by their probabilities (*see appendix A.1.2*) (Brearley et al., 2006). Since the standard deviation outcome is necessary in the analysis, it is important to know how to find the variance. The variance calculates the potential to deviate from the expected return (*see appendix A.1.3*). It is a measure of variability (Brearley et al., 2006). When we have calculated the variance, we can also calculate the standard deviation. It is the square root of the variance (*see appendix A.1.4*). In statistical terms we can say that it is a measurement for the fluctuations of outcomes around an expected value. The standard deviation to a return in a portfolio measures to what extent actual return on a portfolio deviates from the expected return (Jørgensen, 2005).

We use covariance in the analysis, which is a measure of the co-movement between two variables (*see appendix A.1.5*). The sign of the covariance tells how the different asset returns moves relatively to each other. If the covariance is positive, they move together and if it is negative they vary (Bodie et al., 2005) To get a more accurate estimation of how the assets move together, we can calculate the correlation coefficient (*see appendix A.1.6*). When the correlation coefficient is 1, we can say we have a perfect positive correlation between the assets, and vice versa when we have -1, which means we have a perfect negative correlation. Two assets that are negatively correlated leads to the greatest payoff to diversification, but this rarely happens (Brearley et al., 2006). The *allocation of the assets* has an impact on how the *trade-off* between risk and return affect the portfolio. The calculation approaches we use will change when we look at a portfolio with different assets.

First, we can look at the rate of return on the portfolio. In our example we can look at a portfolio with two different assets where $_1$ is one stock and $_2$ is another. The expected return, variance and covariance will now be different (*see appendix A.1.7, A.1.8, A.1.9, A.1.10 and A.1.11*). Variance leads to the standard deviation, and as before the standard deviation is the square root of the variance (*see appendix A.1.12*).

We can reduce risk by *diversifying* our portfolio. An *efficient diversification* requires a risky portfolio that should be able to provide the lowest possible risk at any given level of expected return (Bodie et al., 2005). It is therefore necessary to know which calculation approaches to use.

1.3.2 The risk measures

The quantitative method that we use in this research is based on two different risk measures that can predict what risk the CoS is facing on their financial investments, *Value at Risk and Sharpe ratio*. These measurement need to be explained to get a picture of what they can tell us and how they are used in the research. It is important to have a critical view on these measurements, and also be aware that the validity may not be as strong as we may have assumed beforehand.

1.3.2.1 Value at Risk

Value at Risk can be calculated with a simple number that can say what the total risk on the portfolio is. It tells us what potential loss the portfolio is vulnerable to and highlights the potential loss from extreme negative returns (Bodie et al., 2005; Jørgensen, 2005). From the mid 1990's it has become a popular risk measurement method for financial institutions to use as a measurement for market risk on their portfolio(Lillestøl, 2002). In July 1993 VaR received its first wide representation through the Group Thirty report[11] (Rogachev, 2002). VaR was initiated by Jorion(1997), Dowd(1998) and Saunders(1999) as a risk measurement. Since then VaR has become the most famous risk characteristics tool in the practice of the risk estimates (Rogachev, 2002). It has been used as an aide to identify several things, such as evaluating investment risk, identifying optimal allocation of assets and for measuring the quality of a portfolio (Wirch, 1997).

John C. Hull defines Value at Risk (VaR) in his book *"Options, futures, and other derivatives"* as follows:

"I am X percent certain that there will not be a loss more than V dollars in the next N days"(Hull, 2006, p. 443).

V is a variable and stands for the VaR in the portfolio. N days is the time horizon, and X percent represents the confidence level. There are some terms that need to be defined in order to understand exactly what the VaR measures are. When we use VaR, we also use probability distributions. Probability distributions can either be discrete or continuous. The difference between the two is that the discrete describes distinct values with no intermediate values and is shown in a series of vertical bars, whereas the continuous are actually mathematical abstractions. Continuous distributions assume the existence of every possible intermediate

[11] Group of Thirty is a consultative group on international economic and monetary affairs which represents private and public sector and the academia (Thirty, 2009).

value between two numbers (Mun, 2004). When we use VaR we assume a *discrete distribution*.

There is also a need to define what confidence interval is in order to compute VaR. We can define it as a bound calculated around a statistic. It tries to measure the bound error with a given level of probability. If we have 95 percent confidence interval around the mean statistic, it means that there is a 95 percent chance that the mean will be contained within a specified interval. This will result in a 5 percent chance that the mean will lie outside the interval. Confidence interval helps to determine the accuracy of statistics which contributes to an accurate simulation. In our calculation of VaR we assume normal distribution. Normal distribution describes natural phenomena such as human's IQ's or heights. In the financial world, normal distribution can help decision makers to describe uncertain variables such as inflation (Mun, 2004). An example for VaR calculations, if the confidence level is 95 percent, the loss level over the next N days has a probability of 5 % (100-95 percent) of being exceeded (Hull, 2006). With a probability of 5%, we can expect a loss equal to or greater than VaR (Bodie et al., 2005)[12]. In other words, there is a 5% probability that the loss will be worse than VaR.

A loss greater than VaR occurs only with a small probability since VaR is a loss due to "normal" market movements (Linsmeier & Pearson, 1996). In that way extreme losses are ignored, and it does not tell us what will happen in those small probability cases were the loss exceeds VaR (Christoffersen, 2003). The absolute worst that can happen is not measured with VaR. VaR represents in most cases the percentile of the distribution of changes in portfolio value over the next N days (Hull, 2006). Time horizon and confidence level are the two most important components in VaR models (Hendricks, 1996).

1.3.2.1.1 Critique of VaR

There are limitations with this risk measurement, and several researchers have criticized this method for being superadditive, which indicates that a combined portfolio has a bigger VaR value than two individual portfolios. Although VaR has percentile measures, it still is superadditive which leads to the conclusion that it is not a consistent measure (Wirch, 1997). We can look at an example with the distributions of X and Y. X with light tail probabilities

[12] A graphical presentation is shown in appendix C.3.1

and Y with heavy tail probabilities can have the same VaR. Using VaR can lead to problems if one large firm wants to split up into two smaller firms. In that case the VaR value would not be valid, and this is the main criticism of using the VaR method (Tasche, 2002).

Another critique concerning VaR is that it is only statistically calculated. It does not look at the daily changes of the surrounding environment. The surrounding environment can be financial, economic and social conditions. We can say that VaR provides only quantitative and synthetic measures of risk (Rogachev, 2002).

1.3.2.1.2 Historical simulation versus variance-covariance method

Two different model approaches of VaR are used in this thesis- *historical simulation and the variance-covariance method*. Actual percentiles of the observation period are used in the historical simulation approach as VaR measures. The approach does not make the assumption of normality or serial independence (Hendricks, 1996). When using the historical simulation approach, we involve past data to predict the future.

First, we need to identify the market variables that affect our portfolio. These market variables may be exchange rates, interest rates or equity prices. Historical data from the market variables affecting our portfolio is then collected. If we assume a 99% confidence level and a 1-day time horizon, the VaR estimate is the first percentile of the distribution that represents the fifth-worst daily change. In our example we can have data from the recent 501 days. We get 500 scenarios from these observations that can tell us what might happen between today and tomorrow. The different scenarios represent different percentage changes in the values of all variables. *Scenario 1* tells us that the changes are the same as they were between Day 0 and Day 1 and in *scenario 2* they are the same as between Day 1 and Day 2, and so on (Hull, 2006). The *i*th scenario assumes that the value of the market variable tomorrow will be:

$$\mathbf{1}.\quad v_m \frac{v_i}{v_{i-1}} \text{ (Hull, 2006, p. 447),}$$

v_i is the value of a market variable on Day i and Day m is today.

Historical simulation is easy to implement and is model-free of nature. It lets the past data determine the distribution of tomorrow’s return. In other words, the historical simulation approach does not let any further assumptions interfere other than the past data (Christoffersen, 2003). Trade-offs in the time horizon periods are similar in both the historical simulation approach and variance-covariance approach. When estimating historical percentiles it is best to use a long observation period because of the desire for accuracy.

Extreme percentiles are difficult to estimate accurately when using small samples. So when we are analyzing a 99- or 95 percent confidential level we need to have a long observation period in order to get an accurate estimate of VaR. It is a tendency that longer observation periods produce less variable results (Hendricks, 1996).

While we did not make assumptions of normality and serial independency under the historical simulation approach, we do make this assumption under the variance-covariance approach. Under this approach normality simplifies VaR calculations. This is because it is assumed that all percentiles are known multiples of the standard deviation. In other words, the estimate of the standard deviation of the portfolio's change in value over the holding period is enough to calculate the VaR estimate. When using the term serial independency, the changes in prices one day will not affect the estimation of changes in prices any other day. Assuming both normality and serial independency makes it possible to use a single calculation of daily horizon standard deviation to develop a VaR measure of any given holding period and at any given percentile (Hendricks, 1996). It is necessary to know how to calculate daily standard deviation where we assume that there are 252 trading days per year. The formula is:

$$\mathbf{2.}\ \boldsymbol{\sigma}_{day=\frac{\sigma_{year}}{\sqrt{252}}} \text{(Hull, 2006).}$$

1-day VaR is then calculated by using the formula:

$$\mathbf{3.}\ \boldsymbol{\mu - k\sigma}\ .$$

μ is the daily expected return of the portfolio, k is the critical z-value under normal distribution and σ is the daily standard deviation. We can also calculate a 10-day VaR by using the variance-covariance method. To find the standard deviation over ten days we need to use an adapted formula:

$$\mathbf{4.}\ \boldsymbol{\sigma_{10-day} = \frac{\sigma_{year}}{\sqrt{(\frac{10}{252})}}}\ .$$

10-day VaR is then calculated using the same formula as 1-day VaR, *formula number 3*. Both the historical simulation- and variance-covariance approach relies on historical data. The disadvantage with the historical simulation method can be that the data that is collected over the time horizon period is not typical, and this can under/over state the risk of the portfolio. However, there are also disadvantages with the variance-covariance method because the assumed distribution may not describe the actual distribution of the market factors. In actual distribution there can exist "fat" tail unlike the conditions under normal distribution

(Linsmeier & Pearson, 1996). Since historical simulation uses actual distribution, the VaR calculation with this method would not be attractive if the distribution truly were normally distributed (Christoffersen, 2003). Many risk managers use Value-at-Risk and the reason for that may be because of its attempt to provide a single number that can summarize the total risk in a portfolio with financial assets (Hull, 2006).

We have now looked at Value-at-Risk, and presented a way to estimate the potential loss of the portfolio. The other risk measure we need to look at is the Sharpe ratio.

1.3.2.2 Sharpe ratio

William Sharpe extended Jack Treynor's work in 1966. Treynor's measure gives excess return per unit of risk and uses systematic risk instead of the total risk (Bodie et al., 2005). William Sharpe wanted to make explicit the relationship between recent developments in capital theory and alternative models of mutual performance. He also wanted to subject these alternative models to an empirical test. In his analysis he showed that mutual fund performance could be evaluated with a simple, yet theoretical, measure that considers both risk and return (Sharpe, 1966). Sharpe ratio says something about how much extra return we can achieve in addition to the risk-free rate if we take a given risk. In other words, it is the difference between the fund's *average annual return* and the *pure interest rate*. The investor, who bears the risk, gets the reward (Sharpe, 1966).

By subtracting the risk-free rate from the return on the portfolio and dividing this with the portfolios standard deviation, we get the Sharpe ratio.

The formula is: **5.** $S = \frac{r_p - r_f}{\sigma_p}$ (Jørgensen, 2005, p. 85).

r_p is the average return of the portfolio, r_f is the risk-free rate and σ_p is the standard deviation for the portfolio. We need to know which formulas to use to find these estimates. First, we need to find what the return is on individual assets, and we use the formula for periodic return *(see appendix A.1.1.)*. Since we now have the return on each asset we can calculate the return on the portfolio, r_p *(see appendix A.1.7.)*. Risk-free rate, r_f, is the rate we can earn by leaving money in risk-free assets. These assets can be T-bills, money market funds or the bank (Bodie et al., 2005). The difference between return on portfolio, r_p, and the risk-free rate, r_f, is called *excess return*. In other words, it is the difference between the actual return on a risky asset and the risk-free rate. We can illustrate excess return with the following formula:

6. $E(r)_{t,i} = r_p - r_f.$

The formula for the standard deviation for the portfolio, σ_p, is the same shown in *appendix A.1.12.* To summarize what Sharpe ratio is we can say that it divides average portfolio excess return over the sample period by the standard deviation of returns over that period(Bodie et al., 2005).

1.3.2.2.1 Critique of Sharpe ratio

There have been several researchers criticizing the fact that Sharpe ratio does not work for hedge funds, and we can say that the ratio suits mutual funds best. It depends heavily on statistical properties of return series and can cause a problem for hedge funds. Hedge funds have very different return characteristics from mutual funds and so it is not suitable to compare the two using the Sharpe ratio. Andrew W. Lo looked at that problem and found out that if we use a more appropriate statistical distribution for quantifying the performance of each return history, the Sharpe ratio will be more accurate to use. By doing so, the Sharpe ratio can provide a more complete understanding of risk and reward, a broad array of investment opportunities (Lo, 2002). Another critique the Sharpe ratio measure has faced, is the fact that risk is not an “observable” variable. Return is definite and meaningful; but risk, although it can be measured through standard deviation that can be calculated from any time series return data, is not. The time series may not be similar, and this means that in order to make standard deviation a meaningful statistic at all return time series, it must be generated from a process that is both stationary and parametric. Even if these criteria are met, the Sharpe ratio appears to reward returns and penalize risks, say some researchers (Harding, 2002).

Vinod and Morey developed a “double” Sharpe ratio in 1999. The reason for the development was because of the methodological problem they concluded the Sharpe ratio suffered from. They hold that the Sharpe ratio has a methodological problem because of the presence of random denominators in its definition and the difficulty in determining the sample size needed to achieve an asymptotic normality.

To sum up, the Sharpe ratio does not permit an easy method for evaluating the estimation risk in the point estimate itself. Small-sample distribution of the Sharpe ratio is the reasoning for that, and it is abnormal. The researchers think that because of this usual method on the ratio of statistics, the standard errors are biased and unreliable. In their research for the “double” Sharpe ratio, they critique the Sharpe ratio of showing that two different portfolios have very similar performance if they have similar Sharpe point estimates. They mean that there is an uncertainty behind the point estimates. One portfolio may have little estimation risk on its Sharpe ratio while the other may have a great estimation of risk (Vinod & Morey, 1999).

William Sharpe wrote another article in 1994 called *"The Sharpe Ratio"* where he examined situations where mean and variance could be usefully summarized with the Sharpe ratio. In other words, where two measures could be summarized with one. In the article it is emphasized that the Sharpe ratio will be computed using mean and standard deviation of differential return. Differential return represents the results of a *zero-investment strategy*. It was also discussed which Sharpe ratio to choose from when we face a set of funds in a particular market sector. The greatest predicted Sharpe ratio was the correct answer, but only if the correlations of the funds with other relevant asset classes were reasonably similar. When choosing the Sharpe ratio, it is necessary to know that the Sharpe ratio does not take correlation into account (Sharpe, 1994).

Part 2: Data

2.1 Data used in the analysis

In this analysis we look at the CoS's portfolio and our goal is to find out what risk they take on their financial investments. Two risk measurements are used, *Value at Risk(VaR) and Sharpe ratio*. Since the CoS only invests in financial assets that are quoted on the Oslo Stock Exchange, we will analyze these indexes historically and thereby calculate VaR and Sharpe ratio. To establish a comparison foundation for the CoS, we will also analyze the CoH's portfolio from 2004 to 2007. The comparison between the CoS's and the CoH's portfolio, will enable us to draw an accurate picture of what risk the CoS has taken on their financial investments. When doing VaR calculations, it is appropriate to have a comparable portfolio in order to get calculations that are representative.

2.1.1 Description of the city of Stavanger's portfolio

A historical description of the CoS's portfolio is important to get an idea of what risk they take on their financial investments. In this thesis we look at their portfolio from 2004 to 2008. The *allocation* of asset classes is important to look at in order to see how they *diversify* risk. We got the portfolio data from the annual reports that the CoS has presented from 2004 to

2008. Portfolio pr 31.12.2004 had the following asset classes (approximately) in NOK showed in table 1:

Interest bearing bonds and certificates	50 320 000
Stock index bonds	53 555 000
Stock funds	3 929 000
SR-management	15 008 000
Total amount	122 812 000

Table 1 The CoS's portfolio from 2004

(Stavanger, 2004)

There was an increase in the total amount invested in the portfolio from 2004 to 2005. The portfolio pr 31.12.2005, showed in table 2, was (approximately) in NOK:

Interest bearing bonds and certificates	73 405 000
Stock index bonds	34 122 000
Stock funds	5 469 000
SR-management	21 427 000
Total amount	134 423 000

Table 2 The CoS's portfolio from 2005

(Stavanger, 2005)

The increase in the financial investments from 2004 to 2005 was *9,45 percent* as we can see when we compare tables 1 and 2. In 2006 the CoS made a further increase on their financial investments. The portfolio pr 31.12.2006, showed in table 3, was (approximately) in NOK:

Interest bearing bonds and certificates	133 400 000
Stock index bonds	37 100 000
Stock funds	32 200 000
SR-management	40 800 000
Total amount	243 500 000

Table 3 The CoS's portfolio from 2006

(Stavanger, 2006)

The increase in financial investments was large in 2006, and we can see when we compare tables 2 and 3 that the total increase was *81,14 percent*. In 2006 the increase was not as large as the year before. The portfolio pr 31.12.2007, showed in table 4, was (approximately) in NOK:

Interest bearing bonds and cerificates	111 600 000
Stock index bonds	57 400 000
Stock funds	71 600 000
SR-management	35 500 000
Total amount	276 100 000

Table 4 The CoS's portfolio from 2007

(Stavanger, 2007)

From 2006 to 2007 there was an increase in the financial investment by *13,39 percent* as we can see when comparing tables 3 and 4. The information we received on the portfolio were more specific than we received the previous years. Under the asset class "interest bearing bonds" there is information on which type of bonds they included. Bank bonds were approximately 50,5 mill NOK, offshore bonds were around 53,8 mill NOK and other types of bonds were around 7,4 mill NOK. It is interesting to see that the CoS has invested in offshore bonds. This makes sense considering there are offshore interests in Stavanger, whereby the city receives tax income from the offshore business. This leads to a higher correlation in the portfolio than it would be if they had not invested in offshore bonds. The high correlation leads to a reduction in the diversification that can imply that they are taking a higher risk. It can be argued that the CoS should not invest in oil assets since they have income from that industry.

The portfolio from 2008 has been affected by the financial disturbance that occurred during that year. Because of the big fall on the world's stock exchanges, the CoS has lost on their financial investments. Since the CoS is exposed to the stock market with their Nordic and global stock funds, including long-term interest-bearing securities, they have a unrealized rate loss on their portfolio that was pr 31.12.2008 *92,6 mill NOK*. Fortunately, the CoS had a rate-regulating fund when entering 2008 at 58,6 mill NOK. They got a negative return on their financial investments in total at 24,96%(Stavanger, 2008). The portfolio for 2008, showed in table 5, was pr 31.12.2008 in NOK:

Money market funds	103 650 099
Bonds/responsible/loans	135 565 357
Stock index bonds/index bonds	52 090 000
Mutual funds	6 037 285
Stock funds	52 633 715
Stocks/Primary capital certificates	22 233 738
Other assets	970 297
Total amount	373 180 491

Table 5 The CoS's portfolio from 2008

(Stavanger, 2008)

In 2008 the CoS increased their financial investments by *35,16 percent* and also invested in new asset classes, as we can see from table 5.

We divide the financial assets from the CoS's portfolio into different asset classes when we calculate *VaR and Sharpe ratio*. The asset classes from 2006 and 2007 are the same. We have defined SR-management as stocks and it is defined under the asset class *"Norwegian stocks"*. Stock index bonds are under the same asset class. Interest bearing bonds go under the asset class *"Norwegian bonds"*, and stock funds go under *"Norwegian stock funds"*.

For 2008 we have divided the assets into more classes than the previous years since the CoS has added assets in their portfolio. The portfolio for 2008 is allocated in the following classes when calculating VaR:

Asset classes	Including
Norwegian stocks	30% combination funds
	stock index bonds(AIO) and BMA
	Stocks
Norwegian stock funds	Skagen fund
	Stock funds
Norwegian bonds	70% combination funds
	bonds/responsible/loans
Norwegian risk-free rate	Money-market funds

2.1.2 Comparison with the city of Hagesund- a "Terra" municipality

To get a better picture of what risk the CoS has taken, we can compare its portfolio with the CoH's portfolio[13]. When comparing with the CoH, who took a big risk in 2004, it may help us to find out how low (or high) risk the CoS has taken. The CoH has lost *93,3 million NOK* because of Terra Securities' mismanagement. Back in 2004 the city council placed the profit form Haugeland Kraft in bonds referred to as Credit Linked Note (CLN) because of the case "Reconstruct the profit from Haugaland Kraft". We can look at CLN as a combination of a regular corporate bond and a credit default swap[14]. It is a type of credit derivative that can be used by debt issuers to hedge against their credit risk, and is sold by the note holder who receives a risk premium from the note (HUI, 2001). The investment was originally intended to give a return of approximately 20 million NOK. This allows the issuer to transfer specific credit risk to credit investors. At the time of the investment the CoH considered the risk to be very low(Haugesund, 2008).

When they got a realized loss on the investment in 2005 of 3,5 million NOK, they sold CLN. Instead they bought CDO (Collaterized Debt Obligation) on recommendation from Terra Securities. CDO is a way of *packaging* credit risk. When several classes of securities are created from a portfolio of bonds and when there are rules for determining how the cost of defaults are allocated to classes, we can call them for CDO (Hull, 2006). The new investment was supposed to reduce the risk and prevent new losses in the period. Expected future return was adjusted to approximately 14 million NOK. In December of 2007 it was confirmed that the investment had a much bigger risk for loss than what was informed by Terra Securities informed about. The bond dropped in value, and the loss came to 93,3 million NOK. It was also revealed that the bond had a trigger, which means that the security attached to the bond gives the issuer the right to sell when the value drops under 50 percent of face value. In March of 2008, Citigroup used that right and forced a sale on the bond, which resulted in that the CoH lost more than 130 million NOK(Haugesund, 2008). As we can see from these results, the CoH took a huge risk when they bought American bonds, and faced much bigger losses than they ever could have predicted beforehand.

Since the CoH invested in American bonds, we have to look at indexes that are quoted on an American stock exchange. We use an index that is quoted on the New York Stock Exchange

[13] The city of Haugesund will have the initial CoH throughout the thesis
[14] A credit default swap is a private agreement between two companies that entail credit risk, where a financial institution can be in an offsetting contract with the two companies. If one company default the financial institution still has to honor the contract it has to the other party (Hull, 2006).

in our analysis of the CoH. It is important that investors perform thorough analysis before making such a big investment as the CoH did. CoH's portfolio from 2004 until 2008(pr 31.12), showed in table 6, was in NOK:

	2004	2005	2006	2007	2008
Bonds	248973180	251671062	253118608	338864363	0
Total amount	248973180	251671062	253118608	338864363	0

Table 6 The CoH's portfolio from 2004 to 2008

(Haugesund, 2008)

As we can see from table 6, the CoH only invested in bonds, and in 2008 they had zero investments. From portfolio theory we know that it is important to diversify the portfolio in order to reduce risk. The CoH did not do that and that may have been a contributor to the big losses they experienced on their bond investments.

2.1.2.2 Hypothetical portfolio

In our analysis we use a hypothetical portfolio to illustrate and compare the risk the CoH took in 2004. We use indices that are quoted on the New York Stock Exchange, one for bonds and one for stocks. The allocation between the two asset classes is 60 percent stocks and 40 percent bonds. To compare the CoH with a hypothetical portfolio, might show why diversification is important. We will now show the hypothetical portfolio pr 31.12.2004, showed in table 7, in NOK:

Stocks	150 000 000
Bonds	100 000 000
Total amount	250 000 000

Table 7 The hypothetical portfolio from 2004

VaR and Sharpe ratio are the basis for our risk analysis. We have defined these measures earlier in this thesis, and it is now time to explain how we use them through our calculations in Excel.

2.2 Description of the data calculated in Excel

It is important to know how the data was calculated in order to understand the results. As mentioned earlier in this thesis, we use historical data to calculate VaR and Sharpe ratio. The indices we use are collected from http://finance.yahoo.com/ . Since we use different indices, we also get different trading days that we can use per year. This is because not all the indices were traded on the same day. Some days there were no trading for any of the indices, and some days one index was traded on, but the others were not. In order to make it as accurate and clear as possible, we have shortened the trading days in a way that all the indices were traded on the same days. This leads to the fact that one year may have more trading days than another. For 2001, in particular, there are only 148 trading days. We still expect to get accurate calculations, and correct VaR and Sharpe ratio.

2.2.1 Value at Risk (VaR) in Excel

To calculate Value at Risk we used two approaches, variance-covariance method and historical simulation. We used Excel to find VaR in both methods.

2.2.1.1 Variance-covariance method in Excel

First, we will describe how we used variance-covariance method in Excel. We divided the assets into three different asset classes in 2006 and 2007 and used historical data from the Oslo Stock Exchange to calculate the periodic return from the different asset classes. The log return formula was used to calculate the periodic return:

$$7.\ \ln(P_t/P_{t-1}).$$

The indexes we used from the Oslo Stock Exchange were OSEBX which stands for the Oslo Exchanges Benchmark Index, OSEFX that is the Oslo Exchange Fond Index and ST1X that is one of the bond indexes on the Oslo Stock Exchange. In 2008 we had one more asset class in the portfolio, the money-market fund, in the portfolio, and we used the risk-free interest rate as the market factor that will influence that particular asset class. To find the risk-free rate we downloaded the overnight lending rate from the central bank of Norway’s website. When we estimated the CoH’s VaR we took the ten year Treasury note (^TNX) as the index that affects the CoH’s portfolio since ^TNX can be compared with bonds and is quoted on the New York Stock Exchange. Our hypothetical portfolio have two indices as market factors, ten year Treasury note (^TNX) and S&P500 (^GSPC), which is a stock index quoted on the New York Stock Exchange.

To get as accurate VaR as possible for the CoS, daily historical data back to 2001 are used when calculating VaR for 2006, and in 2007 data back to 2002. The time frame was reduced for 2008 by four years, estimating from 2006 to 2008. For the CoH we used historical data back three years for the VaR calculations in 2006 and 2007. We also did a calculation for the CoH where we compared their portfolio in 2004 with a hypothetical portfolio, and we used historical data for four years when doing those calculations.

After calculating the periodic return for all the indexes we calculated the average return for each index, and then found the expected return for 2006, 2007 and 2008. We simply multiplied the average return by 12 to get the expected return.

It was necessary to find the *covariance* in order to find the variance. In Excel there is a simple function for this calculation. It was also important to know what the asset allocation was. After finding the asset allocation, we calculated the variance-covariance to be able to calculate the variance. The variance was calculated with the weight of the asset classes and the variance-covariance calculations. We then had the variance for the portfolio from 2006, 2007 and 2008 and we could find the standard deviation by taking the square root of the variance. The expected return for the asset classes was the expected return we found using the average returns.

In order to find what the expected return was each day, we first needed to find what the expected return was for the whole portfolio in 2006, 2007 and 2008. The weight was multiplied with the expected returns for the asset classes:

8. (expected return OSEBX*weight stocks)+(expected return OSEFX*weight stock funds)+(expected return ST1X*weight bonds).

For 2008 we added one more asset class into the calculation, money-market fund, and got the asset allocation weight multiplied with the risk-free rate. Daily expected return was the expected return for 2006, 2007 and 2008 divided by 252, since there are 252 trading days per year. We also needed to know the daily standard deviation that is *formula number 2*, that is shown earlier in this thesis.

We assumed VaR with *5% confidential interval in the VaR calculation*, which gave us a critical z-value at 1,645. This mean we are 95 percent sure that the portfolio will not fall more than 1,645 standard deviations from the expected value. Using the definition of VaR that was explained earlier in this thesis we got 1-day VaR in percent using *formula number 3*. To get VaR in NOK we had to multiply the 1-day VaR with the total value of the portfolio. It is beneficial to also find the 10-day VaR. First, we needed to find the expected return and standard deviation for the 10-day period. The expected return is the daily expected return multiplied with 10. We used *formula number 4* to calculate standard deviation for the year. After finding the expected return and standard deviation, we were able to calculate the 10-day VaR. The formula was the same as it was when we calculated 1-day VaR, *using formula number 3*. The same procedure was used for calculating VaR for the CoH for 2004, 2006 and 2007 including our hypothetical portfolio[15].

2.2.1.2 Historical simulation in Excel

We used the same historical data from the indexes as in the variance-covariance method and calculated their periodic returns. In historical simulation we needed to take a *scenario analysis*. Since we were using historical data from 2001 to 2006, we could calculate us to 1375 days of periodic returns. These periodic returns need to be simulated 1375 times over 1375 days. For 2007(2002-2007) we used 1476 days and for 2008(2006-2008) only 735 days. The reasoning for shortening the days for 2008 was to see if the result would be negative if we reduced the time period. For the CoH we used 967 days for 2006(2003-2006) and 954 days for 2007(2004-2007). Our hypothetical portfolio and the CoH's portfolio had 1002 days for 2004(2001-2004).

Because the scenario analysis operation was extreme and time-consuming we used the Visual Basic program to make the procedure easier. In the simulation we needed to take random returns from the indexes in each scenario. After doing the scenario analysis 1375 times for 2006 we got the expected return on the portfolio for each scenario. First, we had to find the expected return for each index and for each scenario. By taking the average return for the indexes in each scenario, we could find the expected return for the portfolio for each scenario. The expected return for the portfolio was calculated the same way as with the variance-covariance method, using *formula number 8*.

In the historical simulation method we found VaR in a different way than we did when using the variance-covariance approach. We had to sort all the expected returns on the portfolio from lowest to highest. 1-day VaR is the 5^{th} worst percentile in this ranking. To calculate the actual loss we can expect in NOK, we had to multiply the 5^{th} worst percentile, expected

[15] The VaR calculations when using the variance-covariance approach in Excel is under the folder "Data and calculations" and are in the following files: "Variance-covariance method Stavanger 2006", "Variance-covariance method Stavanger 2007", "Variance-covariance method Stavanger 2008", " VaR Haugesund" and "Hypothetical portfolio vs. Haugesund 2004".

return, by the portfolio value. The same procedure was used for 2007 and 2008 as well as the VaR for Haugesund for 2004, 2006 and 2007, including our hypothetical portfolio[16].

2.2.2 Sharpe ratio in Excel

To calculate Sharpe ratio in Excel we needed to find the excess return of the portfolio and the standard deviation of the portfolio. In Excel we could find $\mathbf{r_p}$ by using the indexes for the portfolio and multiply them with the allocation weights. We calculated Sharpe ratio from 2004-2008 in the analysis. In order to find the risk-free rate, $\mathbf{r_f}$, we used the overnight lending rates from the central bank of Norway. We took the overnight lending rate per day and divided them with the number of observations we had per year. The number of observations was different each year, but lied between 200 and 270 observations. We used the same procedure for each year, 2004-2008. Calculation of standard deviation for the portfolio was the same as in the VaR calculations. The daily *excess return* was calculated by using *formula number 6*. We took the average excess return per year (all the daily excess returns) to get an excess return per year. After doing that calculation, we used the *formula number 5* for Sharpe ratio to get Sharpe ratio per day. In order to get the Sharpe ratio per year, which we are looking for in the analysis, we needed to annualize the daily Sharpe ratio. The formula is:

$$\mathbf{9.}\ \frac{r_{p-}r_f}{\sigma_p} * \sqrt{observations}\,pr\ pr\ year$$

The results showed us the Sharpe ratio for 2004-2008. The procedure was the same for Haugesund's portfolio[17].

Part 3: Analysis of the empirical results

3.1 Presentation of the results

In our analysis we have found interesting results for VaR and Sharpe ratio. When using historical data back to 2001, we have been able to get results that are relevant for the CoS. It would be interesting to get an overview over the return and standard deviation that the different asset classes have over our analysis period, from 2001 to 2008. We illustrate these results in table 8 below:

[16] The VaR calculations when using the historical simulation approach in Excel is under the folder "Data and calculations" and are in the following files: "Historical simulation 2006", "Historical simulation 2007", "Historical simulation 2008", "VaR Haugesund" and "Hypothetical portfolio vs. Haugesund 2004".
[17] The Sharpe ratio calculations in Excel is under the folder "Data and calculations" and in the file "Sharpe ratio Stavanger and Haugesund".

Asset classes	Average return	Standard deviation, σ
Norwegian stocks	0,034 %	6,197 %
Norwegian stock funds	0,028 %	6,182 %
Norwegian bonds	0,014 %	0,183 %
Norwegian risk-free rate	0,020 %	0,017 %

Table 8 Overview over the average return and the standard deviation Norwegain stocks, stock funds, bonds and risk-free rate

We can see from *table 8* that there is on average a positive return for all the asset classes from 2001 up to 2008. The standard deviation is much higher for stocks and stock funds than for bonds and the risk-free rate. An explanation for this can be that it is a higher risk to invest in stocks and stock funds than it is investing in bonds and assets that are practically risk-free. We can also see that the return on stocks and stock funds are higher than for bonds and risk-free assets. We can see this in the context of risk. As we know from trade-off between risk and return, it is possible to say that the higher the risk the higher the return.
It is also interesting to look at the return on assets from *the American stock market* and calculate their standard deviation. Since we are analyzing the CoH, it is interesting to look at the American stocks and bonds return and calculate the standard deviation from 2001 up to 2007. We have illustrated American stocks and bonds from 2001 to 2007 in table 9 below:

Asset classes	Average return	Standard deviation, σ
American stocks	0,008 %	3,699 %
American bonds	-0,011 %	6,779 %

Table 9 Overview over the average return and standard deviation of American stocks and bonds

We can see from *table 9* that there is a different return and standard deviation from the American assets than it was for the Norwegian asset classes. The American stocks have a very low return on average compared with the Norwegian stocks. It is also interesting to look at the difference between the American bonds and the Norwegian bonds. There is a negative return on average for the American bonds, which is not good. Also the standard deviation for the American bonds is very high. This can mean that if we invested in American bonds from 2001 up to 2007, we would take a high risk and potentially lose money. It is quite the opposite of what would be expected when investing in bonds. Bonds are meant to have lower risk than stocks, but in this case it seems that it has much bigger risk than stocks. We can also see that from the standard deviation. The standard deviation for the stocks is lower than for the bonds.

3.1.1 Value-at-Risk results

It is now time to presents the results from our calculations using the *VaR-method*. We did two types of analysis: variance-covariance method and historical simulation. The results are interesting and they show a difference every year.

First, we will show the results we got using the variance-covariance method with 1-day VaR and 10-day VaR. We will present the results for the CoS's portfolio, the CoH's portfolio and our hypothetical portfolio.

The CoS's portfolio:

VaR					
Variance-covariance		1-day		10-day	
	2006	-0,200 %	-486 962	-0,320 %	-78 546
	2007	-0,258 %	-713 618	-0,280 %	-771 24
	2008	-0,271 %	-1 009 791	-0,057 %	-213 758
	2008	-0,270 %	-1 008 505	-0,054 %	-200 899

Table 10 VaR results using the variance-covariance method

As we can see from our results in *table 10*, there is negative VaR for all the three years. It is interesting to see that the loss is increasing every year, and that it is on it peaks in 2008. We did two calculations for the year 2008, one with the actual expected return and one with zero expected return.

The CoH's portfolio:

VaR					
Variance-covariance		1-day		10-day	
	2004	-0,851 %	-2 118 830	-0,177 %	-439 879
	2006	-0,819 %	-1 233 079	-0,156 %	-234 731
	2007	-0,792 %	-1 192 804	-0,160 %	-241 498

Table 11 VaR results using the variance-covariance method

We also calculated VaR from a *hypothetical portfolio* to get a comparison for the CoH's VaR. As mentioned earlier in this thesis, we created a portfolio that was based on American stocks and bonds. The VaR result using the variance-covariance method is shown in table 12 below:

Hypothetical portfolio:

VaR					
Variance-covariance		1-day		10-day	
	2004	-0,476 %	-1 190 560	-0,099 %	-248 310

Table 12 VaR results using the variance-covariance method

We can see from the results in *tables 11 and 12* that VaR is less negative in 2004 when we used a hypothetical portfolio than when we calculated the CoH's portfolio. All the variance-covariance calculations have smaller VaR over a 10-day period than over a 1-day period. The results show us that VaR is smaller for the CoS. This can bear on the fact that the American assets had a more negative return than the Norwegian assets did.

The next results for VaR are with calculations using the historical simulation method. First, we will *look at VaR for the CoS's portfolio.*

The CoS's portfolio:

VaR			
Historical simulation		1-day(5th percentile)	
	2006	0,004 %	10 806
	2007	0,017 %	47 356
	2008	-0,185 %	-460 123

Tabell 13 VaR results using the historical simulation method

We see a different result than we did using the variance-covariance method. As shown in *table 13*, we had a positive result of VaR in 2006 and 2007. This indicates that the CoS did not take any risk over those years. However, in 2008 we have a negative VaR which indicates a risk for the CoS. The negative result is due to the economic recession during 2008. In 2008 the indices had a big fall in value, and that can be an indicator for the loss the CoS experienced. As we know, the CoH did not have investments in 2008. The result for VaR using the historical simulation method for the CoH is shown in table 14 below.

The CoH's portfolio:

VaR			
Historical simulation		1-day(5th percentile)	
	2004	-0,185 %	-460 123
	2006	-0,192 %	-289 216
	2007	-0,199 %	-300 245

Table 14 VaR results using the historical simulation method

As we can see from table 14, the CoH had a negative VaR in 2004, 2006 and 2007. This shows us that the CoH took a bigger risk than the CoS. We also did a historical simulation calculation for our hypothetical portfolio for 2004 as a comparison with the CoH's portfolio.

Hypothetical portfolio:

VaR			
Historical simulation		1-day(5th percentile)	
	2004	-0,102 %	-253 825

Table 15 VaR results using the historical simulation method

We can see from *table 15*, that the VaR result for the hypothetical portfolio had a less negative VaR than the CoH's portfolio did. This indicates the same as it did using the variance-covariance method.

3.1.2 Sharpe ratio results

Sharpe ratio was the other risk measure we used in our analysis. We calculated it from 2004 up to 2008 for the CoS. Our results are shown in table 16 below.

The CoS's portfolio:

Year	Sharpe ratio
2004	0,5651
2005	0,5727
2006	0,2519
2007	0,0588
2008	-0,441

Table 16 Sharpe ratio results

We can see from *table 16* that the CoS had a positive Sharpe ratio from 2004 to 2007. In 2008 the Sharpe ratio was negative, which can have a connection with the economic recession that was experienced during 2008. This is similar to our result for VaR in 2008. Another interesting discovery with our Sharpe ratio results is that it is gradually decreasing from 2005 to 2008. It reached its peak in 2005.

We also did a Sharpe ratio calculation for the CoH from 2004 up to 2007.

The CoH's portfolio:

Year	Sharpe ratio
2004	-0,001
2005	-0,041
2006	0,015
2007	-0,200
2008	0,000

Table 17 Sharpe ratio results

As we can see from *table 17*, the Sharpe ratio results for the CoH are quite different than for the CoS. It was negative in 2004, 2005 and 2007. In 2006 it was positive, but only with a small number. 2008 is shown in *table 17* and is zero since the CoH had zero investments in 2008.

3.2 Discussion of the results

We have now shown all the results from our analysis. There are several things that are interesting, and it is now time to discuss these results.

3.2.1 Stavanger's results

3.2.1.1 Value at Risk

First, let us discuss the CoS's portfolio and what VaR-analysis told us about their risk. As we can see from *table 10*, the variance-covariance results showed that there was a negative VaR for all the three years. If we compare this with the historical simulation approach, we can question why it was negative since we got a positive VaR for 2006 and 2007 using the historical simulation approach as shown in *table 13*. A reason for the negative VaR can be the assumption of *normal distribution*. We may assume that the assumed distribution does not describe the actual distribution of the market factors as Linseimer & Pearson discussed in their article *"Risk measurement: An introduction to Value at Risk"*. The *difference* between the actual distribution and the normal distribution can be that there can exist a "fat" tail under actual distribution. Using the historical simulation approach, shown in *table 13*, we got a positive VaR in 2006 and 2007, which means that the CoS did not take any risk during that time period. This result is accurate if there exists an actual distribution and not a normal distribution.

Since we had a long observation period, we can assume that the estimate of VaR is accurate. We know from Hendricks's article *"Evaluation of Value-at-Risk Models Using Historical Data"* that we need to have long observation period in order to get an accurate result. The longer the observation period is, the bigger the chance to produce less variable results. In 2008 the CoS had a negative VaR both using the *variance-covariance approach* and the *historical simulation approach* as we can see from *table 10* and *table 13*. This means that the CoS did take some risk in 2008, and this result weakens VaR as a risk measurement.

The negative VaR result in 2008 is in accordance with the result the CoS presented in their annual report for 2008, where they reported a loss on their portfolio *92 588 011 NOK*. The reasoning for the weakening in VaR is that the VaR result for 2007 could not have predicted such a big loss for the upcoming year, as shown in *table 13*. In other words, VaR could not have predicted the shock the economy experienced in 2008 and therefore the CoS could not have predicted it either. This corresponds with Christoffersen's research which claimed that extreme losses are ignored when using VaR. It does not tell us what small probability cases is, where the loss exceeds VaR.

Historical simulation demands that the fundamental data being used is representative. If the fundamental data is accurate and representative, it is a better chance for us to catch the "special" events that occur in the portfolio. We did reduce our observation period for 2008. The reason for doing so was to see if we would get a negative result, since we did not get that for the previous years. It was during 2008 that the stock market decreased a great deal. Therefore we shortened the time period, but still mean we got an accurate result.

When we presented our result in *table 10* we had two variance-covariance calculations for 2008, one with actual expected return and one with zero expected return. The reasoning for this was to see if there was a *difference* in the result of VaR. Since the CoS had lost so much on their financial investments in 2008, we can assume that they would not receive any return on their investments over the next days. So zero expected return would be the accurate number to predict the CoS's VaR for 2008. As we can see from the results in table 10, there is a small difference when we use actual and zero expected return. We can assume that the small difference is due to the small negative expected return, *-0,00035 %,* which the actual expected return showed[18]. VaR is a tool that shows the degrees of risk we take in a portfolio, especially when we assume a comparable portfolio.

When we do compare the CoS's portfolio with the CoH's, we see that the CoS has taken a very small risk up to 2008. It does help that the CoS only invests in financial assets that are quoted on the Oslo Stock Exchange. As we showed earlier, the American indices had worse returns in the same time period.

3.2.1.2 Sharpe ratio

The CoS's *Sharpe ratio* is at its peak in 2005 with *0,5727*, shown in *table 16*. The difference between the Sharpe ratio for 2004 and 2005 is only *0,0076*. This means that it is a small change in Sharpe ratio during that time period. We can say that the Sharpe ratio for 2004 and 2005 is high which can indicate that they take a risk that gives them high return. Over that time period we can assume that the return has been on average positive. In 2004 and 2005 the CoS got profitable return and they took a risk that was suitable. We can observe a decrease in the Sharpe ratio for the year 2006. It has shrunk by *0,3208* which is a relatively large number. This can indicate that the CoS's return has been smaller than the risk they have taken. We can also see that this pattern is followed in 2007 and 2008. In 2007 they have a small Sharpe ratio and the decrease from 2006 is *0,1931*. As for 2006, the return has been small in 2007 compared to the risk they have taken.

Finally, in 2008 the CoS got a negative Sharpe ratio which means that the return was negative that year. The result is in accordance with the return we calculated for 2008. Since the CoS lost on their financial investments in 2008, we can assume that the negative Sharpe ratio result is correct. However, if we would have gotten a positive Sharpe ratio for 2008, we would need to question its *validity*. Although we can assume that the Sharpe ratio results are correct and can give us an idea of what risk the CoS has taken over the time period from 2004 to 2008, it is important to be critical and not rely too much on these results.

[18] The expected return results are shown in folder "Data and calculations" under the file "Variance-covariance method Stavanger 2008"

3.2.2 Haugesund's results

3.2.2.1 Value at risk

We made an analysis of the CoH's portfolio to get a comparable portfolio for the CoS. Since the CoH lost a huge amount of money on their investments in 2007, it is beneficial to compare the CoH with the CoS to see how much risk the CoS actually has taken on their financial investments. We calculated VaR for the CoH using both the *variance-covariance approach* and *historical simulation approach*, shown in *tables 11* and *14*. We did these calculations for 2004, 2006 and 2007. A calculation of VaR for 2004 was important to see if the result could have predicted that the CoH was taking relatively big risk. Since they started their financial investment in 2004, it would be interesting to see if they could have prevented the big loss had they taken a VaR calculation.

To get an accurate picture of how much risk they actually took in 2004, we made a hypothetical portfolio. The hypothetical portfolio consisted of 60 percent American stocks and 40 percent American bonds. By comparing the CoH's portfolio with the hypothetical portfolio we got a result that was interesting. Since the CoH invested in American bonds, we took a hypothetical portfolio that was also American (see tables 12 and 15). VaR for the CoH in 2004 was negative by using the variance-covariance approach and the historical simulation approach. The hypothetical portfolio had also a negative VaR using both approaches, but the VaR was not as negative as when we calculated the CoH's VaR. This can tell us that it is important to *diversify* our portfolio to reduce risk, as Markowitz's suggested in the 1950's. If the CoH had made a VaR calculation in 2004 and seen the negative result, they might have reconsidered to do the financial investment. The reason why we also had a negative VaR when using the hypothetical portfolio, can be because the indices returns fluctuated during that time period.

If we compare the CoH's VaR with the CoS's VaR in 2006 and 2007, we can see a big difference in the results. The CoH had a *negative* VaR with both the variance-covariance approach and the historical simulation approach, whereas the CoS had a positive VaR when using the historical simulation approach. Again we can say that the CoS did not take any risk, whereas the CoH took a big risk.

It is interesting to see that the CoH had the most negative VaR back in 2004. They should have done a VaR calculation at that time to see what risk they were facing. However, since *Terra Securities* recommended that they should invest in the American bonds, the CoH assumed that they did not take a big risk. This is a reason to consider doing a VaR calculation in order to see what risk a firm is facing on their financial investments. By calculating VaR for the CoH, we can see the strengths with VaR. They should have invested in financial assets that were quoted on the Oslo Stock Exchange, as the CoS has done with their financial investments.

3.2.2.2 Sharpe ratio

The results for the Sharpe ratio are negative for the CoH with the exception of 2006, shown in *table 17*. In 2006 the CoH had a small positive Sharpe ratio and in 2007 they have the most negative Sharpe ratio at *-0,200*. Since they had a negative Sharpe ratio the other years, it indicates that they had a negative return on their portfolio. A negative Sharpe ratio also indicates that they do not get a positive return although they have taken a presumably high risk. When comparing with the CoS's portfolio we can see that the CoH does not have as profitable portfolio as the CoS, with the exception of 2008 when the CoS had a negative Sharpe ratio and the CoH did not make any financial investments.

3.2.3 Strengths and limitations with the results

3.2.3.1 Value-at-Risk

We have now presented the results of VaR for the CoS and the CoH's portfolio. In our discussion of the results we have tried to look at what the results actually told us and what they did not tell us. It is important to see both strengths and limitations with our result and look at what we might have done differently in order to get a more accurate result.

As we mentioned in the discussion of the result, we found out that the CoS presumably did not take any risk in 2006 and 2007. However, in 2008 they took a relatively big risk and lost money on their financial investments. Our question should now be: What did the results *fail* to tell us about the risk the CoS took? The most interesting year to look at the VaR calculation was for 2008. This was the first year that the CoS got a negative VaR result when we used the historical simulation approach. It is clear that the VaR result we got for 2007 could not have predicted the big loss Stavanger experienced in 2008. This shows the *limitation* of VaR. Since VaR for 2007 did not predict loss in 2008, how could the CoS predict it?

As researchers have mentioned before, VaR is due to "normal" market movements and in 2008 we experienced "abnormal" market movements. Extreme losses are ignored and that can be a problem when measuring risk. The financial crisis that occurred in 2008 came as a shock and from our VaR calculations we could not have seen it coming. VaR is not designed to detect the kind of shock (in the economy) that we experienced with financial crisis in 2008. One of the biggest limitations with VaR in our analysis is the fact it was not able to estimate the values as punctually as we first presumed. It focuses too much on *short horizons*.

The strengths of the VaR calculations are shown with the CoH's portfolio. It is clear that the CoH should *not* have invested in the American bonds in 2004. With the result of VaR from 2004 we do see a significantly negative result, which should have helped them to see what risk they actually took with the American bonds. If they had taken a VaR calculation, using the historical simulation approach, they could have prevented the big loss they experienced with their financial investments. As mentioned earlier, when we compared with the hypothetical portfolio, we saw that diversification actually reduces risk. It is clear that the CoH should have done two things when they were investing in 2004. They should have done a *VaR calculation* and *diversified* their portfolio. This shows the *strengths* of VaR as a risk measurement and also confirms Makrowitz's portfolio selection model which suggests a *diversification* of the portfolio in order to *reduce risk*.

We can also look at the strengths and limitations of the different approaches we used, the variance-covariance approach and historical simulation approach. The fact that historical simulation is estimated from past data does not let any further assumptions interfere other than that data, as Christoffersen(2003) explained in his article. It can lead to a result that is not representative for the portfolio. As we have mentioned before, the historical simulation approach needs to fundamental past data that is representative in order to get an accurate result and a possibility of catching "abnormal" events in the portfolio. We cannot be one hundred percent sure that our past data is representative for the CoS. It also needs to have foreseen a comparable portfolio. We do compare the CoS with the CoH ,so we can say that we have foreseen a comparable portfolio.

With the variance-covariance approach we cannot be sure that the past data is representative when calculating VaR. We use the same past data with both approaches so the fact that the result may not be one hundred percent accurate needs to be taken into consideration. Another limitation with the variance-covariance approach is that we cannot assume a normal distribution. As we mentioned earlier, we did get a negative result when we calculated VaR using the variance-covariance approach. We cannot trust that the negative result reflect the CoS's actual risk.

If we compare the two approaches, we can assume that the *historical simulation approach* is the most accurate VaR result for the CoS. The reason for this assumption is that we cannot assume normal distribution and we do know that the CoS did not lose on their financial investments before 2008.

However, since the result of VaR from 2007 was positive we can see the limitations with VaR, and the fact that VaR could not have predicted the big losses the CoS experienced in 2008. VaR did not measure the risk *ex post* of the financial crisis, only *ex ante*. This shows us that VaR as a risk measure is not designed for *extreme events* like the financial crisis that occurred in 2008.

3.2.3.2 Sharpe ratio

The theory of Sharpe ratio tells us something about how much extra return we can achieve in addition to a risk-free rate if we take a given risk. Our results for the CoS and the CoH showed us that the CoS did get return given their risk from 2004 until 2007, and in 2008 they got a negative Sharpe ratio because of the negative excess return result in 2008. This seems to be accurate with the recession that happened in 2008. The CoH had a negative Sharpe ratio with the exception of 2006. We can question why they had a positive Sharpe ratio in 2006, but since they had a positive excess return it seems to be an accurate result.

The strengths with the Sharpe ratio when we look at our results for the CoS is it does show positive result when we have low risk compared to our return, and in 2008 it is negative, as it should be because of the loss they experienced on their financial investments. We can also see that the Sharpe ratio result for the CoH is what it should be when we compare it with the risk they have taken. However, since they have a positive Sharpe ratio for 2006, we cannot be a one hundred percent sure that this result is actually comparable with what risk they actual took.

There have been several researchers that have criticized the Sharpe ratio for not being a good measure of risk. Since risk is not an "observable" variable and it cannot be measured through standard deviation according to Harding (2002) we cannot assume that it is an accurate measure of risk. We can relate to that fact with our calculations and also say that the Sharpe ratio cannot be one hundred percent valid as a risk measure.

Conclusion

We have now looked at what risk the CoS is facing on their financial investments. With the Value at Risk analysis-containing the variance-covariance method and the historical simulation method- and a Sharpe ratio estimate, it is possible to analyze what risk the CoS has taken in the past. The presented results are interesting and give a picture of what risk the CoS has taken. As mentioned in the last part of the thesis, there are both strengths and limitations with the risk measures we used. These strengths and limitations are in line with what researchers and practitioners have previously discovered.

The results of this research show that the CoS did take minimum risk in 2006 and 2007. However, in 2008 they did take a relatively big risk due to the recession that occurred in the economy. It is difficult to predict what risk they will face in the future. They did have rate-regulating funds to cover the losses they experienced in 2008, which shows that they invest with assets produced by profit. The fact that VaR did not predict the big loss which the CoS experienced in 2008 limits it as a risk measure. It is not built for big shocks in the economy. It is clear that the CoS could not have predicted the recession if they took a VaR analysis at the end of 2007. The VaR analysis and Sharpe ratio for 2008 is negative, and is a pointer of what risk they should take in 2009. For 2009, the CoS should not make the same financial investment as they did in 2008. Although they have available capital, they should reduce their financial investments. When the recession recovers, the CoS can make bigger financial investments. They should not take unnecessary risk at the moment since they are responsible for the citizens of Stavanger's tax money.

As we have seen from this research, there are clear limitations with VaR and Sharpe ratio. The challenge for future researchers is to find a risk tool that can predict big shocks in the economy. Another challenge for future researchers is to find ways for municipalities/cities to do risk analysis using VaR, Sharpe ratio or other risk measures in order to predict what risk they are facing on their financial investments. I think my research is a pointer on how municipalities/cities should do a risk analysis and why it is important. Since municipalities/cities have responsibilities to their citizens I think it is important to manage their tax money in a way that is responsible and profitable. As we have seen from the analysis of the CoH, taking a significant risk has its consequences.

Bibliography

Abott, B. B., & Bordens, K. S. (2005). *Research design and research:A process approach* (6th ed.). New York: The McGraw Hill companies.

AFKommunepartner. (2005). Forskrift om kommuners og fylkekommuners finansforvaltning, nr. 299 av 05.03.2001. Retrieved 07.03, 2009, from http://www.kommunepartner.no/index.php?option=com_content&task=view&id=28&Itemid=81

Bodie, Z., Kane, A., & Marcus, A. J. (2005). *Investments* (6th ed.). Singapore: McGraw Hill International edition.

Brearley, R. A., Myers, S. C., & Allen, F. (2006). *Corporate finance* (8th ed.). New York: McGraw-Hill/Irwin.

Brown, S. J., Elton, E. J., Goetzman, W. N., & Gruber, M. J. (2007). *Modern Portfolio theory and investment analysis* (7th ed.). Hoboken,New Jersey: John Wiley & Sons, Inc.

Christoffersen, P. F. (2003). *Elements of financial risk management*. San Diego,California: Academic Press: An imprint of Elsevier Science.

Harding, D. (2002). A Critique of the Sharpe Ratio [Electronic Version], 1-2. Retrieved 03.05.2009, from http://www.edge-fund.com/Hard02.pdf

Haugesund, K. (2008). *Årsmelding 08*. Haugesund.

Hendricks, D. (1996). Evaluation of Value-at-Risk Models Using Historical Data. *Federal Reserve Bank of New York: Economic Policy Review*, 69.

HUI, C. H. (2001). Effect on asset value correlation on credit-linked note values. *International Journal of Theoretical and Applied Finance, 5*(5), 23.

Hull, J. C. (2006). *Options,Futures, and other derivatives* (7th ed.). Upper Saddle River,New Jersey: Pearson Education International.

Johannessen, A., Kristoffersen, L., & Tufte, P. A. (2004). *Forskningsmetode for økonomisk-administrative fag*. Oslo: Abstrakt forlag.

Jørgensen, J. P. (2005). *Kommunal finanshåndbok*. Oslo: Kommunaløkonomisk forlag.

Lillestøl, J. (2002). Value at Risk-sett med en statistikers øyne. In P. Bjerksund & Ø. Gjerde (Eds.), *Essays on Uncertainty: Festskrift til Steinar Ekerens 60-årsdag* (pp. 121-144). Bergen: Norges Handelshøyskole.

Linsmeier, T. J., & Pearson, N. D. (1996). Risk Measurement: An Introduction to Value at Risk. *University of Illinois at Urbana-Champaign*, 44.

Lo, A. W. (2002). The Statisitcs of Sharpe Ratios. *Financial Analysts Journal*, 36-52.

Local, A. G. (1992). *Law 1992-09-25 no 107: Local Government Act*.

Markowitz, H. (1952). Portolio Selection. In J. Tobin (Ed.), *Landmarks Papers in Macroeconomics* (pp. 322-336). Cheltenham, UK: Edward Elgar Publishing Limited.

Markowtiz, H. M. (1959). *Portfolio Selection: Efficient diversification of investments*. New York: John Wiley & Sons, Inc.

Mun, J. (2004). *Applied Risk Analysis*. Hoboken,New Jersey: Wiley & Sons Inc.

Rogachev, A. (2002). Dynamic Value-at-Risk [Electronic Version], 2-20. Retrieved 25.05.2009, from http://www.gloriamundi.org/picsresources/ardv.pdf

Saksfremlegg, H.-.-. (2008). *Høring ny forskrift om kommuners og fylkekommuners finansforvaltning*. Retrieved. from http://www.stavanger.kommune.no/publikum/offentli.nsf/SVGalle/C1256F65004F872BC125750C0048F873/$FILE/08069974.DOC

Sharpe, W. F. (1966). Mutual fund performance. *The Journal of Business, 39*(1), 119-138.

Sharpe, W. F. (1994). The Sharpe Ratio. *The journal of Portfolio Management*, 49-58.

Stavanger, K. (2004). *Årsberetning 2004*. Stavanger Kommune.

Stavanger, K. (2005). *Årsberetning 2005*. Stavanger Kommune.

Stavanger, K. (2006). *Årsberetning 2006*. Stavanger Kommune.

Stavanger, K. (2007). *Årsberetning 2007*. Stavanger Kommuune.
Stavanger, K. (2008). *Årsberetning 2008*. Stavanger Kommune.
Takla, E. (2007). Alt om Terra-saken. Retrieved 15. mars, 2009, from http://www.dn.no/forsiden/politikkSamfunn/article1241230.ece
Tasche, D. (2002). Expected Shortfall and Beyond [Electronic Version], 1-18. Retrieved 25.04.2009, from http://www.gloriamundi.org/picsresources/expshortfall.pdf
Thirty, T. G. o. (2009). 30- Group of Thirty. Retrieved 13. mai, 2009, from http://www.group30.org/index.htm
Verdipapirfondloven. (1981). *Lov 1981-06-12 nr 52: Lov om verdipapirfond*.
Vinod, H. D., & Morey, M. R. (1999). A "Double" Sharpe Ratio [Electronic Version], 1-10. Retrieved 05.05.2009, from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=168748
Wirch, J. L. (1997). Value-at-Risk for Risk Portfolios [Electronic Version], *1*, 259-266. Retrieved 25.04.2009, from http://www.gloriamundi.org/picsresources/jw2.pdf

Appendix A:

We need to illustrate the general formulas in financial theory of risk and return.

1.1 Periodic return, r_t (used when calculating VaR):

$$r_{t,i} = \frac{P_{t,i} - P_{t-1,i}}{P_{t-1,i}}.$$

P_t= price today P_{t-1}= price yesterday

1.2 Expected return, E(r) (of an asset):

$$E(r) = \sum_{s=1}^{n} \Pr(\mathrm{s})\, \mathrm{r(s)}$$

Expected return is a probability-weighted average of its return in all scenarios (Bodie, Kane, & Marcus, 2005, p. 174)

s=scenario

Pr(s)= probability of scenario s r(s)=the return in scenario s

1.3 Variance, σ^2 (of an asset's returns):

$$\sigma^2 = \sum_{s=1}^{n} \Pr(\mathrm{s})\, [\mathrm{r(s)} - \mathrm{E(r)}]^2$$

The variance formula summarizes the probability for each outcome multiplied with the difference between the outcome result and the expected result sublimed in second. Higher variance leads to higher probability for each observation in the time period that deviates from the expected return (Jørgensen, 2005).

After finding the variance we need to calculate the standard deviation. In statistical term we can say it is a measurement for the fluctuations of outcomes around an expected value. The standard deviation to a return in a portfolio measures to what extent actual return on a portfolio deviates from the expected return (Jørgensen, 2005).

1.4 Standard deviation, σ (of an asset):

$$\sigma = \sqrt{\sigma^2}$$

In finance theory we can try to measure two risky assets instead of one. When dealing with two risky assets it is important to measure how much the returns of the two risky assets move in tandem.

1.5 Covariance, cov (of two risky assets $_1$ and $_2$):

$$Cov\, r_1, r_2 = \sum_s \Pr(s)\, [r_1(s) - E(r_1)][r_2(s) - E(r_2)]$$

Correlation coefficient is another measure of how two risky assets move together and is easier statistically to interpret than the covariance. The correlation coefficient will always be between -1 and +1 and will say how correlated the assets are.

1.6 Correlation coefficient, ρ (of two risky assets $_1$ and $_2$):

$$\rho_{\,1,2} = \frac{Cov(r_1, r_2)}{\sigma(r_1), \sigma(r_2)}$$ (Jørgensen, 2005)

When the correlation coefficient is 1 we can say we have a perfect positive correlation between the assets, and vice versa when we have -1 which mean we have a perfect negative correlation. Two assets that are negatively correlated leads to the greatest payoff to diversification, but this rarely happens (Brearley, Myers, & Allen, 2006)

Now we can look at portfolios with two risky assets. The expected return on the whole portfolio is different than when we only looked at one asset. To illustrate with a formula we can look at a portfolio consisting of two stocks, $_1$ and $_2$. First we can find the rate of return.

1.7 Rate of return on portfolio, r_p:

$$r_p = w_1 r_1 + w_2 r_2$$

r_1= rate of return on stock 1 r_2= rate of return on stock 2

w_1 and w_2= weights for the assets

We can now find the expected return on the portfolio.

1.8 Expected return on portfolio, $E(r_p)$:

$$E(r_p) = w_1 E(r_1) + w_2 E(r_2)$$

The variance of the portfolio is calculated a little different than when we only had one asset.

1.9 Variance, σ^2_p :

$$\sigma^2{}_p = w^2{}_1 \sigma^2{}_1 + w^2{}_2 \sigma^2{}_2 + 2 w_1 w_2 Cov(r_1 r_2)$$

The covariance can be calculated from the correlation coefficient, this implies:

1.10 Covariance with correlation coefficient:

$$Cov(r_1, r_2) = \rho_{1,2}\sigma_1\sigma_2$$

This means that we can illustrate the variance formula in a different way with the correlation coefficient.

1.11 Variance, $\sigma^2{}_p$:

$$\sigma^2{}_p = w^2{}_1\sigma^2{}_1 + w^2{}_2\sigma^2{}_2 + 2w_1w_2\sigma_1\sigma_2\rho_{1,2}$$

Standard deviation formula is the same is was when we had only one asset. It is always the square root of the variance.

1.12 Standard deviation, σ_p :

$$\sigma_p = \sqrt{\sigma^2{}_p}$$

(Bodie et al., 2005)

We can reduce risk by diversifying our portfolio. An efficient diversification is to construct a risky portfolio that should be able to provide the lowest possible risk at any given level of expected return (Bodie et al., 2005).

Bibliography

Bodie, Z., Kane, A., & Marcus, A. J. (2005). *Investments* (6th ed. Vol. 6th). Singapore: McGraw Hill International edition.

Brearley, R. A., Myers, S. C., & Allen, F. (2006). *Corporate finance* (8th ed. Vol. 8th). New York: McGraw-Hill/Irwin.

Jørgensen, J. P. (2005). *Kommunal finanshåndbok*. Oslo: Kommunaløkonomisk forlag.

Appendix B:

The statistics of risk:

2.1 Measuring the center of the Distribution-The first moment

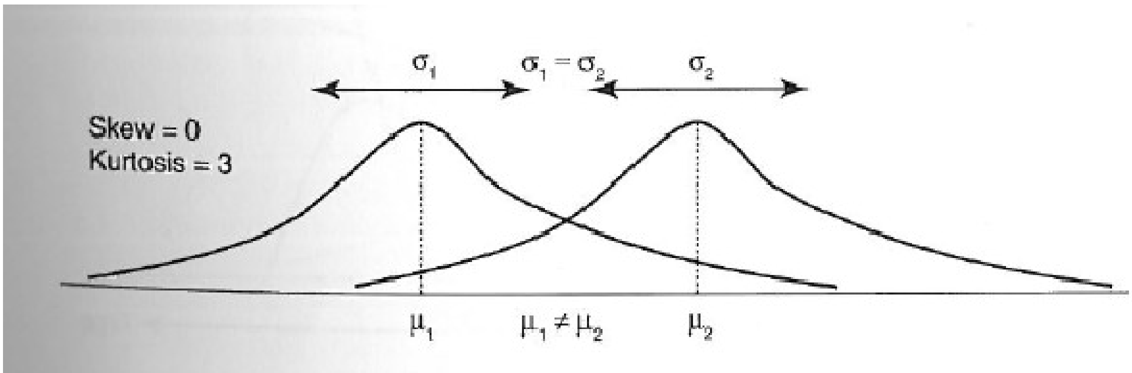


FIGURE 2.1 First moment.

(Mun, 2004, p. 29)

2.2 Measuring the Spread of the Distribution-The second moment

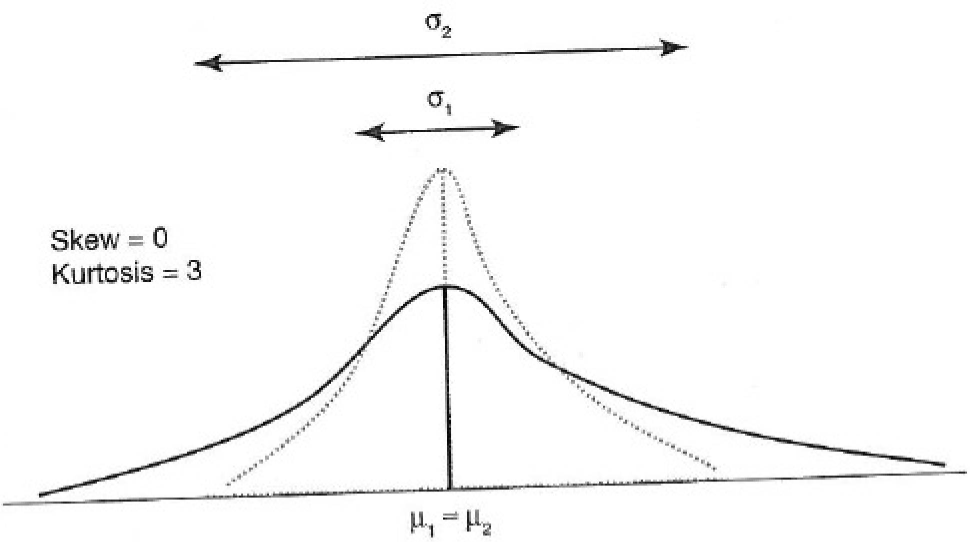


FIGURE 2.2 Second moment.

(Mun, 2004, p. 30)

2.3 Measuring the Skew of the Distribution-The third moment

a.

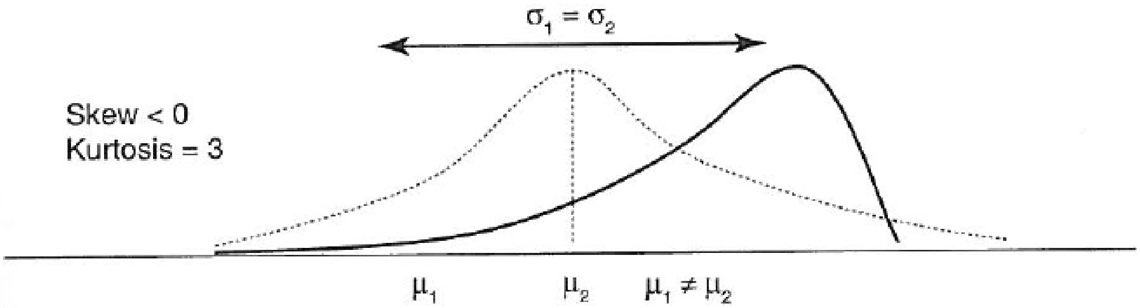


FIGURE 2.4 Third moment (left skew).

b.

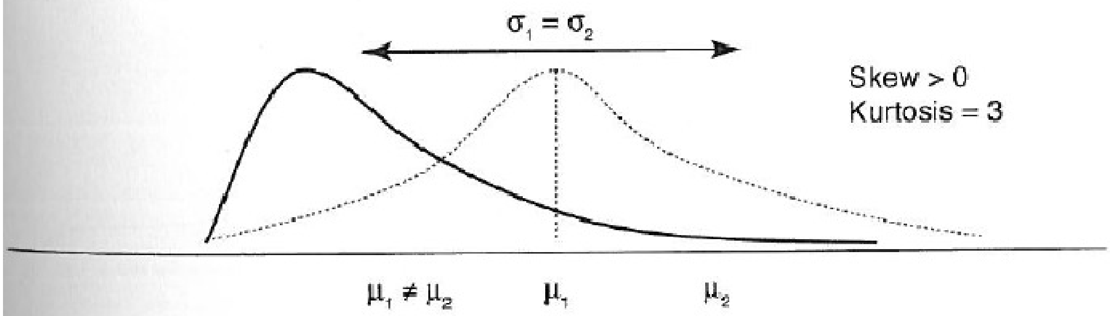


FIGURE 2.5 Third moment (right skew).

(Mun, 2004, p. 31)

2.4 Measuring the Catastrophic Tail Events in a Distribution-The fourth moment

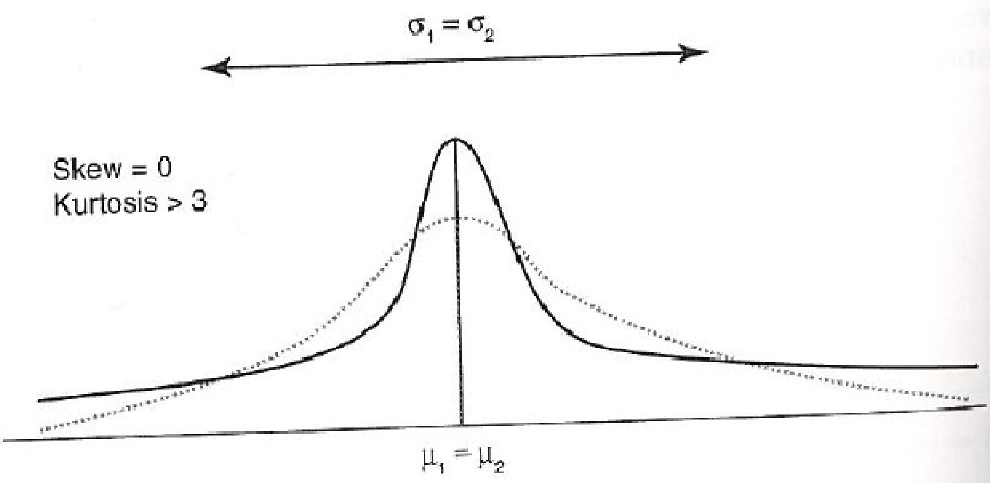


FIGURE 2.6 Fourth moment.

(Mun, 2004, p. 32)

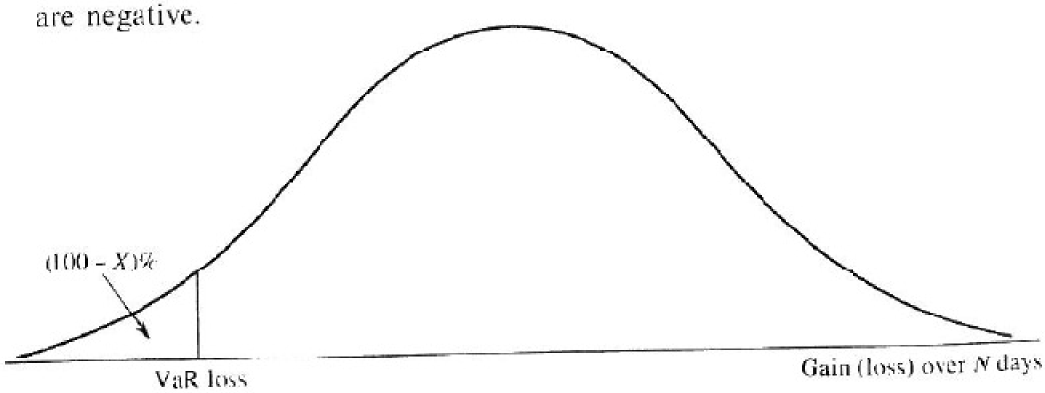
Bibliography

Mun, J. (2004). *Applied Risk Analysis*. Hoboken,New Jersey: Wiley & Sons Inc.

Appendix C:

3.1 Graphical presentation of Value at Risk

Figure 20.1 Calculation of VaR from the probability distribution of the change in the portfolio value; confidence level is X%. Gains in portfolio value are positive; losses are negative.



(Hull, 2006, p. 444)

Bibliography

Hull, J. C. (2006). *Options,Futures, and other derivatives* (7th ed.). Upper Saddle River,New Jersey: Pearson Education International.