Titel:	Credit Default Swap, which factors affect the price?
Seminariedatum:	2005-01-14
Ämne/kurs:	Magisteruppsats i företagsekonomi med inriktning mot finansiering (FEK 591), 10 poäng
Författare:	Anders Westlund Johan Fransson
Handledare:	Göran Andersson
Nyckelord:	Credit derivatives Credit default swap Regression Credit risk Risk management
Syfte:	Syftet med vår uppsats är att undersöka vilka variabler som påverkar prissättningen av av credit default swaps. Vi undersöker även vilken påverkan de signifikanta variablerna har på priset.
Metod:	Vi använder oss av en kvantitativ metod samt en multipel regressionsmodell
Teoretiska perspektiv:	Vi använder oss av Black & Scholes optionsmodell samt put-call parity för att välja variablerna som vi använder i vår regressionsanalys.
Empiri:	I empirin förklarar vi hur vi väljer de oberoende variablerna som vi använder i regressionsanalysen. Vi hävdar att en credit default swap kan ses som en put-option.
Sammanfattning:	Vi presenter en modell med fem variabler som förklarar priset på credit default swaps. Genom att använda en linjär regressionsmodell så kommer vi fram till att alla fem variablerna påverkar priset. Dock är två av variablerna bara signifikanta i ett fåtal av de 13 regressioner som vi genomförde. Vår modell förklarar en stor del av priset, men det finns även andra faktorer och variabler utanför vår modell som påverkar.

Title:	Credit Default Swap, which factors affect the price?
Seminar date:	2005-01-14
Course:	Master thesis in business administration, Finance, 10 Swedish Credits (15ECTS)
Authors:	Anders Westlund Johan Fransson
Advisor:	Göran Andersson
Five key words:	Credit derivatives Credit default swap Regression Credit risk Risk management
Purpose:	The purpose of our thesis is to investigate which variables that are affecting the credit default swap price. We will also investigate which effect the significant variables will have on the price.
Method:	We use a quantitative approach and conduct a linear multiple regression analysis.
Theoretical perspectives:	We use Black & Scholes and put-call parity as a foundation for selecting the variables in our regression analysis.
Empirical foundation:	In this section we will try to explain how we select the independent variables that will be used in the regression analysis. We will here argue that a Credit Default Swap can be seen as a put option.
Conclusions:	Our thesis present a model that is trying to explain the price of credit default swaps. By using a linear multiple regression model, we find that all five variables are affecting the swap price. However, some variables are only present in a few cases. We believe that our model captures a large part of the price of the credit default swap, but that there are still other factors or variables that are affecting the price

1 Introduction

In this chapter we will present the research problem and a brief background to credit derivatives and why we have selected this subject. The purpose of the thesis will be stated as well as its limitations and target group.

1.1 Background

Credit risk is something that most market participants are exposed to. The obvious participants to think of are financial institutions and banks, but also companies with outstanding credits and governments are exposed to this risk. One example of what can happen when credit risk are managed incorrectly is the Swedish financial crisis in the early 1990s. There are several ways to manage credit risk, but one new group of instruments that has been developed are credit derivatives.

ISDA, the Swap and Derivative Association first introduced credit derivatives in 1992. Since then, the market has been growing substantially until today. The Market is expecting to reach a number of around US$ 4800bn in outstanding notional value in 2004.[1] Although the market of credit derivatives has been growing substantially it is still an Over-The-Counter (OTC) market, and there are no global documentation standard.[2]

Buyers and sellers of credit derivatives have increasingly realized the benefits of protecting themselves against credit risk. There are believes that the market will grow even more, mainly due to more market participants, which would lead to a better price transparency and a more liquid market.

So far there have been several examples of market inefficiencies. One example of that was when Mahonia Ltd, an affiliate to JPMorgan Chase entered a $ 3.7 billion contract with Enron in 1998. Mahonia protected its credits by entering six less used credit insurance contracts with 11 different insurance companies. However, in December 2001 Enron filed for bankruptcy and thereby failed to meet their obligations. Mahonia then turned to the insurance companies to and claimed $ 1 billion of its losses. There was a dispute regarding the payments due to unstandardized regulatory contracts on the market. The case later went to court and the insurers finally agreed to pay 60% of the claims. Another market participant, Citibank, had

[1] Brittish Banking Association, *Credit Derivatives Report*
[2] Merrill Lynch, *Credit Derivative Handbook* (2003), p. 4.

outstanding credits to Enron, but they had more conventional credit derivatives and they thereby received all their claims more immediately.[3]

There are several unclear questions in the credit derivative market today, but it is developing very fast at the moment and is still in its developing phase. We see the market of credit derivative as very interesting and we will continue to follow its future developments.

1.2 Problem Discussion

Credit Derivatives first saw the market in the early 1990s. Since then the market has increased substantially, especially during the latest years. Because of the fast increasing market of Credit Derivatives, and the future potential, we see a great need to study these instruments. Several models are trying to explain how Credit Derivatives are being priced and most of the current research is trying to develop or find new models for pricing. These models are in general very mathematical, so instead we want to look at the pricing from another angle.

We will here present some of the few earlier studies that have been conducted in order to determine the variables affecting credit default swap price.

Hull and White (2004) are trying to determine credit default spreads by looking at two main variables. Their study is based on 200,000 spread bids and offers collected from a credit derivative broker, and it covers a 5-year period. They look at the relationship between credit default spreads and bond yields, and their result concludes that this relationship holds fairly well. The second variable that they are using to explain the credit default spreads is the rating announcement issued by Moody's. They find a significant relationship between reviews of a downgrade, but no relationship between the actual downgrade and the spread.[4]

Zhu (2004) conduct an empirical comparison of credit spreads between the bond market and the credit default swap market. The study covers 55 reference entities and is based on a period of three years, starting from January 1999. The conclusion is that the bond spreads and the credit default swap spreads move together in the long run, but not always in the short run. The

[3] Ernst & Young, *Credit Derivatives*, (2003) p. 9.
[4] Hull J, White A, *The relationship between credit default swap spreads, bond yields, and credit rating announcements*, (2004), p.2789ff.

credit default swap market seems to move ahead of the bond market, concerning the price adjustments. This proved to be especially significant when studying U.S. entities[5].

Skinner and Townend (2002) present one of the first empirical examinations of the credit default swap. They refer their study to option pricing theory and argue that a credit default swap can be seen as a put option. They use 29 straight sovereign U.S. credit default swaps for a period of two years, starting in September 1997. They use a model that contains five independent variables when conducting the regression analyses. Their study shows that three or possible four of the independent variables are important when determine the credit default swap price.[6]

Our thesis will be conducted in order to try finding variables that are influencing the price of the Credit Default Swaps. We select to study outstanding Credit Default Swap contracts because they are the most traded product, accounting for 43% of the total Credit Derivative market.[7] We have decided to study the European credit default swap market because no studies are based on simply the European market, and because it is the most liquid market in the world, concerning credit derivatives. We therefore hope to be able to draw more general conclusions regarding credit default swap prices.

1.3 Purpose

The purpose with our thesis is to investigate which variables that are affecting the credit default swap price. We will also investigate which affect the significant variables will have on the price.

1.4 Target Group

With this thesis we target people with basic knowledge in financial theory and statistics. To make the study easier to follow we will include a brief presentation of the credit derivative market and the basic instruments.

[5] Zhu Haibin, *An Empirical comparison of credit spreads between the bond market and the credit default swap market*, (2004) p.15.
[6] Skinner, Townend, *An empirical analysis of credit default swaps*, International review of Financial Analysis (2002), p. 297ff.
[7] Ernst & Young, *Credit Derivatives*, (2003) p.5.

1.5 Limitations

We have selected credit default swap contracts where the reference assets are bonds issued by European companies in the Euro currency. This was done to simplify the comparison between the different contracts. We will limit our study to credit default swap contracts starting no later than 2003 because of the lack of historical information for the credit default swap prices. We selected companies from all available industries, and eliminated those who did not have an issued bond as the underlying asset. The selections of these contracts was done by scanning all contracts available on the Reuters 3000Xtra database and eliminate those who did not fulfill our earlier stated requirements. Further explanations are done in the chapter Empirical Study.

1.6 Disposition

In the second chapter we will describe the methodology that will be used in order to design the method used in our thesis. We will here motivate why we have selected this specific methodology and why it is appropriate to use in this thesis.

In the third chapter we will present the two basic theories that we will use later in order to select the independent variables that will be used in our regression model. We will also explain why we use Black & Scholes option pricing model and the put-call parity condition.

In the fourth chapter we will present a brief background to the market of credit derivatives. We will also present the most commonly used instruments, the regulatory framework and an overview of the concept of credit risk.

In the fifth chapter we will give a deeper explanation of the method used in our study. We will first explain how we selected the variables for the regression. Then we will explain the specific variables more in detail and revile our expectations concerning importance and impact. Some statistical considerations will also be discussed.

In chapter six we will present the results from the empirical test described in the previous chapter, Empirical study. First, we will present the result from the regression analysis, and then the result from the statistical tests.

In the seventh chapter the result obtained in chapter six will be discussed and analyzed. We will present the analysis sorted by the different independent variables from the regression model. Finally, some other possible explanations will be presented and discussed.

In chapter eight we will present the main conclusions of our thesis. We will also give some suggestions for future research.

2 Methodology

In this chapter we will describe the methodology that will be used in order to design the method used in our thesis. We will here motivate why we have selected this specific methodology and why it is appropriate to use in this thesis.

2.1 Quantitative study

The choice of method should be based on the problem and purpose of the thesis, which in our case is to investigate which variables that are affecting the credit default swaps price, and which affect the significant variables will have on the price.[8] To be able to draw any conclusions based on our problem discussion, we argue that a quantitative approach is the best method to use. Consequently, our methodological approach in this thesis will be quantitative.

A methodology based on a quantitative approach will strongly influence the result of the study. In this type of study, it is of great importance for the result that much time and effort are being made on the procedure of collecting data.[9] As a preparation to understand which data that will be needed to be able to fulfill our purpose with this thesis, a literature review will be conducted. We will study existing literature in the area of credit derivatives, manly published articles from business journal.

The quantitative study uses a larger population than a qualitative approach, where usually only a small population is being used. More number of observations gives the researcher a larger basis to start out from when it is time to draw conclusions. The larger number of observations also leads to the fact that the study is more representative and it is easier to generalize the results.[10]

2.2 Approach

There are three different approaches on how to conduct a scientific study. These are an inductive, a deductive or an abductive approach.

[8] Neuman, Lawrence, *Social Research Methods,* (1999), p. 19f.
[9] Bryman, A, *Samhällsvetenskapliga metoder* (2002), p. 78.
[10] Jacobsen, DI, *Vad, hur och varför?* (2002), p. 146.

The use of an inductive approach means that you begin your study by collecting empirical data and then use this data to generalize and form abstract ideas.[11]

If you instead use the deductive approach, you begin with a theory or a hypothesis and then moving towards concrete empirical evidence. You may for example have an idea about how something specific works and wants to test the idea empirically.[12]

The third alternative, the abductive approach, is a mixture of the two approaches previously described. This is the most common one used by researchers today.[13]
The abductive approach means that you are flexible and use both the deductive and the inductive way of applying the underlying hypothesis and use the empirical data at various stages in the study.[14]

The starting point of this thesis is the problem discussion in chapter one. To be able to find an answer to our problem, we will start with research existing theories of option pricing, theories on credit derivatives and a research articles. From this theoretical background, we then will discuss and design the study in a way that makes it possible to fulfil the purpose of the thesis.
In later stages of the study, we might find part of our theory irrelevant, or maybe find that we need to add a deeper theoretical background. If this is the case, we will be open both to shorten and extend the theories and our empirical data to be able to answer the questions of this thesis. Consequently, our thesis will be based on an abductive approach.

2.3 Data collection

In this part, we will try to explain how we are going to collect the required information and how we will conduct our analysis. All data collected for our regression analysis and all literature used for the literature review are secondary data. This means information that is already collected or written by others, but not primarily for our specific study.[15]

[11] Neuman, Lawrence, *Social Research Methods*, (1999), p. 49.
[12] Neuman, Lawrence, *Social Research Methods*, (1999), p. 49.
[13] Ibid p.49
[14] Ibid p. 49
[15] Skärvad, PH, Lundahl, U, *Utredningsmetodik för smahällsvetare och ekonomer* (1999), p.131.

2.3.1 Literature review

Research is an effort of many research studies, and a specific project is just a small part of the total knowledge. A literature review is based on the assumption that we learn from what others have done.[16]

According to Neuman (1999), there are four different goals with a literature review, which are the following:[17]

1. To establish credibility
2. To show how the current project is linked to prior research
3. To summarize what is already known in the specific area
4. To learn and stimulate new ideas

The purpose of our literature review is all the reason mentioned above. Since credit derivatives are a new and unfamiliar to us, we need to know more and gain a deeper understanding of how these instruments works. To be able to write a good thesis, you need a solid theoretical background. We will also use previous research to be able to present an interesting and relevant problem discussion to the readers. Previous research will also be used when designing the quantitative study.

The literature in our literature review is articles from economic journals, dissertations, company reports and presented papers. Most of the literature is collected from the Internet.

2.4 Criticism of sources

2.4.1 Reliability

A high reliability means that the results of the study will be the same, no matter who carries it out, and that the study is not strongly affected by random errors. If no external factors change, two different studies with the same purpose should give the same result.[18]

[16] Neuman, Lawrence, *Social Research Methods,* (1999), p. 445
[17] Neuman, Lawrence, *Social Research Methods,* (1999), p. 446.
[18] Lundahl, U Skärvad, P-H, *Utredningsmetodik för samhällsvetare och ekonomer* (1999), p 152.

In this thesis we have decided to rely on secondary data, mainly financial information obtained from different databases. The circumstances under which the data is collected, or the person that is collecting the data does not affect this secondary data.

There is always the possibility that the providers of the secondary source are affected by their own perception or opinion. This risk is not a big issue when it comes to the financial data collected from third part like Reuters and Eco Win. We assume that these companies provide accurate and reliable information to its users.

This thesis also uses accounting information from companies' annual reports. Although those annual reports are under different government laws, there is still a possibility that the numbers provided is not accurate. Unfortunately, there is no other way for us to gather that particular information and we have to assume that they are correct.

When conduction the literature review, we will use different research articles and company reports. We will try to read research articles published in acknowledged and well known magazines to increase the reliability of this particular source. Company reports, other then annual reports, are also used in this thesis. They are less reliable then research articles and therefore we try to limit their importance to our thesis. These sources are not used in our primary study where we try to see which variables affecting the price of credit default swaps. The company reports are only used when providing the reader a background to the different credit derivatives instruments as well as when trying to show the importance of these instruments to the reader.

2.4.2 Validity

Validity shows if the study measures what it is supposed to measure.[19] In quantitative studies the validity depends on what the study is measuring and if this is clearly stated in the problem discussion. In our study we are trying to investigate the factors that are affecting the price of the credit default swap. We only have the possibility to isolate the variables that we are including in our regression analyses and therefore the study could lack some important explanatory variables. However, we have selected the variables that we after intensive research believe could be the most important once. More accurate variables will then result in a more accurate study.

[19] Eriksson, Wiedersheim-Paul, *Att utreda, forska och rapportera,* (2001), p.153.

3 Theoretical Framework

In this chapter we will present the two basic theories that we will use later in order to select the independent variables that will be used in our regression model. We will also explain why we use Black & Scholes option pricing model and the put-call parity condition.

3.1 Black & Scholes

We will use Black & Scholes option pricing model in the chapter Empirical study, where we select independent variables to our regression model. Black & Scholes theory will be used to support the theory by Skinner and Townend (2002), who argue that a credit default swap can be seen as a put option.

The model is used to price European calls and European put options on a non-dividend paying stock. [20] The model is seen in equation 3.1 below.

$$C = SN(d_1) - Ee^{-rt}N(d_2)$$

$$P = Ee^{-rt}N(-d_2) - SN(-d_1)$$

$$d_1 = \frac{\ln\left(\frac{S}{X}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

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

C = Price of the call
P = Price of the put
S = Price of the underlying stock
E = Exercise price of the option
r = Risk-free rate
σ = Variance
t = Time to expiration date

Equation 3.1: Black & Scholes option pricing model

[20] http://www.ritme.com/tech/mathematicalib/derivatives/options.html (2004-12-05)

These are the assumptions in the Black & Scholes model;[21]

- There are no dividends paid on the stocks during the options life
- Markets are efficient, there are no arbitrage opportunities
- No commissions are charged
- Interest rates remain constant and known
- Returns on the underlying stocks are normal distributed

3.2 Put-call Parity

We will use the put-call parity condition in the chapter Empirical study, where we select independent variables to our regression model. This parity condition will be used to support the theory used later and to motivate the selected variables.

The put call parity suggests that there are two ways of buying a protective put. One way is to buy a put and the underlying stock simultaneously. The total price in this strategy is the price of the put and the price of the underlying stock. The other way is to buy a call and a zero – coupon bond. The price for this strategy would be price of the call, plus the price of the zero-coupon bond. The price of the zero-coupon bond is the same as the present value of the exercise price.[22] The put call parity can be seen in equation 3.2.

$$C + PV(X) = P + S$$

C = Present market value of the call
$PV(X)$ = Present value of the strike price x
P = Present market value of the put
S = Present market value of the underlying stock[1]

Equation 3.2: Put-call parity[23]

[21] http://bradley.bradley.edu/~arr/bsm/pg04.html (2004-12-02)
[22] Ross, Westerfield, Jaffe, *Corporate Finance* (2002), p. 619.
[23] http://www.riskglossary.com/articles/put_call_parity.htm (2004-11-28)

4 Practical Framework

This chapter will present a brief background to the market of credit derivatives. We will also present the most commonly used instruments, the regulatory framework and an overview of the concept of credit risk.

4.1 Background to Credit Derivatives

In this part of the chapter we will give a short summary of the history of credit derivatives. We will describe the current market, regarding size and development. Last we will present the major participants in today's market.

4.1.1 History

In 1992, ISDA first used the term credit derivatives to describe a new type of over the counter traded instrument. The next year J.P. Morgan, Merrill Lynch and Bankers Trust started to market some forms of credit derivatives, but it initially faced some resistance.[24] The market did not take of until 1996, when the market participants started to realize the benefits associated with credit derivatives. Before 1996 the market participants were skeptic whether or not the deals agreed would be completed. Another big reason for the skepticism was that Standard & Poor refused to rate credit derivatives products.[25]

[24] http://www.credit-deriv.com/evolution.htm (2004-11-25)
[25] Dempster, MAH, *Modelling Credit Migration and Default Probabilities for Pricing and Hedging* (2002) p. 4.

4.1.2 The Market

Credit derivatives are traded over the counter on an OTC market. Credit derivatives are used to hedge credit exposure, transfer credit risk and for regulatory capital relief[26]

As can be seen in table 4.1, the credit derivatives market is growing very fast. The market is expected to continue to grow as the pricing becomes more effective and the market becomes more liquid.[27]

Year	Value (bn US$)
1997	180
1998	350
1999	586
2000	893
2001	1189
2002	1952
2004	4799

Table 4.1: Market size[28]

Table 4.2 shows the relative size of the different products. The most traded product is the single name credit default swap, accounting for almost half the total market.

	1999	2001	2004
Single-name CDS	38%	45%	43%
Portfolio Products	18%	22%	26%
Credit-linked notes	10%	8%	8%
Spread Products	5%	5%	6%
Basket Products	6%	6%	6%
Other	23%	14%	11%

Table 4.2: The most traded instruments.[29]

4.1.3 Market Participants

The credit derivatives market can be divided into three groups. These are the protection buyers, the protection sellers and the intermediaries. As can be seen in table 4.3, the largest participants in the credit derivatives market are commercial banks. Even if the commercial banks account for the largest part of the market, it is not wide spread across the banking

[26] Merrill Lynch, *Credit Derivative Handbook* (2003), p. 3.
[27] Ibid p. 4.
[28] Brittish Banking Association, *Credit derivatives report*
[29] Ernst & Young, *Credit Derivatives* (2003) p.5.

sector. The commercial banks and securities houses are not only big sellers and buyers, they are also involved as intermediaries. Trading credit derivatives has become very profiting.[30]

During 2004 the insurance companies became the biggest sellers of credit derivatives. One reason for this could be that credit derivatives represent a new type of asset that allows the insurance companies to diversify their investment risk. Probably, the most important reason for the insurance companies increasing involvement in the credit derivative market is their historical background. Insurance companies are used to hold risks for a long time and to efficiently price these risks. Many insurance companies have restrictions regarding investments in derivatives, but they are able to invest in credit derivative portfolio products. This is probably an explanation for the rapid growth of these instruments.[31]

	Buyers		**Sellers**	
	2001	2004	2001	2004
Commercial Banks	52%	47%	39%	32%
Securities Houses	21%	17%	16%	15%
Fund Managers	15%	19%	10%	16%
Insurers	6%	8%	33%	33%
Corporates	4%	7%	2%	4%
Government Bodies	2%	2%	0%	0%

Table 4.3: The largest market participants.

4.1.4 International Swap and Derivative Association

The International Swap and Derivative Association (ISDA) was founded in 1985, in order to reduce the risk in the derivatives and risk management business. It is now an international trade organization and it is representing the participants in the privately negotiated derivative industry. The association covers issues concerning swaps and options in all the major assets classes such as currencies, commodities, interest rates, energy, credits and equity.[32] Today it has over 600 member institutions representing 47 countries. ISDA fulfills many related issues in the derivative industry, but one of the most important once is the developing of the ISDA Master Agreement. This agreement works like a legal framework for the participants in the global credit derivatives industry, and could be used as an advice when designing a contract.

[30] Ernst & Young, *Credit Derivatives* (2003) p.6.
[31] Ibid p.5.
[32] http://www.isda.org/ (2004-11-20)

4.2 Credit Derivatives Instruments

In this part we will describe the most commonly used credit derivative instruments. Our selection of the most important instruments is based on a report by the British Bankers Association (BBS). We will present a more detailed description of the credit default swap, since that is the instrument studied later in our regression model. The other instruments are used to give the reader a broader perspective of credit derivatives, and they will therefore be discussed more briefly.

4.2.1 Credit Default Swap

Credit Default Swaps are the most used credit derivatives with a forecasted market share of around 43% in 2004.[33] Credit default swaps are an over-the-counter (OTC) contract between parties, where the seller agrees to make a payment to the buyer in the case of a contract specified event. In exchange for this, the seller receives a fixed payment or series of fixed payments[34]. The buyer, for example a commercial bank, can eliminate or reduce their risk with a credit default swap contract. If the bank is lending money to a company they can buy protection against the risk of that specific loan. The loan that the bank approved to the company is also known as the reference entity. The seller, for example an investment bank, offers to assume the credit risk of that loan for certain price and condition as to a reference asset. The reference asset could be bond value or a commercial paper issued by the company, or sometimes a debt instrument issued by a company with similar credit rating[35]. The lender is obligated to pay the seller a fixed fee in order to preserve the option. This fee is similar to an interest rate and is often expressed in basis points. The amount of the fee depends on the creditworthiness of the company. For a large public company with a high credit rating this fee could be around 20 to 30 basis points, while for a smaller company with lower credit rating this fee could be much higher.[36]

There are many reasons for using credit default swaps; one is to transfer the credit risk of the balance sheet. Another reason is to limit or reduce the need of capital. The capital requirements could be lowered substantially. A bank being a member of the Organization for Economic Cooperation and Development (OECD) could lower its capital adequacy from

[33] Ernst & Young, *Credit Derivatives* (2003), p. 5.
[34] www.investordictionary.com/definition/Credit+Default+swap.aspx, (2004-11-22)
[35] Batten, Hogan, *A perspective on credit derivatives*, International Review of Financial Analysis (2002), p. 254.
[36] Ibid p. 254.

100% to 20%.[37] An important factor when using credit default swap is that to be fully hedged against the risk, the maturity of the credit derivative contract has to be the same as the maturity of the reference entity. If the maturities are not matching each other, the protection buyer is still exposed to a credit risk. Credit default swap contracts are widely used, especially with borrowings from large public companies where proper credit ratings are available, such as from Standard & Poor's and Moody's.

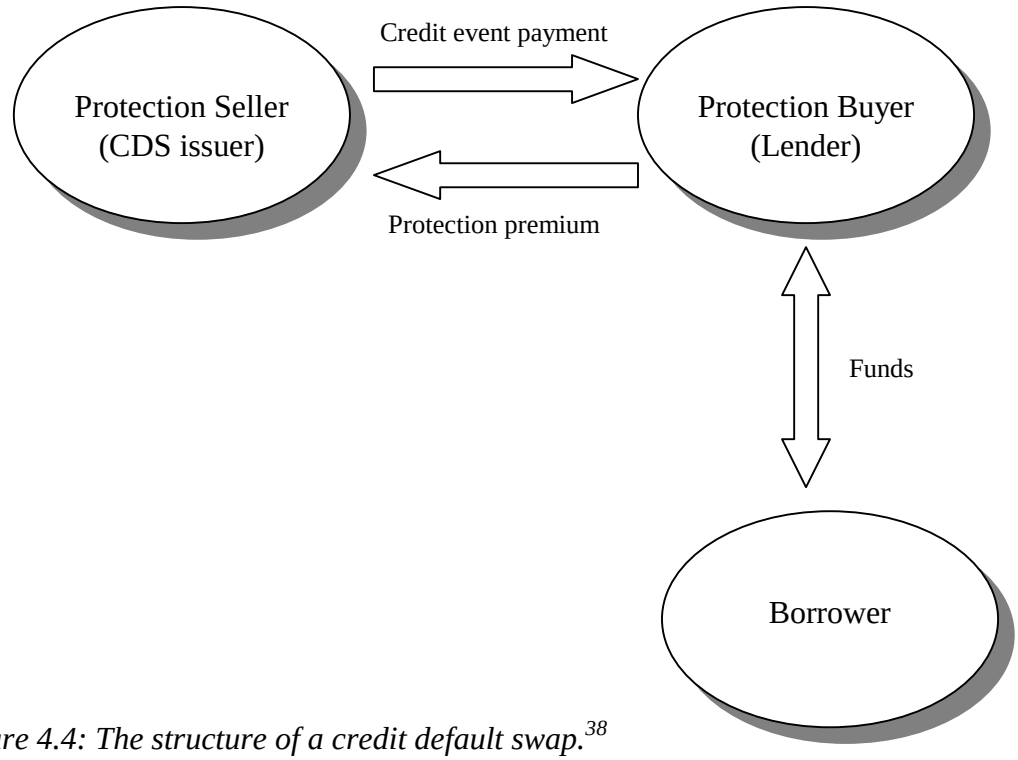

Figure 4.4: The structure of a credit default swap.[38]

4.2.2 Other Instruments

Credit-Linked Note

Similar to the credit default swaps, a credit-linked note is a financial instrument used to protect the buyer against a credit risk. The buyer of the credit-linked note, the bank, issues a note that has a similar or identical maturity as the customer's obligation. The matching could be done in different ways, and if the bank want to be eliminate the interest rate risk it should match the maturities. The seller of the protection, the investment bank, buys the note so that the customer's bond or loan is fully covered by the contract.[39] The protection seller then receives the interest on the note. On maturity, the protection seller receives the principal sum less any sums, which reflects a credit event specifically defined in the credit derivative

[37] Batten, Hogan, *A perspective on credit derivatives*, International Review of Financial Analysis (2002), p. 254.
[38] Ibid p. 254.
[39] Ibid p. 254.

contract.[40] The seller of the protection is in this contract exposed to risk from two participants. First, from the company that borrows from the bank, and second, from the bank itself. The buyer has, if matching maturities, no credit risk.

The usage of credit-linked notes is more appealing for banks that have customers of substantial size. This is due to the relative high costs of issuing bonds and to manage bank loans with fixed maturities. The transaction size is of importance because of the relatively high costs associated with an issuance of a note.

Basket Default Swap

A basket default swap is similar to a credit default swap, and protects the seller against a loss in case of default. The difference, compared to a credit default swap, is that the basket default swap assures protection against all underlying credits in the basket, as to only one, in the case of a credit default swap. There are different kinds of basket default swaps. The 1st-to-default basket default swap, gives the protection buyer the right to claim compensation for the losses in the first credit defaulted, and is the most commonly used one of the basket products.[41] Another basket default swap is the 2nd-to-default basket default swap, which covers the second underlying defaulted. In general all these products are called Kth-to-default basket default swap.[42] The pricing issue of the basket default swaps is more complicated than the ordinary credit default swap and when pricing basket swaps one has to include the following inputs:[43]

- Number of reference entities
- Probability of default of reference entities and protection seller
- Default correlations between reference entities
- Default correlation between reference entities and protection seller
- Maturity of swap and expected recovery value of the reference entities

There are a number of reasons why investors use basket swaps. One is to improve portfolio yields. Portfolio managers who want to improve their range of investment opportunities, by investing in lower rated and higher yielded assets use this strategy. They can sell protection

[40] Batten, Hogan, *A perspective on credit derivatives*, International Review of Financial Analysis (2002), p. 254.
[41] Bernd, *Mathematical Finance* (2003), p. 9.
[42] Ibid p 9
[43] Merill Lynch, *Credit Derivative Handbook* (2003), p. 86.

on a basket of approved names that meets the yield hurdle. This is something that sometimes is not possible when using just credit default swap, because some of them don not meet the reference entity hurdle on their own. Another benefit from using basket swaps is the example of an investor, that believes that the combined credits have a higher correlation than the than the correlation on the basket swap. The investor can then sell protections on the basket.[44]

Portfolio products

The fastest growing segment of the credit derivative market is portfolio proucts, which are securities backed by a diversified pool of exposures.[45] Protfolio products contains of collateralised loan obligations, collateralised debt obligations and collateralised bond obligations.[46] There are many variations and different names for portfolio products, but the function is the same; to transfer portfolio credit risk.

There are two main variations of portfolio products. One that is constructed, and use assets that are alredy present at the company's balance sheet, called Balance Sheet Deal. The other one, where the underlying asset is bought specificly for the purpose of creating a portfolio that can be reselled, is called Arbitrage Deal.[47]

Spread Products

There are different types of spread products including options, forwards and swaps. The underlying asset of spread products is the difference between the return on two different classes of assets, and the margin between them is the spread.[48]There are two types of spreads that are being traded:[49]

- Absolute spread – The spread relative a benchmark rate that is regarded as risk free
- Relative spread – The spread between two assets

Credit spread instruments are not linked to a specific credit event as many of the other credit derivatives. Instead, the instrument is open to all events that may influence the spread. This also includes macroeconomic events as well as more firm specific events.[50]

[44] Merill Lynch, *Credit Derivative Handbook* (2003), p.92.
[45] Rizzy, JV, *Risk implications of credit derivative instruments*, Commercial Lending Review (2003), p. 20.
[46] Duke street capital, www.altassets.com/pdfs/DukeStreetCDM_FAQs.pdf, (2004-12-05)
[47] Ibid
[48] Batten, Hogan, *A perspective on credit derivatives*, International Review of Financial Analysis (2002) p. 258.
[49] Dempster, MAH, *Modelling Credit Migration and Default Probabilities for Pricing and Hedging* (2002), p 10
[50] Batten, Hogan, *A perspective on credit derivatives*, International Review of Financial Analysis (2002) p. 259.

4.3 Credit Risk

Credit Risk arises due to uncertainty that counterparty's cannot meet their obligations. Counterparties and lenders could be of many types, from institutions and governments to individuals. When measuring the credit risk of a single counterparty the lender has to consider the three following issues:[51]

- *Probability of default*: This is the risk that the counterparty will default within the timeframe of the obligation or within a specific time horizon. If this is calculated for a one-year time horizon it could also be called expected default frequency.
- *Credit exposure*: Measures how large the outstanding obligation would be in an event of default.
- *Recovery rate*: This measures how much of the exposure that may be recovered in a case of default. An example of this is the amount that could be recovered after a bankruptcy proceeding or any other settlement.

4.4 Credit Rating

There are several measurements of the credit quality of an obligation. The credit quality could for example be the ability of a lender to perform on its obligations. To score a lenders ability to perform on its loan, the lenders may use credit ratings. This measurement could be used to make credit decisions and to determine what interest rate the company will use when issuing a bond. A higher credit rating will then result in a lower interest rate for that specific company. Some companies and institutions are using credit analysts who rank the lenders ability to meet their obligations. Other firms are making their business on ranking companies, which can be used either by investors or by other third parties.[52] Some of the major companies that are specializing on rating other companies are Standard & Poor's, Moody's and Fitch. Especially institutions that are publicly traded will use these or other rating companies to prepare ratings for their debt. The system of the credit ratings depend on that company's own system, for example Standard & Poor's uses rating from a scale of AAA rating to D, where AAA would be the best rating and a D would some payment default on that companies obligation has actually already occurred.

[51] http://www.riskglossary.com/articles/credit_risk.htm (2004-12-08)
[52] Ibid

4.5 Credit Events

The regulations regarding credit events are very important so that the participants know what is going to happen in a case of default. The Master Agreements issued by ISDA has standardized credit derivative contracts used by most participants. The Master Agreement has been updated several times with the latest one occurring in 2003. There are six potential credit events, although some of them are just used in certain markets:[53]

- *Bankruptcy*- The maybe most obvious one where a corporate becomes unable to repay its debts or obligations.
- *Failure to Pay*- A payment default on an obligation by the reference entity. This is typically subject to a threshold (Payment requirement) of $1 million. The payment must be in accordance with the terms of such obligation, which would occur after any grace period extension.
- *Obligation Acceleration*- A situation where, for reasons of default, obligations on the reference entity have become due and repayable prior to maturity, it has been accelerated.
- *Obligation Default*- Would be triggered by an event of default, but requires only that an obligation has become capable of being made due and payable prior to maturity. This is very seldom included in an actual credit derivative contract.
- *Repudiation/ Moratorium*- A potential repudiation/ moratorium could be triggered by an authorized officer of a reference entity or by a government authority refusing to honour obligations or impose a moratorium, which would prevent an entity from making a payment.
- *Restructuring*- In 2003 ISDA started to use five objectives and 1 subjective criterion's for determine if a restructuring event has occurred. This covers events as a result of which the terms, as agreed by the reference entity or by the government authority and the holder of the relevant obligation, governing the relevant obligation have become less favourable to the holders that they would otherwise have been.[54]

[53] Merill Lynch, *Credit Derivative Handbook* (2003), p. 52.
[54] http://www.credit-deriv.com/isdadefinitions.htm (2004-12-05)

5 Empirical Study

In this fifth chapter we will give a deeper explanation of the method used in our study. We will first explain how we selected the variables for the regression. Then we will explain the specific variables more in detail and revile our expectations concerning importance and impact. Some statistical considerations will also be discussed.

5.1 Credit Default Swap and Put Call Parity

In this section we will try to explain how we select the independent variables that will be used in the regression analysis. We will here argue that a Credit Default Swap can be seen as a put option.

The right hand side is the discounted value of a risk free bond, treasury bill, that is worth the exercise price X at time t. Under certain conditions the left hand side of equation 5.1is a form of bond portfolio insurance or a risk free asset. These conditions are the following four:[55]

- The options must be European
- The underlying asset pays no dividends
- S and P must be written on the same underlying asset
- S and P must have the same maturity date.

$$S + P - C = X^{-rt}$$

S = Price of the underlying firm
P = Price of the put option
C = Price of the call option
X = Exercise price that underlies both option contracts
r = Risk free rate
t = Maturity date of both options

Equation 5.1: Put-call parity.

[55] Skinner, Townend, *An empirical analysis of credit default swaps*, International review of Financial Analysis (2002), p. 299ff.

Black & Scholes (1973) suggests that if a credit risky zero coupon corporate bond is bought, the buyer purchases the underlying firm S and sells a European call option C written on the firm.[56] When the corporate bond is exercised it has a promised value of X. This value is the same as the exercise price of the call.

At maturity of the call, if the value of the firm S is more than the terminal value of the debt, the bond seller will chose to exercise the call by paying back the debt at price X, and thereby buying back the firm. This is done because the bond seller only pays X, and receives an asset S that is worth more.

The opposite relationship is created if the value of the firm S is less than the value of the debt X. In this situation the bond seller would choose not to pay back the debt, since the value of the firm is less than the value of the debt. The debt holders could instead declare bankruptcy, and receive the value of the firm. As mentioned before, this would be less than the value of the debt.

We can therefore assume that a credit risky debt B is a combination of a long position in the underlying firm, S, and a short call, C. This means that equation 5.1could be re-written as equation 5.2.[57]

$$B + P = X^{-rt}$$

P = Price of the put option
B = Price of credit risky debt
X = Exercise price that underlies both option contracts
r = Risk free rate
t = Maturity date of both options

Equation 5.2: Modified put-call parity.

[56]Skinner, Townend, *An empirical analysis of credit default swaps*, International review of Financial Analysis (2002), p. 299ff.
[57] Ibid p. 299ff.

We will now try to explain how a credit default swap works, and the similarities to put call parity. A long position in a credit default swap requires payments, which are based on the outstanding notional value of the reference asset, in this case a bond. The credit default swap will then be exercised in an event of default. The promised amount is defined by the recovery rate of the credit default contract. So, in other words, the buyer of the credit default swap is insuring its credit risky bond against default. A long position in a credit risky bond and a credit default swap on the same asset reflects the value of a treasury bill, and the credit default swap is similar to a put option. There are several implications in our assumptions that a credit default swap can be seen as a put option. We will here discuss these issues: [58]

- In a credit default contract the event of default is unknown, and it may occur before the maturity of the treasury bill. One can then suggest that the equation may not hold because of different maturities, but this will not be a problem, as default prior to maturity will result in cash flow, which can be reinvested in an ordinary treasury bill for the remaining time. This could then imply that the put option is of American nature rather than European.
- Another issue is that the timing of an exercise, for an American put option, is determined by the option holder, when the timing of exercise for a credit default swap is determine by the event of default. This issue should not be a problem since we suggest that the holder of a put option does not really determine when to exercise. A reasonable investor would only exercise when he thinks that the underlying asset will not depreciate further.

If you assume that the credit default swap can be seen as a put option, the following variables are used to determine the price according to Black & Scholes (1973):[59]

- Current stock price
- Exercise price of put
- Annual risk-free rate of return
- Variance of the stock return
- Time to maturity

[58] Skinner, Townend, *An empirical analysis of credit default swaps*, International review of Financial Analysis (2002), p. 299ff.
[59] Ross, Westerfield, Jaffe, *Corporate Finance* (2002), p. 629.

5.2 Variable selection

We have earlier explained why we suggest that a credit default swap can be seen as a put option. We will now use the same variables that are determining the put price for our model pricing the credit default price. The only different is that we use swap premiums quoted as yield rather instead of price as in traditional option pricing. This is done in order to avoid errors when doing measurements.

As can be seen later in this chapter, we have decided to study each credit default swap contract separately. As a consequence of this, we will exclude the exercise price from the regression model. This is done because this variable will be held constant throughout the time of the contract. The regression model can be seen in equation 5.3.

$$y = \beta_0 + \beta_1 yield + \beta_2 RF + \beta_3 TTM + \beta_4 vol + \beta_5 risk + u$$

y = Price
β_0 = Intercept
β = Coefficient
Yield = Yield of the underlying asset
RF = Risk free interest rate
TTM = Time to maturity
Vol = Volatility of the underlying asset
Risk = Proxy for risk
u = Error term

Equation 5.3: Regression model for the price of the credit default swap.

We are using the following proxies in order to explain our dependent and independent variables used in the regression analysis:

5.2.1 Price

The price of the credit default swap was found on Reuters 3000Xtra, and is presented in basis point. When using Reuters Database we can obtain the historical bid and ask prices for that specific credit default swap contract, from the date of issue until present time. We use daily data for all those days when the swap has been traded. Some of our swaps have been traded more frequent than others, so for those we can obtain more observations. Those cases give us better data for conducting the regression analysis.

5.2.2 Risk-free interest rate

When estimating the risk-free rate we use a one-month T-bill rate. Because all our credit default swap observations have an underlying bond in Euro, we selected the one-month Eurobond as the risk-free rate measurement. We collected daily data, and used them for the days when the credit default swap had been traded. This data was obtained from the Eco Win Database.

5.2.3 Volatility

For a proxy of the volatility, we used one-month historical volatility of the underlying bond. We used the following equation 5.4.

$$\sigma = \sqrt{\frac{\sum (X-u)^2}{n}}$$

σ = Volatility
X = Observation
u = Mean
n = Number of observations

Equation 5.4: The equation for standard deviation.

As variable X and u, we used the yield of the underlying bond. We assumed that a month contains of 20 market days, and therefore we used 20 historical observations to calculate the daily volatility.

5.2.4 Time to maturity

The maturity is measured as the time between the start and end date of the credit default swap contract. We used 5-years credit default contracts in most cases since this is the most common used length of these contracts. We calculated the remaining days until the credit default swap contract matured. This information was also collected from Reuters 3000Xtra.

5.2.5 Risk

As a proxy for credit risk we use a model that is used for calculations of default risk premiums. We decided to use this specific model for credit risk instead of credit ratings published by the major rating institutions. This is done because those institutions only give out their ratings in their own specific system. Small changes are thereby not reflected immediately and some changes can not be observed because of the different steps in their systems. For example a small change in a company's credit worthiness will not correspond to a change in Standard & Poor's or Moody's ratings. Thereby, this will give us a more accurate estimation of the credit risk. The model is can be seen in equation 5.5.

$$R(\tau)=\left(\frac{-1}{\tau}\right)\ln\left[N(h_2)+\left(\frac{1}{d}\right)N(h_1)\right]$$

$R(\tau)$ = Risk proxy
τ = Time remaining to maturity
d = Leverage ratio
σ^2 = Variance of the underlying asset
$N(h_i)$ = Normal distribution of h_i, where

$$h_1=-\frac{\left[\frac{1}{2}(\sigma)^2-\ln(d)\right]}{\sigma}$$

$$h_2=-\frac{\left[\frac{1}{2}(\sigma)^2+\ln(d)\right]}{\sigma}$$

Equation 5.5: Formula for calculating the risk proxy.[60]

We used the leverage rate obtained from the companies' annual reports. Therefore the leverage ratio will be a yearly estimation. The leverage ration was calculated by dividing all the company's borrowings with the shareholders founds plus the total borrowing.[61] In the case of volatility, we use the volatility of the underlying bond, which was the same that we calculated earlier.

[60] Saunders A, *Financial Institutions Management* (1997), p.211f.
[61] Arnold G, *Corporate Financial Management* (2002), p. 807.

5.2.6 Observations

To find out which variables that affect the price of the credit default swap, we decided to study all swaps separately. We started by selecting 15 different credit default swap contracts, with a bond as the underlying asset. After collecting the needed data on all the contracts, we had to eliminate two, due to too few observations on those. This left us with 13 remaining contracts for our regression analysis.

5.2.7 Expectations

We expect that the yield will have a positive effect on the price of the credit default swap. A higher yield indicates a higher risk in that specific bond. If the investors believe the bond is risky, they will require a higher risk premium then for a less risky bond. Therefore, a higher yield on the underlying asset of the credit default contract will probably result in higher price.

According to Black & Scholes option pricing theory, an increase of the risk free interest rate will affect the option price negatively. This means that the price of the option will fall if the risk free rate increases. Hereby, in our study the credit default swap price will fall as a consequence of a higher risk free interest rate.

Time to maturity will probably affect the price of the credit default swap positive. Holding other factors constant, the probability of a credit event that triggers a payment will decrease with time. A longer time to maturity will result in a higher price of the contract.

We think that the volatility of the underlying bond will have a positive effect on the price. A higher volatility means a higher risk, which normally means a higher premium. The probability of default will increase with a higher volatility. This means that if the volatility increases, the price of the credit default swap will increase.

We expect the risk proxy to have a positive effect on the swap price. We believe that a higher risk will result in a higher risk premia. Telia and Sonera merged during the time of our study, and therefore we could not obtain the leverage ratio for those two companies. This made it impossible for us to calculate the risk proxy used in our regression model.

5.3 Statistical Problems and Tests

In order to test our regression models for statistical problems we will conduct tests to discover if these problems are present in our regressions. We will test our regressions for the following three problems; autocorrelation, collinearity and heteroskedasticity.

5.3.1 Heteroskedasticity

When there is heteroskedasticity the variance of the residuals are not constant. They are then different for different observations. The problem arises when the variances are unequal, because then the relative reliability of each observation is unequal. Larger variance causes lower importance for that specific observation. This problem becomes clearer when the value of this variance has a relation to more independent variables.[62] To test if there is heteroskedasticity in our regression model we will conduct White's test.[63] We used the program EViews 4 to conduct this test. We first state our null hypothesis, which is that there is no heteroskedasticity in the tested model. The null hypothesis is the following, seen in equation 5.6:

$$H_0 : \sigma_i^2 = \sigma^2$$
$$H_1 : \sigma_i^2 = f(x_i)$$

Equation 5.6: Hypothesis for testing heteroskedasticity

If the hypothesis is rejected we assume that there is heteroskedasticity in the tested regression model.

5.3.2 Collinearity

This term is used in a regression to indicate a situation where the explanatory variables are related by a linear function, which makes the estimation of the regression coefficients difficult.[64] Approximate collinearity could also cause problems when estimating regression coefficients, especially if the multiple correlation for the regression of a particular explanatory variable on the others are high. This will then cause the variance of the corresponding estimated regression coefficient to also be high.[65] In order to test our models for collinearity

[62] http://www.telecom.csuhayward.edu/~esuess/Links/Software/RegressionExplained/regression_explained.doc
[63] Wooldridge, JM, *Introductory Econometrics* (2003). p. 268f.
[64] Everitt, BS, *The Cambridge Dictionary of Statistics* (2002), p. 251.
[65] Ibid, p. 252.

we created a matrix over the collinearity between the independent variables in the models. If there is a high degree of correlation between the variables in the regression we will assume that there exists collinearity in the model.

5.3.3 Autocorrelation

Autocorrelation occurs when there is a covariance between the explanatory variables used in the regression. This could cause wrongly standard deviation between these variables. In order to determine if there is autocorrelation in our models, we will use the Durbin-Watson test.[66] We will first calculate the Durbin-Watson value with help from SPSS. We then compare this value with the values obtained from the table of critical Durbin-Watson values. The null hypothesis is that there is no significant autocorrelation in our models.

If the value we obtain from SPSS is lower then the critical value d_l of the Durbin-Watson table we have positive autocorrelation in the model, and if the value is larger than d_u we have negative autocorrelation.

[66] Verbeek M, *A Guide to Modern Econometrics* (2002), p. 81.

6 Result

In chapter six we will present the results from the empirical test described in the previous chapter, Empirical study. First, we will present the result from the statistical tests and then the results from the regression analysis.

6.1 Result of the statistical tests

When we tested our models for correlation we obtained values that sometimes were high, but the same variable where not significant in a large number of samples. We therefore assume that our model is still valid and that all our explanatory variables will be included in the model.

White's test showed that there where heteroskedasticity in almost all regressions. We rejected the null hypothesis that there is no heteroskedasticity present in the model in all cases except for one. Only in the case of Sonera we couldn't find any sign of heteroskedasticity.

The Durbin-Watson test for autocorrelation showed that it was present in most cases. In two cases we couldn't neither reject neither accept the null hypothesis that no autocorrelation was present. In one case we could accept this hypothesis. In all the other cases we observed a positive autocorrelation in the models.

In order to correct the regression results for these statistical problems we conducted a Newey-West correction. The results discussed later are the result after adjustments for the above mentioned statistical problems.

6.2 Regression result

In order to make the regression results easier to follow, we will present a summary of it in one table. Starting from this table, we will explain the results further in the text. After running 13 different regressions we detected that all variables affected the price of the credit default swap contracts, although there where no one that where significant in all the regressions. We also experienced a high explanatory value in all our regressions. The R square values where between 41% and 92%.

All the regressions, except for one, had at least one significant variable at the 5% level. Table 6.1 shows that the number of significant variables varies between the different credit default swap contracts. In the regressions made on Rolls Royce and MMO2 four of the five variables were significant. In the regression made on Telia, none of the variables where significant.

	Yield	Risk Free	Time to mat.	Volatility	Risk	R-square
Aventis	9.787375 (3.181) ***					0.533
Basf	-5.888123 (2.693) **	16.21910 (5.291) ***				0,586
Dutch State Mine		21.24711 (-6,102) ***				0,412
EDF	-28.28102 -4,271 ***		0.071837 -0,013 ***			0,697
Gaz de France	-14.70296 (5.622) **	-13.27550 (5.068) **	0.057935 (0.014) ***			0,659
MMO2	93.53574 (4.113) ***		-0.133313 (0.022) ***	693.6994 (180.086) ***	-526.4968 (173.580) **	0,915
MREAL	88.96837 44.424 **					0,437
Rolls Royce	79.49974 (6.408) ***		-0.164286 (0.019) ***	1053.237 (138.050) ***	-663.3308 (96.593) ***	0,897
SAS	102.0277 (21.224) ***				181.6940 (88.431) **	0,475
Stora Enso	-16.04105 (4.955) ***	39.76230 (8.586) ***				0,584
Telecom Italia		59.02106 (12.382) **		304.3329 (99.094) ***	223.3473 (31.052) ***	0,768
Telia						0,507
Sonera			-0,031931 (0,012) **			0,697

*Table 6.1:*Significant at 10% level, **Significant at 5% level, ***Significant at 1% level The numbers in brackets are the standard errors and the other numbers are the coefficients.*

As the table shows, yield is the independent variable that is significant in most of our regressions. It is significant in nine of the 13 regression analysis. Volatility, on the other hand, is only significant in three of the regressions.

The sign of the coefficient, called β in the regression model described earlier, is very important to be able to determine the effect a specific variable has on the price of the credit default swap contract. We observed the following signs from our 13 regression analysis:

- **Yield –** In five of the nine significant observations, the sign of the coefficient was positive.
- **Risk free** – The coefficient was positive in one observation and negative in one.
- **Time to Maturity** – The sign of this coefficient was difficult to determine. We observed three negative and two positive.
- **Volatility** – All three significant observations had a positive sign.
- **Risk** – Two of the significant observations where positive, and two where negative

7 Analysis

In this chapter the result obtained in chapter six will be discussed and analyzed. We will present the analysis sorted by the different independent variables from the regression model. Finally, some other possible explanations will be presented and discussed.

7.1 Introduction to analysis

The result of our regression analysis shows that all of the variables affect the price of the swaps, but volatility is only significant in three and the risk proxy in four of the 13 regressions. As can be seen in the results, the other three variables are significant in at least five of the regressions.

7.1.1 Yield

Yield is significant in nine of the 13 regressions that we have studied. This is an indication that the yield of the underlying bond is influencing the price of the swap contract. One reason for a higher yield could be that the risk free rate is increasing, but another reason, which is in line with our regression analysis result, could be that a higher yield probably means that the underlying bond has a higher risk. If the market is efficient and price risk correctly, a bond with a high yield will probably have a higher probability of default than a low yield bond. The reasonable investor would in other words require a higher premium on a more risky investment, and therefore the higher yield of the bond.

Five of the nine significant yield coefficients from our regression have a positive sign, which indicates that our expectations where correct and that a higher yield means a higher price on the credit default swap contract. The theory that the yield of the underlying bond is affecting the credit default swap price is also supported by Hull and White (2004). Their results indicated that this relation holds fairly well. Our results also show that four of the significant variables have a negative sign, which is the opposite of our expectations. This could be an indication that other factors then risk may be influencing the yield of the underlying bond.

7.1.2 Risk-free interest rate

The risk free interest rate is significant in five of our regression analysis at the 5% level. We therefore draw the conclusion that this also could be one of the variables affecting the price of the swaps. All, except for one of the significant coefficients, have a positive sign, which is the

opposite sign from what we expected. A negative sign is also supported by other studies. Skinner and Townend (2002) find a negative relation between the risk free interest rate and the swap premia.

One explanation for our result could be that the credit default issuer will require a higher premium on the contract if the interest rate is higher. The return from an alternative investment will probably increase if the risk free interest rate rises. A reasonable investor would then require a higher return on the credit default swap contract. This will then result in a higher premia on the credit default swap.

7.1.3 Time to maturity

In five of the 13 regressions it is shown that time to maturity is affecting the price of the credit default swap. This is according to our results also a factor when determine the swap price. Two of the five significant observations have a positive sign, which means that the price increases when time to maturity increases. A positive sign is in line with our expectations. The risk is the highest in the beginning of the contract due to more days until maturity. The future of the underlying bond is more uncertain as the time horizon is longer. The day before the contract expires; the risk of default is very low compared to a much higher risk of default in the beginning of the contract if other factors are held constant.

The three coefficients with negative signs are harder to explain. One reason could be that the macroeconomic conditions have changed during the time period of our study. If the macroeconomic environment has been developing in an unfavorable direction for the studied companies during the study period, the risk of default for those specific companies will increase. This will lead to a higher premium of the credit default swap, even if the time to maturity is decreasing.

7.1.4 Volatility

The fourth variable in our regression is the volatility. This variable is only significant in three of the 13 regressions. We believe that this variable has less impact on the price of the credit default swap than the three previously discussed. All three times when the volatility showed some significance, it had a positive sign. This is the same as our earlier predictions. A higher volatility will result in a higher risk of that specific bond, and therefore a higher possibility of default. This will be reflected by the higher price of the credit default swap contract.

One reason for the low number of significant observations could be that we are using the historical volatility. Our result may have changed if we had used implied volatility. Skinner and Townend (2002) reached an inconclusive result regarding the significance of implied volatility. However, Bankert (2004) finds that both historical and implied volatility shows significance, but that the implied volatility could explain more of the credit default swap premia than the historical volatility.

7.1.5 Risk

The last variable in our regressions is the proxy for risk. This variable where only significant in four of the 13 regressions, and we therefore come to the conclusion that it only has a minor effect on the price of the credit default swap. Before we did the regressions, we thought that this variable would have a larger effect on the price than it turned out to have. One reason for this could be that our risk proxy does not capture the risk correctly.

Other researchers such as Hull and White (2004) have studied the relationship between credit rating and the swap premia. Their result shows that the actual change in credit rating does not affect the price, but that reviews of a downgrade will have a significant effect. The inconclusiveness of the signs and the low number of significant observations supports our thoughts that our risk proxy might not capture the risk correctly. A higher risk should according to us, and financial theory, lead to a higher price of the credit default swap.

7.1.6 Other explanations

The R-square value of the 13 regression analysis is between 41% and 92%. This indicates that the five variables included in our regression model capture a big part of the price. For some companies, such as Rolls Royce and MM02, the model explains around 90% of the price. Since our model does not explain all the price of the credit default swap, we believe that there are other factors that are affecting the price. Those factors could for example be that the market of credit derivatives is not very liquid, that there is no standardized regulatory framework and that there is low transparency.[67]

We believe that the liquidity of the market is relatively low. In some of our credit default swap contract studied we found very few closures. This is a sign of a market that has low

[67] Merrill Lynch, *Credit Derivative Handbook* (2003), p. 4.

liquidity. The swaps are still traded OTC, and therefore the secondary market is relatively small. A low liquidity will affect the efficiency of the pricing. This could change very rapidly due to the fact that more trading now takes place electronically.

The low transparency of the market makes pricing more difficult due to lack of information. It has been very hard to get information regarding price and terms of the contracts previously, and still is to some distinct. However, there are now several providers just starting giving both real-time and historical price information of credit derivatives. There are several specialized providers of this information such as Creditex, but recently also the big ones like Bloomberg and Reuters provide this information. This will probably make the market more transparent, leading to more efficient pricing.

The lack of a standardized legal framework for all the participants in the market makes the trading process more complicated and keeps potential participants out. Fewer participants then affect the liquidity negatively. Regarding the regulatory framework ISDA is the major coordinator and provider of information. ISDA is constantly developing new legal frameworks for the market participants. This will then probably make the trading of these instruments easier, which may attract new participants and thereby improve the liquidity of the market.

8 Conclusions

In this last chapter we will present the main conclusions in our thesis. We will also give some suggestions for future research.

8.1 Conclusions

Our thesis present a model that is trying to explain the price of credit default swaps. The model consists of five variables, which are volatility, time to maturity, yield, risk-free interest rate and a risk proxy. By using a linear multiple regression model, we find that all of the variables are affecting the price of the swap. However, the volatility of the underlying bond shows significance in only three of the 13 regressions used and the risk proxy in only four.

Our conclusion then is that three of the five variables used in our model are explaining the swap price. We believe that all these three are good explanatory variables when explaining the price of the credit default swap. However, the risk free interest rate and the time to maturity, are not as important as the yield of the underlying bond when determine the swap price.

The yield of the underlying bond is one variable explaining the price of the swap contract. A higher yield results in a higher price of the swap. The risk free rate and the time to maturity are both affecting the price as well. An increase in the risk free interest rate results in a higher price of the swap while the sign of the time to maturity is harder to determine.

Our explanatory values in the regressions are in most cases relatively high, but the variables are not explaining the entire price. We believe that there are other variables not used in our model that could affect the price as well as other factors. Those factors could for example be that the market is not liquid, that there is no standardized pricing models, no perfect regulatory framework and a lack of transparency in the market.

8.2 Future research

We think that it would be interesting to do a similar study as ours in a few years. We believe that there will be more historical data available and more observations could then be obtained. More observations will probably lead to more accurate regressions and higher significance. It would also be interesting to investigate other markets than the European, and compare them with each other.

Another interesting thing would be to study one or more of the other credit derivative instruments. This could be more difficult due to lack of information and more complicated pricing models, but those issues could perhaps be easier to overcome in the future, if the market continues to develop as it has the latest years.

9 Reference list

9.1 Published sources

Arnold G, *Corporate Financial Management* (2002)
Financial Times Professional Limited

Bankert C, *Explaining credit default swap premia*, (2004)
The journal of Futures Market, Vol. 24

Bryman, A, *Samhällsvetenskapliga metoder* (2002)

Batten J, Hogan W, *A perspective on credit derivatives*, (2002)
International Review of Financial Analysis

Brittish Banking Association, Credit derivatives report 2003/2004

Dempster, M A H, Modelling *Credit Migration and Default Probabilities for Pricing and Hedging* (2002)

Everitt B. S., *The Cambridge Dictionary of Statistics* (2002)
Second Edition, Cambridge University Press

Ernst & Young, *Credit Derivatives* (2003)

Hull J, White A, *The relationship between credit default swap spreads, bond yields, and credit rating announcements*, (2004), Journal of Banking and Finance Vol. 28

Jacobsen, DI, *Vad, hur och varför?* (2002)

Lundahl, U Skärvad, P-H, *Utredningsmetodik för samhällsvetare och ekonomer* (1999)
Studentlitteratur, Lund

Merrill Lynch, *Credit Derivative Handbook* (2003)

Neuman, W, Lawrence, *Social Research Methods* (1999)
Pearson Education

Rizzy, J V, *Risk implications of credit derivative instruments* (2003)
Commercial Lending Review

Ross Westerfield Jaffe, *Corporate Finance* (2002)
McGraw-Hill,

Saunders A, *Financial Institutions Management* (1997)
Irwin

Skinner F, Townend T, *An Empirical Analysis of Credit Default Swaps* (2002)
International Review of Financial Analysis

Verbeek M, *A Guide to Modern Econometrics* (2002)
Thomson

Will Bernd, *Mathematical Finance* (2003)

Wooldridge J M, *Introductory Econometrics* (2003)
Thomson

Zhu Haibin, *An Empirical comparison of credit spreads between the bond market and the credit default swap market,* (2004)
BIS Working papers

9.2 Electronic sources

Bradley University, December 2, 2004
http://bradley.bradley.edu/~arr/bsm/pg04.html

Contingency Analysis, November 28, 2004
http://www.riskglossary.com/articles/put_call_parity.htm

Credit Derivatives, December 7, 2004
http://www.credit-deriv.com/evolution.htm

Duke street capital, December 15, 2004
http://www.altassets.com/pdfs/DukeStreetCDM_FAQs.pdf

Innova Financial Solutions, December 12, 2004
http://www.ritme.com/tech/mathematicalib/derivatives/options.html

International Swap and Derivatives Association, November 25, 2004
http://www.isda.org/

Investor Dictionary, December 7, 2004
www.investordictionary.com/definition/Credit+Default+swap.aspx

Vijah Gubta Publications, December 28, 2004
http://www.telecom.csuhayward.edu/~esuess/Links/Software/RegressionExplained/regression_explained.doc

9.3 Annual reports

Aventis, Annual Report 2003

BASF, Annual Report 2003

Dutch State Mine, Annual Report 2003

EDF, Annual Report 2003

Gaz de France, Annual Report 2003

MM02, Annual Report 2003

MREAL, Annual Report 2003

Rolls Royce, Annual Report 2003

Stora Enso, Annual Report 2003

Telecom Italia, Annual Report 2003

10 Appendix

10.1 Appendix 1 – Regression results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	9.787375	3.180654	3.077158	0.0028
RF	-4.122781	4.439922	-0.928571	0.3557
TTM	0.000977	0.008298	0.117693	0.9066
VOL	-0.035058	0.475475	-0.073732	0.9414
RISK	0.113760	77.44401	0.001469	0.9988
R-squared	0.533377	Mean dependent var		26.59341
Adjusted R-squared	0.511674	S.D. dependent var		3.898655
S.E. of regression	2.724393			
Sum squared resid	638.3195			

Table: Aventis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	-5.888123	2.692948	-2.186497	0.0328
RF	16.21910	5.291352	3.065209	0.0033
TTM	-0.004385	0.005246	-0.835888	0.4066
VOL	57.27399	48.11944	1.190246	0.2388
RISK	2.867105	93.53858	0.030652	0.9757
R-squared	0.585777	**Mean dependent var**		13.58730
Adjusted R-squared	0.557210	**S.D. dependent var**		4.917496
S.E. of regression	3.272224			
Sum squared resid	621.0320			

Table: Basf

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	3.352278	3.926565	0.853743	0.3947
RF	21.24711	6.102035	3.481972	0.0007
TTM	-0.013652	0.008676	-1.573590	0.1178
VOL	44.72410	112.0129	0.399276	0.6903
RISK	-21.07272	161.0761	-0.130825	0.8961
R-squared	0.412131	Mean dependent var		30.62838
Adjusted R-squared	0.395687	S.D. dependent var		6.614024
S.E. of regression	5.141583			
Sum squared resid	3780.330			

Table: Dutch State Mine

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	-28.28102	4.270925	-6.621757	0.0000
RF	4.535118	8.417107	0.538798	0.5905
TTM	0.071837	0.012614	5.695060	0.0000
VOL	-467.3582	374.9605	-1.246420	0.2139
RISK	616.1763	474.0335	1.299858	0.1949
R-squared	0.697153	Mean dependent var		33.75210
Adjusted R-squared	0.691954	S.D. dependent var		16.15881
S.E. of regression	8.968451			
Sum squared resid	18740.92			

Table: EDF

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	-14.70296	5.621568	-2.615455	0.0108
RF	-13.27550	5.067959	-2.619497	0.0107
TTM	0.057935	0.014372	4.031196	0.0001
VOL	-144.4060	101.8534	-1.417783	0.1605
RISK	291.2124	233.8522	1.245284	0.2170
R-squared	0.658699	Mean dependent var		17.03797
Adjusted R-squared	0.640250	S.D. dependent var		9.153174
S.E. of regression	5.489995			
Sum squared resid	2230.363			

Table: Gaz de France

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	93.53574	4.112525	22.74412	0.0000
RF	-9.866805	20.93451	-0.471318	0.6379
TTM	-0.133313	0.021695	-6.144812	0.0000
VOL	693.6994	180.0859	3.852046	0.0002
RISK	-526.4968	173.5803	-3.033159	0.0027
R-squared	0.915076	Mean dependent var		103.6667
Adjusted R-squared	0.913443	S.D. dependent var		76.78533
S.E. of regression	22.59064			
Sum squared resid	106150.1			

Table: MMO2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	15,13603	15,19997	0,995793	0,3333
RF	31,32733	19,49066	1,6073	0,1264
TTM	-0,031931	0,011612	-2,749884	0,0137
VOL	165,3132	104,9059	1,575824	0,1335
R-squared	0,697258	Mean dependent var		52,33333
Adjusted R-squared	0,643833	S.D. dependent var		14,57166
S.E. of regression	8,696323			
Sum squared resid	1285,643			

Table: Sonera

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	88.96837	44.42397	2.002711	0.0535
RF	-34.01036	78.24399	-0.434671	0.6666
TTM	0.036512	0.115603	0.315840	0.7541
VOL	-904.4550	653.9080	-1.383153	0.1759
RISK	647.1732	543.8243	1.190041	0.2425
R-squared	0.436610	Mean dependent var		243.1053
Adjusted R-squared	0.368320	S.D. dependent var		29.90868
S.E. of regression	23.77090			
Sum squared resid	18646.84			

Table: MREAL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	79.49974	6.408341	12.40567	0.0000
RF	30.60359	19.26833	1.588284	0.1133
TTM	-0.164286	0.018762	-8.756158	0.0000
VOL	1053.237	138.0496	7.629415	0.0000
RISK	-663.3308	96.59309	-6.867270	0.0000
R-squared	0.895682	Mean dependent var		88.96321
Adjusted R-squared	0.894262	S.D. dependent var		65.07065
S.E. of regression	21.15923			
Sum squared resid	131627.6			

Table: Rolls Royce

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	102.0277	21.22367	4.807259	0.0000
RF	-2.897870	92.22033	-0.031423	0.9750
TTM	-0.119785	0.097242	-1.231829	0.2208
VOL	-390.1720	221.1266	-1.764473	0.0806
RISK	181.6940	88.43126	2.054636	0.0424
R-squared	0.474595	Mean dependent var		600.8716
Adjusted R-squared	0.454387	S.D. dependent var		92.90787
S.E. of regression	68.62696			
Sum squared resid	489804.6			

Table: SAS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	-16.04105	4.955052	-3.237313	0.0014
RF	39.76230	8.585670	4.631240	0.0000
TTM	0.005542	0.013351	0.415123	0.6785
VOL	182.2469	150.5746	1.210343	0.2277
RISK	-171.9675	203.6934	-0.844247	0.3996
R-squared	0.583762	Mean dependent var		50.44271
Adjusted R-squared	0.574858	S.D. dependent var		12.42430
S.E. of regression	8.101003			
Sum squared resid	12272.11			

Table: Stora Enso

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	-21.67310	13.80524	-1.569918	0.1183
RF	59.02106	12.38203	4.766669	0.0000
TTM	0.014995	0.034469	0.435031	0.6641
VOL	304.3329	99.09373	3.071162	0.0025
RISK	223.3473	31.05170	7.192757	0.0000
R-squared	0.768352	Mean dependent var		98.81356
Adjusted R-squared	0.762965	S.D. dependent var		34.55849
S.E. of regression	16.82522			
Sum squared resid	48691.15			

Table: Telecom Italia

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD	-1,297291	7,434054	-0,174507	0,862
RF	8,400623	16,73867	0,501869	0,6175
TTM	0,011564	0,010962	1,054933	0,2955
VOL	37,78215	42,59812	0,886944	0,3785
R-squared	0,507321	Mean dependent var		43,93939
Adjusted R-squared	0,483481	S.D. dependent var		10,36693
S.E. of regression	7,45063			
Sum squared resid	3441,737			

Table: Telia

10.2 Appendix 2 - Correlation Matrix

Aventis					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	0.631579	0.885781	0.68038	0.405586
Risk Free		1	0.764251	0.603132	0.465897
TTM			1	0.828246	0.471692
Volatility				1	0.561134
Risk					1

EDF					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	0.376425	0.539547	0.10288	0.11039
Risk Free		1	0.713119	0.220107	0.220783
TTM			1	0.581732	0.250705
Volatility				1	0.522041
Risk					1

SAS					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	0.525701	0.603892	0.183233	0.120995
Risk Free		1	0.676946	-0.09046	-0.14989
TTM			1	0.277246	0.160348
Volatility				1	0.975787
Risk					1

BASF					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	0.516688	0.668049	0.497913	0.281672
Risk Free		1	0.729274	0.50811	0.342297
TTM			1	0.807377	0.267401
Volatility				1	0.420862
Risk					1

Dutch State Mine					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	0.51887	0.674719	0.21366	-0.04718
Risk Free		1	0.788264	0.299638	0.233497
TTM			1	0.602816	0.209353
Volatility				1	0.405063
Risk					1

Gaz de France					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	0.224444	0.613797	0.040076	0.153927
Risk Free		1	0.402044	0.279786	0.642532
TTM			1	0.522803	0.249839
Volatility				1	0.315383
Risk					1

MMO2					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	0.86814	0.856305	0.696931	0.191545
Risk Free		1	0.708262	0.807471	0.250873
TTM			1	0.710452	0.250873
Volatility				1	0.528565
Risk					1

MREAL					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	-0.16092	0.212809	-0.57988	-0.25426
Risk Free		1	-0.16667	0.030763	-0.18362
TTM			1	0.18148	0.215038
Volatility				1	0.823821
Risk					1

Rolls Royce					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	0.849871	0.830878	0.45086	0.216135
Risk Free		1	0.704545	0.471846	0.348142
TTM			1	0.557442	0.30671
Volatility				1	0.850856
Risk					1

Stora Enso					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	0.636369	0.808818	0.230602	0.208522
Risk Free		1	0.80895	0.111705	0.170603
TTM			1	0.41569	0.207698
Volatility				1	0.486208
Risk					1
Telecom Italia					
	Yield	**Risk Free**	**TTM**	**Volatility**	**Risk**
Yield	1	0.60059	0.562453	0.685798	0.675625
Risk Free		1	0.854776	0.29154	0.206215
TTM			1	0.402956	0.26231
Volatility				1	0.869636
Risk					1

10.3 Appendix 3 - Durbin-Watson Test for Autocorrelation

	Dl	du	Durbin-Watson
Telecom Italia	1.71	1.80	0.37
Sonera	1.00	1.68	1.92
Telia	1.50	1.70	0.44
Aventis	1.57	1.75	1.22
EDF	1.75	1.82	0.41
SAS	1.61	1.76	0.93
BASF	1.46	1.73	1.52
Stora Enso	1.72	1.81	0.38
Rolls Royce	1.82	1.86	0.27
Dutch State Mine	1.68	1.79	0.38
Gaz de France	1.53	1.74	1.18
MREAL	1.26	1.72	1.62
MMO2	1.74	1.81	0.27

10.4 Appendix 4 - White's test for heteroskedasticity

Aventis			
F-statistic	13.76189	Probability	0.0000
Obs*R-squared	72.54895	Probability	0.0000
EDF			
F-statistic	5.101567	Probability	0
Obs*R-squared	76.11622	Probability	0
MMO2			
F-statistic	8.867603	Probability	0
Obs*R-squared	102.2764	Probability	0
SAS			
F-statistic	4.160269	Probability	0.000002
Obs*R-squared	52.97372	Probability	0.000082
Basf			
F-statistic	9.413055	Probability	0
Obs*R-squared	50.01244	Probability	0.000075
Dutch State Mine			
F-statistic	5.906995	Probability	0
Obs*R-squared	71.32542	Probability	0
Gaz de France			
F-statistic	3755.975	Probability	0
Obs*R-squared	78.93905	Probability	0
MREAL			
F-statistic	7.364197	Probability	0.000061
Obs*R-squared	34.06778	Probability	0.02567
Rolls Royce			
F-statistic	9.503565	Probability	0
Obs*R-squared	121.4159	Probability	0
Stora Enso			
F-statistic	4.040752	Probability	0
Obs*R-squared	61.61859	Probability	0.000004
Telecom Italia			
F-statistic	3.971494	Probability	0
Obs*R-squared	59.71667	Probability	0.000008
Telia			
F-statistic	6.989399	Probability	0
Obs*R-squared	43.38687	Probability	0.000074
Sonera			
F-statistic	0.569594	Probability	0.812592
Obs*R-squared	8.61917	Probability	0.656998