

UNIVERSITY OF TARTU

Faculty of Economics

Taavi Jürgenson

**THE INVESTOR'S UNDERESTIMATION OF CREDIT
RISK IN THE NORDIC COUNTRIES**

Master's Thesis

Supervisors: Allan Teder

Ingvar Matsson, PhD, Swedbank AB (Karlstad University)

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INTRODUCTION

The global financial crisis of 2008-2009 has highlighted the importance of accurate credit risk estimation. What had started with the collapse of a few credit institutions in the United States, ended with deeply negative effects on the global credit derivative market. Investors, who had protected their bonds against an event of default with credit default swaps, never thought the protection wouldn't be able to meet investor's needs due to the incompetent risk assessment by the swap issuers. Nevertheless, the credit default swap market has grown steadily after the financial crisis in line with the growth of bond market, requiring investors to precisely assess the credit risk in the underlying bonds. A better understanding of the underlying credit risk on the market is not only important for the risk management of bond portfolios as well as pricing of credit derivatives and risky debt, but also useful for the central bankers to assess the functioning of the financial market to extract more precise information about the market sentiment.

The great deal of credit risk underestimation during the global financial crisis of 2008-2009 has forced the practitioners to reexamine the underlying credit risk on the market. In this light, the investor's risk sentiment after the global financial crisis needs to be assessed. The strong relationship between bond credit spreads (the yield difference between the equivalent corporate bonds and government bonds) and credit default swap spreads gives ground to examine investor's over- or underestimation of credit risk during the period of economic recovery until the first quarter of 2015. On one side, the credit risk is priced by banks (credit default swaps) and on the other side the credit risk is priced by investors (bonds). Thus the adequate risk estimation is not only important for the investors, but for the whole economy as well. Serious credit risk perception differences might increase the exposure of one party to a great extent during a credit event or an economic crisis.

The main objective of the thesis is to find evidence to investor's credit risk underestimation by comparing model estimated credit default swap spreads to actual credit default swap spreads. The model estimated credit default swap spreads are based on bond spreads, which is an important indicator of investors' risk sentiment.

In order to reach the main objective, six research tasks are formed. The following tasks complement the finding of the main objective by helping to give a better structural overview of the paper. The research tasks are as follows:

1. To give a comparative overview of high grade and low grade bonds;
2. To explain the concept of a credit default swap and to differentiate between the various credit default swap pricing models;
3. To summarize the methods and results for analyzing credit spreads and to review literature on investor's credit risk underestimation;
4. To explain the market background and to give an overview of the companies included in the analysis;
5. To analyze model estimated and actual credit default swap spreads across three industry sectors in the Nordic countries;
6. To summarize the results and to give concluding remarks.

The sample includes 16 companies from the Nordic countries, which have been divided into three industry sectors, of which two are investment grade and one is sub-investment grade. The time period during which the analysis is conducted spans from January 2010 to March 2015. Each company included in the analysis has at least three outstanding bonds during the previously mentioned time period.

The daily bond spread and credit default swap spread data used in the thesis is acquired from Bloomberg database. Bloomberg database is an online database providing current and historical financial quotes, macroeconomic data, business news, descriptive information, research and statistics on over six million financial instruments across all asset classes. The access to Bloomberg database is granted through dedicated terminals.

Credit default swap (CDS) is an over-the-counter bilateral agreement designed to transfer the risk between two parties. Credit default swaps are bought by investors (protection buyer) from banks (protection seller) to protect against a default or a similar

credit event of the bond issuing corporation (reference entity). CDSs deliver a significant value to the global economy and they have created a liquid marketplace for trading or offsetting credit risk.

The relationship between bond credit spreads and credit default swap spreads, including their pricing, has been previously explored by several studies (Blanco *et al* 2005, Zhu 2006, Galil *et al* 2014). The main results have concluded that a strong relationship exists between the two, with credit default swaps often leading the bond spreads. Although the results might differ between investment grade and sub-investment grade bonds, the variation is insignificant for the sake of this analysis.

A few limitations to this paper exist. Initially the sample period was supposed to span for 11 years, from January 2005 to March 2015. The extended period would have included the credit default market situation and risk perception before, during, and after the global financial crisis of 2008-2009, but due to the lack of available bond spread data for the companies originating from the Nordic countries, the sample period was shortened to the latest five years. Also the credit default swap estimation is based solely on bond spreads and recovery rate, due to which a simplified model for the estimation is used. The future researches could involve a larger scope of industry sectors during a longer time period for an even more profound study.

The main part of the thesis is split into two parts: theoretical and empirical. The theoretical part itself consists of three sub-chapters, which give an overview, explore and analyze the different concepts of credit default swaps, bonds and credit risk found in the scientific literature. Section 1.1 discusses the characteristics of high grade and low grade bonds and brings out their differences. The literature on credit default swaps and the pricing models are reviewed in section 1.2. The section also shows how the two forms of credit default swap pricing models are formulated. In section 1.3, the previous studies in the field of credit risk and its underestimation are reviewed. In addition, an overview of the time period sub-samples used by different authors is given.

The empirical part of the thesis is also split into three sub-chapters. Section 2.1 describes the market background, which is relevant for the better understanding of the analysis. Also a descriptive overview of the countries and the companies included in the

analysis is presented. This is followed by section 2.2, which breaks down the model used to estimate credit default swap spreads. After that, the time series are tested for unit root and cointegration, which are the immediate prerequisites for the vector error-correction model used to establish long term relationships between the actual and estimated credit default swap spreads. In section 2.3 the results of the analysis are presented, including the detailed interpretation of results across the three industry sectors: industrials, paper & pulp and utilities.

Main part of the thesis is interconnected, e.g. the theoretical part helps to understand the topic's background and gives insight to empirical analysis. The results are also bound to the theoretical framework and help to extend the credit default swap and credit risk research further. The thesis ends with conclusion, which is followed by a list of references and a summary in Estonian.

1. A THEORETICAL OVERVIEW OF BONDS, CREDIT SPREAD AND THE PRICING OF CREDIT DEFAULT SWAPS

1.1. Bonds and their most common characteristics

Today, in the low interest rate economic environment, the interest rates are so low that investing in “safe” government bonds might not yield more than a few basis points. For example, German government bonds currently yield a negative percent on their 2-year and 5-year bonds¹. The current economic situation forces investors to search for higher yield. More investors turn their eyes to corporate bonds, especially high yield bonds, which bear a greater risk than government bonds or investment grade bonds, but also grant a much higher yield. The following chapter gives a comprehensive understanding of corporate bonds and explains their different characteristics.

The Securities and Exchange Commission (SEC) (What Are Corporate ... 2013: 1-2) defines corporate bonds as debt obligations, which are issued by corporations and sold to different investors. In return, the corporation makes a legal commitment to pay investors interest and the principal, i.e. the original amount of debt issued. Based on their credit ratings, bonds are usually divided into investment grade and non-investment grade bonds. Investment grade bonds are regarded as more likely to pay on time than non-investment grade. In return, non-investment grade bonds offer a higher interest rate in order to compensate the higher risk. Table 1.1 gives an overview of the rating structure of the most common rating agencies.

¹ Based on data from Bloomberg, on 17.04.2015 German Government 2 year bond yielded -0.27% and 5 year bond -0.16%.

Table 1.1. Bond rating structure and rating transformation to cardinal value.

Rating classification	Standard & Poor's	Moody's	Fitch	Cardinal value
<i>Investment grade</i>				
Highest grade	AAA	Aaa	AAA	1
High grade	AA+, AA, AA-	Aa1, Aa2, Aa3	AA+, AA, AA-	2, 3, 4
Upper medium grade	A+, A, A-	A1, A2, A3	A+, A, A-	5, 6, 7
Medium grade	BBB+, BBB, BBB-	Baa1, Baa2, Baa3	BBB+, BBB, BBB-	8, 9, 10
<i>Speculative grade</i>				
Lower medium grade	BB+, BB, BB-	Ba1, Ba2, Ba3	BB+, BB, BB-	11, 12, 13
Speculative	B+, B, B-	B1, B2, B3	B+, B, B-	14, 15, 16
Poor standing	CCC+, CCC, CCC-	Caa1, Caa2, Caa3	CCC	17, 18, 19
Highly speculative	CC	Ca	CC	20
Lowest quality	C	C	C	21
In default	D	N/A	DDD/DD/D	22

Source: (Wang and Zhang 2014: 800).

Corporate bonds are usually trading at a premium (depending on coupon rate and yield to maturity), which compensates the bond buyer for the comparatively higher credit risk compared to a low-risk government bonds. Government bonds are issued by a national government and provide a guaranteed return. Both corporate bonds and government bonds are subject to political risk. Political risk is the risk that arises as a result of the potential actions of governments and other political forces within and across nations. (Huang *et al* 2014: 1) In addition to corporate bond yields, such uncertainty also affects the government bond yields, meaning countries with higher political risk (e.g. Russia) have a higher yield than countries with low political risk (e.g. Sweden, Germany).

Non-investment grade bonds, better known as high-yield bonds, are bonds with credit ratings below BBB- (S&P) or Baa3 (Moody's). Essentially they are a combination of equity and riskless bonds. The reason high-yield bonds offer a greater return than riskless bonds is that they include the risk of default associated with equities. Thus, the credit risk of high-yield bonds is more compensated for by their higher yields. (Tuysuz 2013: 29) High-yield bonds are usually issued by companies which are smaller in size, act in an uncertain environment or are not rated by a credit rating company (e.g. Moody's, S&P, Fitch). As investment grade corporate bonds have been issued for more than a century now, the modern high-yield bond market is a relatively new asset class.

The high-yield bond market first emerged in the late 1970s and since then has experienced strong but cyclical growth (Reilly *et al* 2009: 66).

Corporate bonds either have a floating or fixed interest rate. Fixed interest rate bonds pay the same amount of interest for its entire term. Floating interest rate means that the bond has a variable interest rate and it's tied to a benchmark such as the U.S. Treasury bill rate, Libor, Euribor etc. Compared to fixed rate bonds, floating rate protects investors against a rise in interest rates. When the interest rates are stable, it generally doesn't matter whether bonds are issued with floating or fixed interest rate, because short term they both roughly yield similarly. Leveraged Finance News (2014) state that until recently high-yield bonds have had trouble competing with loans because investors fear that rising interest rates might make bond's interest rate unattractive. Thus more bonds are being issued with floating interest rate, tied to Libor or Euribor. Floating rate bonds usually yield less than comparable fixed-rate bonds which means investors are compensated less for the additional risk.

When bond trading occurs on the secondary market, higher bond liquidity helps investors to sell and buy holdings faster and at an equitable price. In short, liquidity of bonds is the ease with which bonds can be sold or bought in the secondary market. Illiquidity happens when there is a lack of sufficient number of buyers and sellers at a preferable price or in a timely manner. (Understanding liquidity ... 2015) Thus the illiquidity of corporate bonds has captured the interest and attention of numerous researchers and practitioners, especially after the financial crisis of 2008 where both credit risk and illiquidity intensified at the same time, making it difficult trade bonds.

In their research paper, assessing the illiquidity of corporate bonds, Bao *et al* (2011: 941-942) concluded the main reasons for bond illiquidity. In particular, bond illiquidity increases with a bond's age and maturity, and decreases with its issuance size. Illiquidity of individual bonds can fluctuate substantially over time and during a market wide illiquidity, periods of market turmoil such as market crises or major bankruptcies, the illiquidity increases sharply. The history has also shown that high yield bonds are generally less liquid than investment grade bonds due to smaller issue size and higher risks. Another frequently used measure to calculate illiquidity is the effective bid-ask spread, although it does not fully capture many important aspects of liquidity such as

market depth and resilience (Bao *et al* 2011: 913). Bid-ask spread is the difference in bond's price between the buyers willingness to pay and the sellers willingness to sell. The bigger the bid-ask spread, the more illiquid is the bond.

Volatility reflects the expectations and fears of the market, mainly proving to be the one of the most important determinants of asset value for stocks and bonds. Volatility refers to the amount of risk or uncertainty in the bond's value. A higher volatility means that a bond is trading at a wider range of prices which means over a short time period it can change dramatically in either direction. The main cause of the volatility is the flow of asymmetrical information and its impact on the investors' perceptions about the risks and prices of bonds (Zhou 2014: 216). Reilly *et al* (2010: 179-180) suggest that high yield bonds are more volatile than investment grade bonds due to their wider credit risk spread. Specifically, the price of the high yield bonds is subject to change more frequently than safer, investment grade bonds. Because high yield bonds provide much higher yield depending on the market situation, investors suddenly showing more interest in high yield bonds can push the volatility higher and widens the price range.

It's not uncommon that during recessions sharp increases in volatility coincide with spikes in default rates. In 2008 high volatility led bond spreads to explode, as BB-rated bonds peaked at 1,250 basis points (bps), B-rated bonds at 1,800 bps and CCC-rated bonds at 2,800 bps (Reilly *et al* 2009: 65). Analysis of the volatility for high yield bonds has shown that during periods of stability in the economy and financial markets, the volatility is very similar to investment grade bonds. During economic or political uncertainty, the volatility of high yield bonds becomes two or three times greater than the volatility of investment grade bonds, showing similar levels as common stocks. The biggest impact to high yield bond volatility comes from CCC-rated bonds, whose risk of default becomes fairly significant during economic recessions. (Reilly *et al* 2009: 76-77) These findings confirm that there is a consistently strong relationship of changes in volatility with the economy, as volatility peaks during economic recessions and stays relatively low during economic upturn.

The valuation of bonds plays an important role when investors or fund managers buy securities. One way is to compare the yield spreads of different bonds, to determine best value for money. Yield spread, commonly known as credit spread, is a compound of

yield and spread. Yield describes how much money as interests or dividends investors can earn from a security and spread describes how wide or narrow a distribution is. High-yield bond spread is defined by Investopedia (2015) as the percentage difference in current yields of various classes of high-yield bonds compared against investment-grade bonds, government bonds or another benchmark bond measure. The spreads are usually expressed as a difference in percentage points or basis points.

Like any other investment, bonds involve different risks. The higher the risk, the higher is the variance in spread. Main factors causing variance in spread can be divided into company-specific and environmental variables. Company-specific variables include, among others, rating, seniority, term, callability, and zero-coupon status. Environmental variables are spread versus government bonds, yield curve, default rate, interest rate changes, and high yield returns. (Fridson, Bersh 1998: 29) The biggest risk, in the eyes of the investors, is default/credit risk. Altman and Bana (2004) define bond's default as a bond issuer's inability to pay their interest coupon payments on time, announcement of a distressed restructuring (usually offering the investor a lower interest rate or an extension of the period for payment), or filing for bankruptcy. When default occurs, there is a chance that investors won't get the principal back in the full amount.

In the event of default, the amount of principal which can be recovered is known as recovery rate. The term "recovery" can either refer to the price of the bonds at the time of default or to their value at the end of the distress period (Altman and Kishore, 1996: 57). The amount recovered after default is expressed as a fraction of the exposure at default and the average historical recovery rate is assumed to be 40%, meaning on average bondholders will be able to recover 40% of the sum loaned to the firm (Elkamhi *et al* 2014: 194). Bond's seniority within the corporate capital structure is directly linked with the recovery rate. As seen on table 1.2, on average higher seniority grants higher recovery rate.

Table 1.2. Historical global recovery rates (1982-2014).

Lien Position	Issuer-weighted		Volume-weighted	
	2014	1982-2014	2014	1982-2014
1 st Lien Bank Loan	78.4%	66.6%	80.6%	62.5%
2 nd Lien Bank Loan	10.5%	31.8%	10.5%	28.5%
Sr. Unsecured Bank Loan	n.a.	47.1%	n.a.	40.2%
Sr. Secured Bond	59.5%	52.8%	76.5%	52.4%
Sr. Unsecured Bond	43.3%	37.4%	34.3%	33.6%
Sr. Subordinated Bond	46.9%	31.1%	28.3%	26.0%
Subordinated Bond	38.8%	31.4%	38.0%	26.3%
Jr. Subordinated Bond	n.a.	24.7%	n.a.	17.1%

Source: (Ou *et al* 2015: 7)

Historically 1st lien bank loan has the highest recovery rate, thus being the safest form of corporate debt for an investor. Senior secured bonds, as seen in table 1.2, are the second safest form of corporate debt. The most common bonds, senior unsecured bonds, have a historical recovery rate of just 37.4% (issuer-weighted) or 33.6% (volume-weighted). Thus the assumed historical bond recovery rate of 40% roughly holds true, when accounting for all of the bond lien positions.

During company's bankruptcy or liquidation, some bonds are ranked above other debt instruments and obligations. Firms issue various bonds with different seniority, which can be generally classified as senior or junior bonds. Senior bonds have a superior claim on the assets compared to junior bondholders. (Wang and Zhang, 2014: 784) In addition bonds, which are secured, rank above similar unsecured bonds. Altman and Kishore (1996) have classified bonds into five categories according to their seniority (from high to low):

- 1) Senior secured (6.89%);
- 2) Senior unsecured (74.15%);
- 3) Senior subordinate (14.20%);
- 4) Subordinate (0.12%);
- 5) Junior subordinate (0.20%).

Using the descriptive statistics from the study of 6,635 bonds conducted by Wang and Zhang (2014), the percentages to distribute bonds by seniority have been added by the

author. Of the 6,635 bonds studied, 74.15% of them were senior unsecured, which are by far the most commonly issued bonds on the market. Bondholders with the highest seniority receive their payments first, followed by those on the lower lever. Common owners of equity are the last to receive their payments. Also bond's seniority is negatively correlated with bond's yield; the lower the seniority, the higher the yield.

Maturity of a bond is the period of time during which it remains outstanding. At maturity date bond issuer will repay the investor the original sum loaned. Bonds are often referred as to being short-term (up to 3 years), medium-term (4-10 years) or long-term (more than 10 years). Baker *et al* (2003) find that the longer maturity a bond has, the higher its return is. In other words, the maturity of a bond is negatively related to the term spread. Tewari *et al* (2015) analyzed 4,495 corporate bonds issued between 1980 and 2012, of which 1,033 were high yield issues. Maturity distribution showed that investment grade bonds are mostly issued as medium-term and long-term bonds and high yield bonds are mostly issued as short-term and medium-term bonds. Since high yield bonds carry higher risk of default, longer term bonds would include a considerable coupon premium to attract investors, making it too expensive for high yield issuers. Therefore high yield bonds are generally limited to short maturities.

Newly issued high yield bonds have a noticeable variance in the spreads, which depend on different factors, mostly company-specific and environment-specific. In seeking to explain variance in the spreads, Fridson and Garman (1998) concluded in their study that high-yield bond's yield spread will be greater the lower its senior-equivalent rating, the lower its seniority in the capital structure, the longer its maturity, and if it is callable prior to its maturity, if it is a zero coupon security, if it is the issuer's first bond issued, or if it is underwritten by a commercial bank, all other things being equal. Also market environment will push the yield higher the wider the secondary market spread between BB and B corporate bonds is and if government bond yields rose in the month preceding issuance. Also, during the periods of recession the spread is seen to increase and during periods of expansion it decreases. Therefore bond's yield spread is affected by several factors both issuers and investors need to account.

An early paper by Fridson and Bersh (1994) presented an overview whether credit risk spread differences propose investment signals, in response to some investors who made

attempts to make investment decisions based on this. The authors contended that some investors might feel when the prevailing high yield bond yield spread is above its long-term mean value, the bonds might be undervalued and should be bought and when the spread was below its long-term value, the bonds should be sold. They concluded that these allegations provide no support for using this investment decision rule and that the market self-corrects it almost instantly. Subsequently Reilly *et al* (2010: 204) examined the statistical properties of the credit risk spread of high yield bonds in order to conclude which factors should impact these spreads. The strongest impact came from a combination of default risk variables and capital market risks, mainly the volatility of small capital and New York Stock Exchange (NYSE) stocks and the moving average of high yield bond volatility. This means that analysts and capital managers should consider the use of separate models with different variables when evaluating spreads for high yield bonds with different ratings.

Bond covenants are designed to protect the interests of both investors and issuers. A restrictive bond covenant, included in the debt contract, is a provision that restricts the bond issuer from certain actions potentially detrimental to bondholders' wealth after bond issuance (Cook *et al* 2014: 122). Covenants can include restrictions on financial activities (additional debt, negative pledge), investment activities (risky investments, mergers-consolidations) and payouts (dividends). To analyze the effect on negative covenants on bonds, Riesel (2014) studied 4,267 bonds issued by 1,302 companies. She found that small firms with low tangible assets, which have mostly a low credit rating, are more likely to include restrictive covenants. By contrast, investment grade firms with low leverage mostly avoid covenants as they may outweigh the benefits. Firms with high market-to-book value are also less likely to include negative covenants, especially negative pledge and restriction on investment activities.

During the latest financial crisis in 2008 many investors suffered great losses as bonds issued before the crisis included fewer covenants. Liquidity and solvency components of financial distress had a significant effect on bond's health. Cook *et al* (2014) studied the effects of liquidity and solvency risk on the inclusion of bond covenants by comparing the liquidity/bond covenant relationship during the pre-crisis, crisis and post-crisis years. Liquidity reduces the likelihood of inclusion of restrictive bond covenants,

as financially healthy companies and high rated companies are more likely to meet their payments. During financial crisis, when a massive contraction in liquidity occurs, firms dependent on borrowing from credit market are forced to include restrictive covenants on bonds to attract and protect bondholders. The latest financial crisis of 2008-2009, with the bankruptcies of several financial institutions, increased investor's concerns about the safety of bonds, and the importance of covenants.

Alternate methods to moderate the impact of potential financial instabilities include structured provisions, like convertible provision and call provision. A convertible bond offers the investors the option to exchange it for a predetermined number of shares of the issuing firm at certain point in time (Ballotta and Kyriakou, 2015: 118) Convertible bonds usually offer lower rates because from the investor's perspective a convertible bond adds both value and security. If the investor chooses not to convert the bond, then the bond acts as a straight bond.

A call provision grants the issuer the right to buy back previously issued bonds before the maturity date. If the issuer decides to use the right to call the bond, the bondholder is usually compensated with an option premium, because the investor bears the risk to re-invest the received cash. Hence, the price of the callable bond is always lower than the price of an equivalent straight bond. (Samet and Obay, 2014: 2) Tewari *et al* (2015) identify that the call premium in nonconvertible callable bonds acts as an effective protection against investors' reinvestment risk, when the issuing firm's credit rating improves and can suddenly issue bonds at a lower price. When interest rates are high, almost all investment grade issues and bonds with long maturities (>20 years) include a call premium. When interest rates are low, virtually all investment grade bonds issued during that time are callable at par. The data also suggests that while both investment grade bonds and high yield bonds include a call premium when interest rates are high, only high yield bonds include a call premium when interest rates are low (*Ibid.*: 352). Some callable bonds have also included a noncallable period, during which the bond can't be redeemed early.

The issue size of a bond can vary depending on the amount of cash required and the company's rating. Usually companies with lower credit ratings, which are smaller in size and bear higher credit risk, can issue bonds smaller in size than larger companies

with high credit ratings. Based on the bond data from Bloomberg database, the average global corporate bond issue size is roughly €700 million and the average corporate bond issue size in the Nordic countries amounts to €100 million. To conclude this chapter, author has concentrated the main bond characteristics into the following table 1.3.

Table 1.3. The distinction between investment grade bonds and high yield bonds.

Characteristic	Investment grade bonds	High yield bonds
Rating	AAA to BBB-	BB+ to C
Issue size	Above average (€700m globally, €100m in the Nordics)	Below average
Coupon	Fixed or floating	Fixed or floating
Liquidity	Less likely to become illiquid	More likely to become illiquid
Volatility	Low	High
Maturity	Medium-term to long-term (usually above 5 years)	Short-term and medium-term (usually up to 5 years)
Yield/spread	Low/medium	High
Default probability	Very low (<0.2%)	Considerable (>2%)
Recovery rate	Depends on bond's seniority, usually above 40%	Depends on bond's seniority, usually below 40%
Covenants	Less likely to include restrictive covenants, especially restrictions on investment activities	More likely to include restrictive covenants (restrictions on financial activities, investment activities, payouts)
Provisions	Convertible provision; call provision mostly at par	Convertible provision; call provision mostly at a premium

Source: (Compiled by the author).

High yield bonds are bonds with a credit rating below BBB- and investment grade bonds exceed that rating. High yield bonds are usually issued by firms smaller in size or acting in an uncertain environment. Compared to investment grade bonds, sub-investment grade bonds are smaller in issue size, less liquid and bear more risk. Investors are thus compensated with higher yield or spread, which in turn is gaining more attention in current low interest rate environment. Due to the riskiness of high yield bonds, the chance of a default is considerably high, which in turn forces bond issuers to include restrictive covenants to protect investors. In the event of default, high yield bonds have generally lower recovery rate, i.e. how much the investor is able to

recover from the original sum loaned. Some bonds are convertible, which means they can be traded for a predetermined number of shares of the issuing firm at certain point in time. High yield bonds are more likely to be callable at a premium, which means the firm is able to call back their bonds after a certain amount of time by paying bondholders back the principal with a small premium. On the other hand, investment grade bonds are mostly callable on par, usually at any given time.

1.2. The pricing of credit default swaps

In the past 15 years, the credit default swaps have widely grown in popularity and its market has grown into a multi-trillion euro market with participants from nearly every sector in the financial world. Credit default swaps (CDSs) are derivative instruments which allow market participants to redistribute or transfer credit risk. The following chapter gives an overview of the nature of credit default swaps, including its benefits and costs. Given the liquid nature of the credit default swap market, CDS might also provide useful information about the credit market and its participants. Secondly, the issues and risks regarding credit default swaps arising from the recent financial crisis development are discussed. Finally, the different CDS pricing models and credit spreads discussed in this chapter give a deeper understanding of the nature of the credit default swaps.

Credit default swap is a derivative contract aimed at transferring default risk of an underlying bond from one market participant to another. The protection seller assumes the credit risk of the underlying bond by committing to compensate the protection buyer for the loss suffered in case of the bond's default, in return for a regular protection fee paid by the CDS buyer. After the default takes place, the seller makes a payment to the buyer equal to the notional value of the contract, and in turn receives defaulted bonds of equivalent notional value. (Schneider *et al* 2010: 1517) CDS can differ in the specification of the default payment. Possible alternatives are: physical delivery of the reference assets against repayment at par, notional minus post-default market value of the reference asset (cash settlement) and a pre-agreed fixed payoff, irrespective of the

recovery rate (Terzi, Ulucay 2011: 984). The previous is illustrated in the following figure 1.4, which shows the relationships between the parties.

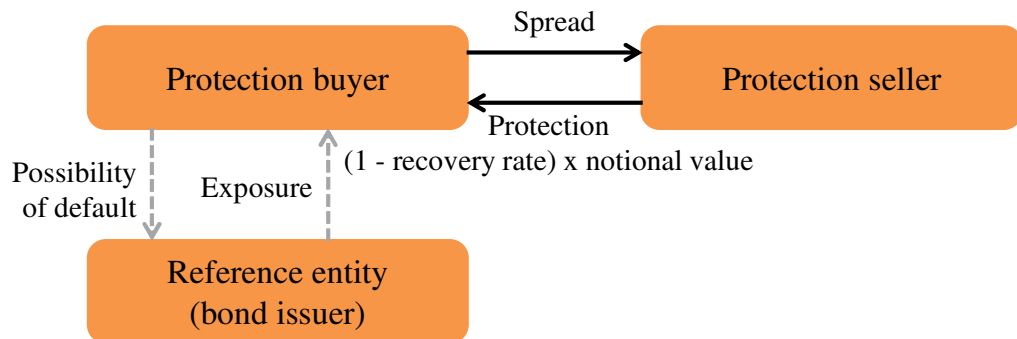


Figure 1.1. Schematic representation of a credit default swap (Compiled by the author).

In a way, credit default swap is similar to conventional insurance. CDS is considered to be insurance against non-payment. A buyer might be speculating that there is a possibility that the third party will default. A key difference between a CDS and an insurance policy is those buying a CDS can trade in and out of their contracts, which is generally not possible in the insurance market. Insurance policies (i.e. property insurance or life insurance) are required to be sold by regulated entities and whoever purchases insurance must own the underlying asset. (Vogenbeck 2009: 2) As opposed to insurance, credit default swaps do not require an insurable interest in the reference entity. Depending on whether the company is in a bad situation and may soon default, investor owning bonds can buy or sell a CDS in order to make profit. Such ambitions do not hold true with insurance.

Credit default swap trading has historically had a positive impact on bond market development. Evidence from Asia show that CDS trading improves bond market development by lowering average spreads and enhancing market liquidity, mostly before and in the early stages of a financial crisis. The main reason behind this positive impact is the bondholder's ability to hedge their exposures much more easily and efficiently. In addition, credit default swaps facilitate the pricing of instruments by making it easier to reorganize risks and exploit arbitrage opportunities. (Shim and Zhu: 2014: 472-473) Ashcraft and Santos (2009) evaluated the impact of CDS market on the cost of corporate debt, in order to confirm that CDSs have lowered the cost of debt

financing to firms by creating new hedging opportunities for investors. Contrary to popular opinions, they found that risky and informationally opaque firms appear to be adversely affected by the CDS market, while safe and transparent firms have benefited from a small reduction in both bond and bond loan spreads. It appears that credit default swap trading has a positive impact both on market level and firm level by providing better liquidity and lowering the costs of borrowing.

In addition to financial benefits, credit default swaps can have both social benefits and costs. The social benefit is that CDS makes it easier for credit risks to be borne by those who are in the best position to bear them. Also CDS enables financial institutions to make loans they would not otherwise be able to make and the trading of CDS reveals useful information about credit risk. (Stulz 2009: 3) On the cost side, there is widespread recognition that CDS can give rise to market manipulations, especially when the market environment is not sufficiently transparent. In addition, CDS contracts might invite excessive speculation because of their relatively greater liquidity and higher degree of achievable leverage, and CDS can facilitate short-selling. (Anderson 2010) Whether the social benefits outweigh the costs, it is still yet uncertain. Nevertheless an investor trading with CDS should familiarize himself with both benefits and costs.

The recent financial crisis has brought attention to the forced sale of bonds. In the event of a shock, financial intermediaries (mutual funds, hedge funds, insurance companies) are forced to sell their underlying bonds due to different regulatory pressures. Massa and Zhang (2012) find that credit default swaps help to reduce the forced sale in bonds. CDS reduces the need of investors to liquidate their bonds in the face of credit deterioration, thus helping investors to protect their investments. The presence of CDS reduces yield spreads and increases liquidity, especially for investment grade bonds. Main event triggering forced sales by bond institutional investors is bond rating downgrade from investment grade to high yield grade (*Ibid.*: 5). Therefore during financial crises CDS helps to reduce risk contagion and guarantee bond's liquidity.

After the recent financial crisis development, credit default swaps have come under increasing criticism. In May 2011, German regulators banned naked² CDS positions in Eurozone sovereign bonds due to concerns over negative CDS effects in the sovereign bond market. In July 2011, The European Union Parliament also voted in favor of a similar ban on sovereign bond CDS positions. (Ismailescu and Phillips 2015: 43) Many observers have argued that credit default swaps trade in a largely unregulated over-the-counter market as bilateral contracts involving counterparty risk and that they might facilitate speculation. What is more, the lack of transparency of the credit default swap market has made it possible for market participants to manipulate the market. (Stulz 2009: 2-5) One such example is the American International Group (AIG), which insured more than \$440 billion of fixed income investments. In September 2008, AIG went bankrupt due to the enormous exposure to CDS and the defaults of most of its insured bonds. (Xinzi 2013: 4-5) AIG failed to see the credit bubble crunch and was exposed to more risk than it could cover.

Counterparty risk has emerged as one of the most important factors driving financial markets. Counterparty risk, also known as default risk, is the risk to each party of a contract that the counterparty will not fulfill its contractual obligations. After default events experienced by high profile institutions such as Lehman Brothers and Bear Stearns during the recent crisis, counterparty risk has emerged as a key problem in risk management (Bo, Capponi 2015: 29). When protection sellers are inadequately capitalized, counterparty risk in combination with lack of transparency and liquidity might act as a channel for systemic risk. Systemic risk is the possibility that an event could trigger severe instability or collapse an entire industry or economy. Therefore it is necessary to reduce the interconnectedness between the credit market parties. Loon and Zhong (2014) propose central clearing counterparty as a measure to reduce counterparty risk, which in turn reduces systemic risk. Central clearing counterparties are organizations (mainly banks), which help to facilitate trading done in bond and CDS markets. In addition they found that centrally cleared reference entities experienced an improvement in both liquidity and trading activity relative to noncleared entities.

² A CDS in which the buyer has no holdings or direct involvements in the underlying bond.

In the literature, the theoretical pricing of CDS has received a good amount of attention. There are two main approaches on how to price credit default swaps: structural models and reduced form models. Structural models, introduced by Black and Scholes (1973) and Merton (1974) assume that a firm defaults at the end of the period when the value of the firm's assets is lower than a preset level. Black and Cox (1976) extended this approach allowing for default to occur at the first time when the firm's asset value drops below a certain threshold. The parameters of reduced form models are difficult to estimate because the bond's volatility and market value are difficult to observe. Reduced form models, initially developed by Litterman and Iben (1991) and Jarrow and Turnbull (1995) no longer refer to the firm's asset value process. Instead they determine credit risk by the occurrence of default and the amount recovered at default. In these models, default is usually represented by a random stopping time with a stochastic or deterministic arrival intensity and the recovery rate is assumed to be constant (Houweling, Vorst 2005). Thus default is treated as an unpredictable event and its outcome as a random jump process. Usually the reason for default is not specified. All the reduced form models, in one way or the other, rely on the estimation of a default probability.

The empirical literature suggests that there is no need for structural models to separately model the hazard and recovery components of credit risk. Longstaff and Schwartz (1995) developed a credit derivative valuation model by incorporating bond's credit spread as the main source of information. They found that the mean-reverting property of credit spreads has many important implications for the pricing, despite being an exogenous process. Duffie and Singleton (1999) focused on applications to the term structure of interest rates for bonds in order to value credit-spread options. Collin-Dufresne and Goldstein (2001) developed a model with stationary leverage, which generates larger credit spreads for firms with low initial leverage ratios. By estimating the spread process, Cariboni and Schoutens (2004) assume that the asset price process is driven by a pure-jump Lévy process and default is triggered by the crossing of a preset barrier. Opposite to Gaussian process, which is based on the notion of the normal distribution, Lévy models can be asymmetric and are able to allow artificially introduced unexpected defaults. Yang *et al* (2014) incorporated the jump component, stochastic default barrier and the first passage time together into the valuation of CDS.

Contrast to the classical model, where an event of default is assumed to occur when the asset value of a firm crosses a constant barrier, they assume the asset price of the firm to follow a double exponential jump diffusion process, and the value of the debt is driven by a geometric Brownian motion. In conclusion CDS price with jump component is higher in longer maturities than CDS price without jump component and the price difference generally isn't significant for maturities under one year. The previously discussed models have been summarized in the following figure 1.2, indicating their description and limitations.

Structural models	Description	Limitations
Merton (1974)	A firm defaults at the end of maturity when the value of the firm's assets are below a preset level. There are no market restrictions and transaction costs. Risk-free interest rate is constant in time. Firm's asset value follows a stochastic diffusion process and continuous trading is assumed in time.	Assumes too much simplicity. Default can only occur at the maturity of debt. Term structure of interest rate is stochastic in time. Firm's asset value is unobservable and needs to be estimated.
Black and Cox (1976)	Default occurs at the first time when the firm's asset value drops below a certain threshold. The model also takes into account safety covenants, debt subordination, and restrictions on the sale of assets.	Limited by the assumption of constant interest rates and absolute priority rules (creditor's claim has an absolute priority over a shareholder's claim).
Longstaff and Schwartz (1995)	The model allows interaction between default risk and interest rate risk by allowing stochastic interest rates. Also violations of the absolute priority are allowed.	Does not accurately describe the true behavior of the asset value, as sudden drops or jumps of a firm asset value are possible.
Collin-Dufresne and Goldstein (2001)	A structural model of default with stochastic interest rates that captures its mean-reverting behavior. In addition, firms adjust their capital structure to reflect changes in asset value and proceeds of new debt issuance are used to repurchase equity, leaving firm value unchanged.	Unable to capture the time-series behavior of both CDS spreads and equity volatility.
Yang, Pang and Jin (2014)	The asset price of a firm follows a double exponential jump diffusion process, the value of the debt is driven by a geometric Brownian motion, and the default barrier follows a continuous stochastic process.	Does not fit CDS term structure in the long term.
Reduced form	Description	Limitations
Litterman and Iben (1991)	Simple discrete time setting model, zero recovery assumed at default. Model uses three inputs: current term structure of riskless bond yields, current term structure of risky bond yields and evolution of riskless interest rates.	Recovery rates are not an input (100% loss in the event of default is assumed).
Jarrow and Turnbull (1995), Madan and Unal (1998), Duffie and Singleton (1999)	Possibility of default is allowed in the immediate future (hazard rate approach). Essentially an exogenous model for the hazard rate (likelihood of the firm defaulting over the next period). Model generates realistic short maturity credit spreads.	Lack of structural definition of the default event. As a consequence, the resulting hazard rate model is reduced form with parameters that lack structural interpretation and offer no guidance in the presence of a structural change in firm specific variables.

Figure 1.2. An overview of some of the CDS pricing models (Compiled by the author).

CDS spreads, including its pricing, are affected by the underlying firm's value, among others. When the market value of a firm decreases, hitting the default barrier becomes more likely and the probability of default increases. Since firm value is unobservable, it cannot be efficiently measured. Changes in the firm value are induced by changes in the

firm's equity value and structural models imply that downward trends in the equity level are accompanied by upward trends in the CDS spread. Since firm value can be quite volatile over time, it is intuitive that hitting a default barrier becomes more likely when the firm value itself fluctuates widely. As firm value, so is equity volatility quite unobservable and they have to be approximated. (Alexander, Kaeck 2008: 1010) Structural models hold firm value and volatility as major input data; therefore these models suffer from a considerable drawback. In addition, Aunon-Nerin *et al* (2002) concluded that rating is the most important single source of information in the spread, although other factors, including interest rates, liquidity, stock prices, leverage, index returns and time-to-maturity, add significant information to CDS spreads as well.

Changes in credit spreads are different depending on whether credit default swap spreads are observed before, during or after a financial crisis. In the light of the 2007-2009 global financial crisis, Breitenfellner and Wagner (2012) examined risk factors that explain daily changes in aggregate CDS spreads in different economic situations. Before and after the crisis, spread changes are mostly determined by stock returns and implied stock market volatility. During the crisis, stock market returns lead spread changes, while after the crisis period a bidirectional relationship emerges. Thus they concluded that aggregate spread changes are quite informative for market participants, possibly measuring systemic risk. In addition, Blau and Roseman (2014) examined CDS spreads for nearly all European countries before and after August 5th, 2011 when the United States sovereign credit rating saw a downgrade. They found that while United States CDS spreads remained at relatively normal levels, European CDS spreads saw a sudden surge during the downgrade event. The reaction in the European CDS market began five days prior to the downgrade announcement and continued for approximately 10 days. The largest increase in CDS spreads was in European countries with the smallest GDP per capita and countries that had not recently been downgraded. Thus credit default swap spreads can sometimes anticipate unfavorable announcements and events.

The second theoretical chapter gave a brief overview about credit default swaps and their pricing. A CDS is a derivative contract aimed at transferring default risk of an underlying bond from one market participant to another. One might find it similar to

insurance, because it basically insures bondholder against the company's default. As opposed to insurance, credit default swaps do not require an insurable interest in the reference entity and they can be traded in and out of contract. CDSs can have financial benefits on the firms issuing bonds: they increase transparency, lower credit spreads and increase volatility, especially for firms who are issuing bonds for the first time. After the recent financial crisis development, credit default swaps have become under increasing criticism. Many observers have argued that credit default swaps trade in a largely unregulated over-the-counter market as bilateral contracts involving counterparty risk and that they might facilitate speculation. What is more, the lack of transparency of the credit default swap market has made it possible for market participants to manipulate the market, which largely caused the defaults of highly rated financial institutions such as AIG, Bear Stearns and Lehman Brothers. Literature suggests that there are two main approaches in pricing credit default swaps: structural models and reduced form models. Structural models assume that a firm defaults when its asset value drops below a certain threshold, while reduced form models no longer refer to the firm's asset value process. Instead they determine credit risk by the occurrence of default and the amount recovered at default.

1.3. The empirical evidence of credit spreads and credit risk underestimation

The third part of theory gives an overview of the empirical evidence of credit spreads and credit risk underestimation. Relationships between credit default swap spreads and bond spreads and the linking determinants are examined. In addition, the different time periods and their segmentations used in some of the newest articles have been examined.

First of all the dynamic relationship between CDS spreads and bond spreads needs to be explored. In order to perform an analysis, the data needs to follow the compliance criterion: 1-year CDS spread and 1-year bond spread, 5-year CDS spread and 5-year bond yield, 5-year CDS spread and firm's 5-year probability of default etc. If the criterion is not met, the data needs to be interpolated or modeled to make it match. Forte and Peña (2009) examine the relationship between stock market implied credit spreads,

CDS spreads and bond spreads. In all cases of the analyzed 16 companies, the cointegration relationship appeared between CDS spreads and bond spreads. In about 1/4 of cases, the CDS market led the bond market, whereas the opposite was true only in one case. At the same time, stock market led CDS market also in 1/4 of cases and the opposite was true in one case. The bond market seemed to lead the stock market in 1/3 of cases according to the entire sample analysis. Surprisingly, these results do not translate into a clear evidence of leadership from the markets. Still the relationship between the CDS spreads and bond spreads was found very strong and they tend to increase or decrease together, with CDS spreads mostly in the lead.

Since there is clearly a dynamic interrelation between corporate bond spreads and their respective credit default swap spreads, the link between government bond spreads and credit default swaps needs to be assessed as well. Similar to existing empirical studies, the CDS and government bond linkages are examined by Delis and Mylonidis (2011). Unlike the previous studies on corporate bonds, the data on 10-year government yield spreads and their underlying CDS are used, focusing on the four Southern European countries (Greece, Italy, Portugal and Spain) during the sovereign debt crisis. The linkages have been examined with rolling Granger-causality tests, which allow for the emergence of a clearer picture of the possible dynamic linkages. The results suggest that during the whole five-year analysis period (2005-2010), CDS spreads almost uniformly Granger-cause bond spreads, especially after the start of the financial crisis. Feedback causality is detected during periods of financial and economic turmoil, thereby indicating the high risk aversion, which tends to perplex the transmission mechanism between CDS prices and government bond spreads. To a certain extent, the results can also be applied to corporate bonds. This demonstrates that CDS spreads and bond spreads are more linked during economic turmoil and other major credit events affecting the underlying entities.

There are several determinants to explore the relationship with CDS spreads. In order to compare the pricing of credit risk in the bond market and the fast-growing credit default swap market, Zhu (2006) analyzed 24 CDS entities in the US, Europe and Asia. The panel data study and the vector error-correction model (VECM) analysis both suggest that the CDS market tends to move ahead of the bond market, and the liquidity factor

matters for the adjustment dynamics, particularly for US entities. Moreover, the study also finds that the market practice differs considerably between the United States and other regions, pointing to a certain degree of market segmentation. Surprisingly, the terms of a credit default swap contracts and the short-sale restriction in the cash market only have a very small impact.

The same findings were later also confirmed by Blanco *et al* (2005), who provide evidence that credit default swap spreads may reflect changes in credit risk more accurately and quicker than corporate bond yield spreads. They concluded that the CDS market leads the bond market in determining the price of credit risk. What is more, macro variables (interest rates, term structure, equity market returns) have a larger immediate effect of credit spreads and firm specific equity returns and implied volatilities have a greater immediate effect on CDS prices. In other words, CDS spread should lead the changes in bond spread, being a better measure of risk. In the long run though, the empirical findings showed that bond spreads and CDS spreads move together, as theory predicts. This gives implications that the empirical part of this paper should show similar results, which means that actual CDS spreads extracted from database should lead CDS spreads calculated from bond spreads.

Galil and Soffer (2011) linked CDS spreads with credit ratings to find out how CDS market responds to rating actions. In total, they explored a sample of 2866 rating announcements throughout the period between January 1, 2002 and June 30, 2006 and CDS spreads for more than 2000 entities during the period. They confirmed that CDS spreads change abnormally following announcements of rating changes and rating reviews. What is more, they were able to show for the first time that clustering of rating actions reflects the economic significance of developments in a firm's credit quality. Generally the market response to bad news is stronger than to good news. A similar study was conducted by Wengner *et al* (2015) among 294 firms for the period 2004-2011. For both upgrades and downgrades, statistically significant positive or negative cumulative abnormal changes were observed around the announcement dates. In addition to findings from the previous study by Galil and Soffer (2011), they found differences in the market reaction across industries and rating directions. Furthermore, the findings provided evidence that rating events affect competitors within the same

industry as well. This gives investors even more reason to analyze competitors as well upon bond purchases.

Galil *et al* (2014) used a 718 US firm database to study the determinants of credit spreads from early 2002 to early 2013. They found that market variables, such as stock return, the change in stock volatility, and the change in the median CDS spread in the rating class, have the most explanatory power after controlling for firm-specific variables inspired by structural models. In the absence of these variables, other factors (change in spot rates, the change in the slope of the term structure) may also be used to explain the CDS changes. The structural models used for the analysis showed better results for investment grade firms than speculative grade firms. This result is in contrast to Avramov *et al* (2007), who had found that the structural models explain better credit spreads for high yield bonds. Though they used a different sample period (1990-2003 vs 2002-2013) and the source of the spread data was from bonds instead of CDS, showing that different time periods and sources of spread data have a significant impact upon analyzing credit default swap spreads.

A few years earlier, Ericsson *et al* (2009) concluded a similar study to investigate the relationship between theoretical determinants of default risk and actual CDS spreads. They used a dataset of bid and offer quotes credit default swaps from 1999-2002. These determinants, firm leverage, volatility, and the riskless interest rate, were found statistically significant and that their effect is economically important. According to their results, a 1% increase in annualized equity volatility raises the CDS spread by 1-2 bps and a 1% change in the leverage ratio raises the CDS spread by 5-10 bps. These findings give approval for using the theoretical variables to calculate default risk.

Corporate bond yield spreads are compensated for the various sources of risk, including default, systematic factors, default and taxes. Though the empirical studies conducted by Galil *et al* (2014) and Ericsson *et al* (2009) attempted to fully explain the determinants of the spreads, corporate bond yield spreads are still larger than can be explained by these known determinants of credit spreads. Several possible risk factors for this lack of explanation power have been put forward, such as illiquidity, systematic risk, tax effect, bond portfolio diversification etc. (Guo 2013:295). Thus the credit spread puzzle can't be declared fully solved yet and a part of the dynamics of credit

spreads remain unexplained. In addition, some observations (e.g. Bushman *et al* 2010) provide strong empirical evidence to support the information-based credit risk models and ambiguity-based pricing models, which suggest credit spreads embed an information risk spread and ambiguity spread that are ignored by the traditional bond pricing models. At the center of these observations lie the shocks created by the bailout of Bear Stearns and liquidation of Lehman Brothers. As late as October 2007, or four months before the collapse, Bear Stearns CDS spreads were evolving smoothly like most other investment grade debt, when policy makers and industry participants were assuring us that the subprime crisis was contained (Li, Mizrach 2010: 1535). The credit risk was severely underestimated and just six months later after the March 2008 collapse, things span out of control.

Credit risk underestimation can be recalled as one of the reasons for the subprime crisis in the United States. As previously mentioned, policy makers and industry participants severely underestimated the subprime exposure of Bear Stearns and Lehman Brothers, which resulted in credit risk underestimation. These are not the only examples, as the whole market mistook the underlying credit risk due to the booming economic situation. Investors were simply blind to the sequential increase in credit risk. (*Ibid.*: 1529-1531) Credit risk underestimation in bond market can for example be caused by wrong estimation of bond's liquidity and firm's debt maturity structures. Until recently, the credit rating agencies also tended to ignore the effects of firm's debt maturity structures, which caused them to underestimate the maturity risk. In addition, due to the effect of liquidity on firm's credit spreads, commonly used variables for default risk estimation such as the credit default swap spread may also absorb the intended liquidity effects and therefore cause credit risk underestimation. (He and Xiong 2012: 393-415)

The collective use of the same credit risk valuation rules means the exogenous measures of risk underestimate the degree of endogenously created risk by investors buying and selling the bonds at the same time. Before the crisis of 2008-2009 pension funds and insurance companies outsourced their investments to firms that could not hold liquidity risk because of their short-term funding and use of market prices to measure risk and return. As liquidity risk suddenly increased, the investment firms were forced to sell these illiquid instruments, which led to the collapse in prices, forcing them to sell more.

(Underestimating Risk ... 2015) The whole situation could have been prevented when the right people would have held the right assets, i.e. these illiquid assets were held by investors with long-term investment horizon.

The premium in the asset prices can be decomposed into two components; a base premium that compensates the investors for the probability of default and an “excess” premium that compensates them for taking the risk of default. The literature has not widely considered the effect of investor’s characteristics, such as their risk aversion and financial performance, on the cost of financing. Lizarazo (2013) presented a model that analyzes the importance of investor’s characteristics in the determination of endogenous sovereign risk, interest rates, and capital inflows of emerging countries. The model’s results state that risk averse investors cause lower overall levels of volatility for the trade balance than risk neutral investors. Also, the credit spread volatility increases for risk averse investors for the year previous to default, while the credit spread volatility decreases for the year previous to default. Overall, the consideration of risk averse investors explained a large part of bond spreads and the behavior of borrowers and investors. The investor’s individual risk sentiment can therefore be a significant reason for credit risk underestimation (or overestimation), as risk neutral or risk seeking investors can severely underestimate credit risk prior to an event of default. Meanwhile, risk averse investors can handle the periods of high volatility in economy relatively better than investors with higher risk attitude.

The global financial crisis of 2008-2009 and the period preceding the crisis have been rather extensively covered in the previous CDS spread analyses (e.g. Galil *et al* 2014, Narayan 2015, Wengner *et al* 2015, Han and Zhou 2015). Depending on the paper’s objective, authors either analyze the whole chosen time period or split it into several different periods. Galil *et al* (2014) applied their analysis on both the whole period (January 2002 to February 2013) and three different splits of the time period: before the global financial crisis, January 2002 to June 2007; during the global financial crisis, July 2007 to June 2009; and after the global financial crisis, July 2009 to February 2013. A similar period segmentation was done by Narayan (2015), who split the time period of September 2004 to March 2012 into four different sub-samples, excluding the whole full-sample period. The four sub-samples are: from 9 September 2004 to 26

February 2007 the pre-crisis period; from 27 February 2007 to 31 December 2010 the crisis period; from 27 February 2008 to 14 September 2008 the pre-Lehman crisis period; and from 15 September 2008 to 31 December 2010 the post-Lehman crisis period. The last two sub-samples are assessing the impact of the collapse of Lehman Brothers, which is believed to have a significant effect on the analysis. If the time periods in the previous paper were consecutive, e.g. the three periods followed each other, then Narayan (2015) considered the latter two sub-samples to run simultaneously with the first two, but starting and ending at different times. In both of the previously mentioned cases, the segmented periods were first analyzed separately and then compared to each other, upon which the conclusions were drawn.

On the other hand, Wengner *et al* (2015) included a single time period of 2004-2011 in their analysis. Although they described the data separately for each year, the data analysis was applied to the whole period. Instead of expanding the work by analyzing different consecutive time periods, they included six different sectors, upon which the conclusions were drawn. Similar approach was applied by Han and Zhou (2015), whose data covered the period of January 2001 to December 2012. Again, some descriptive analysis was conducted for some significant events, including periods before and during the crisis, but the analysis itself was applied to the whole time period. Overall the multitude of time sub-samples allow to analyze the CDS spread reactions to market conditions, which had happened during the sub-samples. This allows to give a better overview of the CDS spread dynamics. The previously mentioned time period segmentation and its rationale have been summarized in the following table 1.4.

Table 1.4. The time periods analyzed by different authors.

Author	Time period	Sub-periods	Rationale
Galil <i>et al</i> (2014)	January 2002 - February 2013	3: January 2002 - June 2007 (before crisis); July 2007 - June 2009 (crisis); July 2009 - February 2013 (after the crisis).	To explain changes in CDS spreads more accurately and to compare the results between sub-periods.
Narayan (2015)	September 2004 - March 2012	4: 9 September 2004 - 26 February 2007 (before crisis); 27 February 2007 - 31 December 2010 (crisis); 27 February 2008 - 14 September 2008 (before Lehman collapse); 15 September 2008 - 31 December 2010 (after Lehman collapse).	To test whether spillover is time-varying and to account for the different CDS returns.
Wengner <i>et al</i> (2015)	January 2004 - December 2011	None; data has been described separately for each year.	Event-based analysis during the whole period; splitting period into sub-periods add no value.
Han and Zhou (2015)	January 2001 - December 2012	None; the significance of some events has been highlighted separately.	The objective is to analyze the determinants of the CDS slope during the whole period.

Source: (compiled by the author).

Interestingly enough various authors classify same periods of time differently. For example, according to Galil *et al* (2014) the global financial crisis started in July 2007 and ended in June 2009. Narayan (2015) placed the crisis between 27 February 2007 and 31 December 2010. Han and Zhou (2015) keep the crisis period as simple as possible, putting it between 2008 and 2009. Wengner *et al* (2015) explicitly controlled their dummy variables for crisis periods and stated the starting point of the crisis as 7 February 2007, when the leading financial institutions such as HSBC announced that aggregate loan impairments and loss provisions would be substantially higher than expected because of deteriorating conditions in the US housing market. These findings suggest that the choice of time period sub-samples and their splitting depends on the source of the data and the author's interpretation of the event. Although many papers base their time period segmentation upon previous and similar works, this can't be always done, e.g. newer time periods which have not yet been comprehensively analyzed.

The previous chapter provides evidence to the widespread analysis of credit default swap spreads. Since their emergence in the 1990s, the dynamics of the CDS spreads have caught the attention of numerous researchers. The theory suggests that there is a distinctive link between CDS spreads and bond spreads, enabling to carry out the empirical analysis in the next chapter. CDS spreads reflect changes in credit risk more accurately and quicker than corporate bond yield spreads, being an important measure of risk. Also the CDS market often leads bond market in terms of reaction to market events, e.g. rating changes or sovereign debt crises. Credit risk underestimation can have severe consequences on the economy as whole, as happened in the United States prior to the financial crisis of 2008-2009. The reasons for credit risk underestimation on bond market, among others, can be caused by wrong estimation of bond's liquidity and firm's debt maturity structures. Also the literature suggests that risk neutral investors are more likely to underestimate credit risk than risk averse investors during the period before default.

Each researcher has based the choice of the sample period on the availability of data and the presence of some important credit event, which in the latest papers has namely been the global financial crisis from 2008 to 2009. Although different researchers define the starting and ending point of the recent crisis differently, it tends to follow a certain trend in relation to credit events, e.g. the collapse of Lehman Brothers. One way to expand the reach of the analysis is to segment the analyzed time period. The number of sub-periods depends on whether the sub-periods are clearly distinguishable by some important credit event or whether segmentation provides additional value to the analysis.

2. THE COMPARISON OF MODEL ESTIMATED AND ACTUAL CREDIT DEFAULT SWAP SPREADS IN THE NORDIC COUNTRIES

2.1. Market background and overview of the companies

The following sub-chapter gives an overview of the current credit default swap market situation, introduces the model used to perform the analysis and explains the data and its background. In addition, the parameters used in the analysis are explained and the companies analyzed are divided into industry sectors.

The economy in Europe has started to stagnate in the last few years. The 3 month Euribor index (Euro Interbank Offered Rate³) has never been negative and as low as it currently stands at -0.007% (as of 04.05.2015). Same depreciation has happened to currency indices in the Nordic countries, with the exception of Norway (see figure 2.1). The interbank offered rate is also indirectly linked with economic growth and inflation, as they tend to move together. Low interest rates are explained by the fall of inflation and by sluggish economic growth. ECB expansionary monetary policy program has accelerated the decrease in interbank market rates in the euro area. The low-interest-rate environment is expected to persist at least during the period of the ECB asset purchase program. At the same time, the market has become more positive about the recovery of interbank market interest rates. Besides the euro area, Denmark, Sweden and Switzerland have also introduced negative policy interest rates, and/or negative central bank deposit rates. (Mertsina 2015: 1) Thus investors are forced to accept lower yields in the low inflation environment.

³ Interbank offered rate is the rate at which a bank is willing to lend the domestic currency (Euro for Europe, Swedish krona for Sweden etc.) to a prime bank for maturities from 1 week to 12 months on an unsecured basis.

The negative interbank offered rates in the Eurozone, Sweden and Denmark have created an interesting situation, where floating rate bonds can yield a negative interest, which means that theoretically the investor has to pay the company/government for holding their bonds. Same can be true for mortgage loans, which generally have a low interest rate linked to the interbank offered rate. In practice a bond only establishes a one sided claim between the parties and there has never been an intention of the parties of any payment going in the other direction. Therefore in the Nordic countries the investors have not had to pay the issuer of the bond due to the negative yield. Also many new issuers are applying explicit interest rate floors for their bonds to avoid negative bond yields.

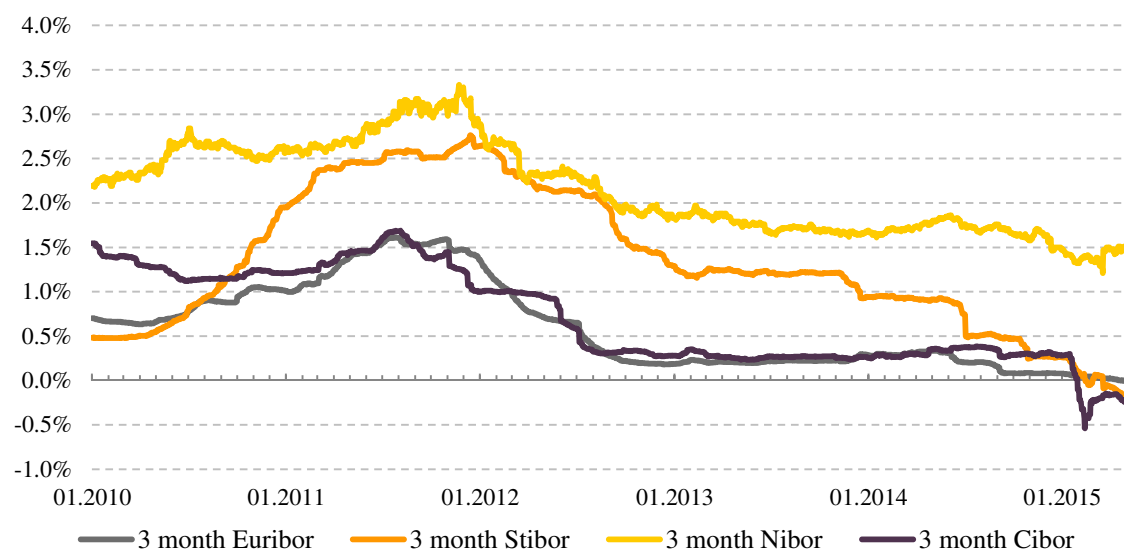


Figure 2.1. 3 month interbank offered rates for Euro, Swedish krona, Norwegian krona and Danish krona from January 2010 to March 2015 (Bloomberg database, compiled by the author).

The 3 month interbank offered rates seen in figure 2.1 are also an important part of the bonds used in the analysis. As explained in the theoretical part of the thesis, bonds can either have a fixed or a floating interest rate. Floating interest rate incorporates a fixed part and a floating part, which is the 3 month interbank offered rate. The floating rate bonds issued in late 2011, when the interbank offered rates were highest in the last five years, have seen a significant decrease in their yields and spreads.

Since the occurrence of the credit default swap in the 1990s, its pricing has been widely analyzed. The CDS market has further grown over the last decade and has thus become more prominent in the financial literature. Several studies, including Blanco *et al* (2005) and Zhu (2006) have studied the relationship between bond credit spreads and CDS spreads. A majority of the studies have been performed within a database of United States firms, with time periods ranging from 5 to 20 years. Since United States comprises the largest financial market in the world, researchers have mostly solely focused on that market.

In this paper, the author focuses on the companies originating from the Nordic countries. The Nordic countries are a geographical and cultural region in Northern Europe and the North Atlantic, consisting of five countries (Norway, Sweden, Denmark, Finland, and Iceland). Since Iceland has no relevant companies issuing 5-year CDS, the country has been excluded. The reasons the Nordic countries were chosen to analyze are the geographic proximity to author's location, the similarity of business culture and the lack of similar currently available studies in this region. Contrary to most of the CDS spread analyses, the author has included three different industry sectors, which are analyzed separately. The three industry sectors are: industrials, materials and utilities. This allows to carry out a cross-sector analysis, which might produce some relevant results. Other sectors (consumer discretionary, consumer staples, financials, energy, healthcare, information technology, telecommunication services) were excluded due to the small firm sample size, lack of bonds available with spread data or incompatibility with the chosen sectors.

In the past 15 years, of the total 4132 corporate non-financial bonds issued in the Nordic countries 1568 were issued in Sweden, 1856 in Norway, 426 in Finland, 258 in Denmark and 24 in Iceland. The average issue amount for the period is €100 million and the average coupon is 4.15%. The issuance of corporate non-financial bonds in the Nordic countries has skyrocketed in the past few years, though the issued volumes are starting to decline (refer to figure 2.2). During the first half of the 2000s, the trend has been quite stable. After the financial crisis of 2008-2009, Nordic corporations were in a higher need of capital, thus issuing more bonds. For a corporation, bonds as a source of capital often offer lower interest expenses than bank loans, making them a desirable

source of cash. In the past few years, investors have been showing more interest in bonds because they offer a considerable higher margin than safe government bonds or bank deposit rates.

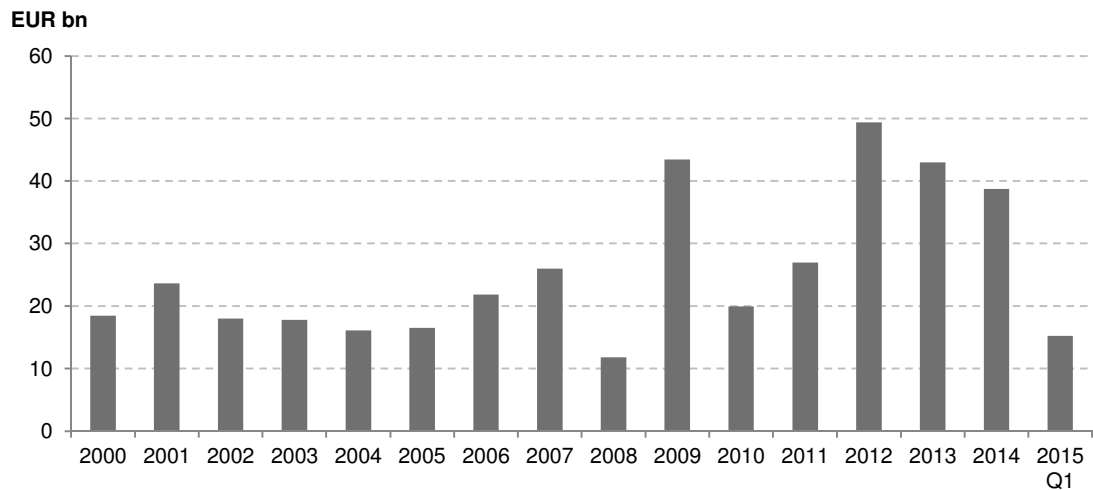


Figure 2.2. Corporate non-financial bond issuance volumes in the Nordic countries from 2000 to Q1 2015 (Bloomberg Database; author’s calculations).

For each firm in the analysis, the 5-year CDS spreads are observed. Although there are also 1-year, 2-year, 3-year, 7-year and 10-year CDS spreads available, the 5-year CDS spread is by far the most common and liquid of them all. Also since the Nordic companies are not so liquid than mostly previously analyzed big US corporations, the other CDS spread maturities are simply not available for most of them. The CDS spread data is extracted from the Bloomberg database daily.

The aim of this paper is to compare the calculated and actual CDS spreads, in order to find evidence credit risk over- or underestimation compared to theoretical spread across three different sectors. Thus the CDS spreads of the companies originating from the Nordic countries between January 2010 and March 2015 are analyzed. The author evaluates the linkage between calculated and actual CDS spreads, inspired by reduced form models. A framework similar to that used in Hull *et al* (2005) is used estimate the CDS spreads. The choice in favor of the reduced form model was made to avoid overcomplicating the data and analysis. The main inputs to the model are the bond credit spreads, which have been obtained from Bloomberg database.

Another important input to the model is recovery rate. Recovery rate is the extent to which the principal of the bond can be recovered after the event of a default. When the issuer files for bankruptcy, the ultimate recovery rate is the present value of cash and/or securities that the creditors actually receive when the issuer exits bankruptcy, typically 1-2 years after the initial default date. In 2014, the recovery rates were for the most part correlated with the priority of claim in the capital structure, with higher priority of claim enjoying a higher average rate of recovery. The only exception was the senior subordinated bonds recovered at a slightly higher rate of 46.9% relative to the senior unsecured bonds' 43.3%, though the senior subordinated average is based on only four defaults. (Ou *et al* 2015: 6-7) In the last 5 years, the recovery rates have been higher than the historical average (see table 1.2) by approximately 5%. Higher recovery rates increase investor confidence and also lower the corporate bond spreads by a small margin in the long run. The recovery rates for the period of empirical analysis are presented in table 2.1.

Table 2.1. Defaulted corporate bond and loan recoveries 2010-2014.

Lien Position	2014	2013	2012	2011	2010	2010-2014
1st Lien Bank Loan	78.4%	75.1%	66.4%	70.9%	70.9%	69.4%
Senior Secured Bond	60.9%	59.8%	51.2%	63.3%	62.5%	59.5%
Senior Unsecured Bond	43.3%	43.8%	43.0%	41.3%	51.5%	45.3%
Senior Subordinated Bond	46.9%	20.7%	33.7%	36.7%	37.5%	36.0%
Subordinated Bond	38.8%	26.4%	37.3%	35.4%	33.7%	35.5%
Junior Subordinated Bond	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Source: (Ou *et al* 2015: 23)

The most commonly issued bonds are senior unsecured bonds, followed by secured bonds. The historical average recovery rate is generally agreed to be 40%, which is confirmed by Moody's Annual Default Study. Therefore the recovery rate used in the model is 40%, which can be regarded as a constant for all of the bonds.

In total, 440 bonds with a maturity from January 2010 were included in the analysis. Of those bonds, 301 were priced and had historical spread data available. In this analysis, the bond spreads obtained from Bloomberg database are Z-spread mid prices, which in essence is the number of basis points that would have to be added to the spot yield

curve so that the bond's discounted cash flows equal the bond's present value. Whenever Z-spread was unavailable for a bond, Bloomberg Spread to Benchmark was used as an alternative spread measure. If the Bloomberg Spread to Benchmark was also unavailable, the bond was excluded from the analysis. The bond spread data is collected from January 1, 2010 to March 28, 2015. The spread frequency is daily, which, including weekends, makes 1913 possible spread figures per each bond. The bonds were issued by 16 different companies, divided into three previously mentioned industry sectors: industrials, materials and utilities. The data has been summarized by companies in table 2.2.

Table 2.2. Overview of the companies included in the analysis.

Industry Sector	Company	Country of Origin	Rating (S&P)	No. of Bonds Total	No. of Bonds Priced
Industrials	Assa Abloy AB	Sweden	A- (stable)	28	13
	Atlas Copco AB	Sweden	A (stable)	10	10
	Metso Corp.	Finland	BBB (stable)	12	6
	SKF (Svenska Kullagerfabriken AB)	Sweden	BBB+ (neg)	10	8
	Scania AB	Sweden	A- (stable)	44	26
	AB Volvo	Sweden	BBB (neg)	116	74
Materials (Paper & Pulp)	Metsä Board Corp.	Finland	BB (stable)	3	3
	Norske Skog (Norske Skogindustrier ASA)	Norway	CCC+ (neg)	19	19
	SCA (Svenska Cellulosa Aktiebolaget)	Sweden	A- (stable)	8	8
	Stora Enso Oyj	Finland	BB (stable)	23	15
	UPM-Kymmene Corp.	Finland	BB+ (stable)	11	8
Utilities	DONG Energy A/S	Denmark	BBB+ (stable)	13	13
	E.ON Sverige AB	Sweden	A- (neg)	35	28
	Fortum Oyj	Finland	A- (neg)	21	19
	Statnett SF	Norway	A+ (stable)	35	16
	Vattenfall AB	Sweden	A- (stable)	52	35

Source: (Bloomberg Database, author's calculations)

Some companies were excluded from the analysis due to the small size of outstanding or recently matured bonds, or non-existent bond spread data. Since the materials industry sector contains only paper & forest products companies, the industry sector can be regarded as paper & pulp. Of the 16 companies included in the analysis, four are speculative grade (Metsä Board, Norske Skog, Stora Enso, UPM-Kymmene) and the rest 12 are investment grade companies. Since 4/5 companies in Paper & Pulp are sub-investment grade, the whole sector can be regarded as high yield which means the CDS spreads in the sector should generally be higher than in the other two investment grade industry sectors.

The bond spread and the recovery rate are then used in the model to calculate the bond's 1-year default rate, which can also be applied to the company. The average 1-year bond default rate for the 16 companies between the period of January 2010 and March 2015 was:

- Industrials – 0.70%;
- Paper & Pulp – 8.32%;
- Utilities – 1.08%;
- Investment grade companies – 0.87%;
- High yield companies – 10.20%.

The calculated 1-year default rate figures are clearly above the historical average 1-year default rates between years 1920-2014, which according to Moody's is for investment grade companies 0.15% and for high yield companies 2.83% (Ou *et al* 2015: 29-31). The large difference between probabilities of default calculated from bond prices and probabilities of default calculated from historical data is a common feature of credit markets. The main reason for this feature is the fact that bond traders do not base their prices for bonds only on the actuarial probability of default, but also build in an extra return to compensate for the risks they are bearing. The default probabilities calculated from historical data are also known as real-world default probabilities, and those calculated from bond prices are known as risk-neutral default probabilities. (Hull *et al* 2005: 1) The historical annual global issuer-weighted default rates are presented in the following figure 2.3.

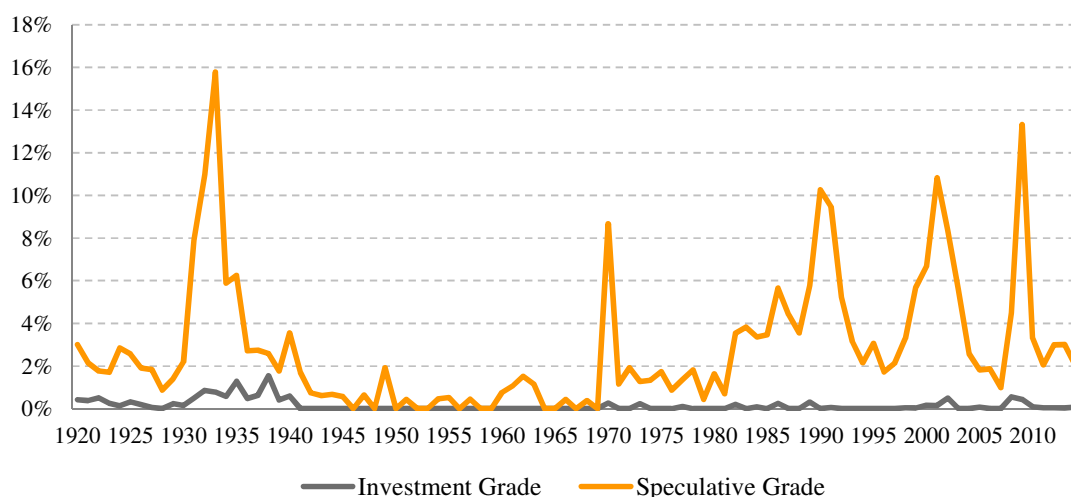


Figure 2.3. Annual issuer-weighted global corporate default rates, 1920-2014 (Ou *et al* 2015: 29-31).

As it is apparent on the figure 2.3, the historical default rates for investment grade companies have stayed relatively low below 0.2% annually, with the exceptions during the economic crises when the default rates can rise above 0.5%. The default rates for speculative grade companies on the other hand fluctuate remarkably and can rise above 10% during economic crises. The risk of default in high yield companies is thus considerable and investors need to account for this.

To sum it up, credit default swaps are over-the-counter derivatives, which are mainly traded in New York or London. The daily CDS mid-market data used in the analysis is supplied by Bloomberg Database for all of the 16 companies. The data run from 1 January 2010 to 28 March 2015. The pricing source used is the Bloomberg average intraday quotes, which is an average of quoted spreads in the past 24 hours. If there are more than 5 quotes, then the lowest and the highest quotes are excluded from the average. All CDS prices are for five years, which is by far the most liquid maturity in the CDS market. Some time series have missing values, which are replaced by values from other sources, if available. The data is split into three industry sectors: industrials (six investment grade companies), paper & pulp (five sub-investment grade companies) and utilities (five investment grade companies). In total the companies had 440 bonds available with maturity from January 2010, but only 301 of them were priced. Thus the study includes 301 bonds, which are analyzed in the next sub-chapter.

2.2. The model and the long term relationship between actual and estimated credit default swap spreads

The second empirical sub-chapter explains the model used to estimate credit default swap spreads for the three industry sectors. The CDS spreads are estimated for the whole sample from January 2010 to March 2015, containing a total of 1913 observations for each industry sector. In addition, the presence of long term relationship between the actual CDS spreads and estimated CDS spreads is evaluated. In order to test for the long term relationship for the three industry sector CDS spreads, the six time series first need to be confirmed non-stationary by testing for the presence of a unit root. After that, the cointegration between the sector variables can be tested. Finally the stationary relationships between the time series are modeled with vector error-correction model. The calculations have been conducted in statistics program Stata.

The model used to estimate the CDS spreads is being examined below. First the implicit one year default rates from bond spreads are calculated. Then they are transformed into five year default rates. Finally the implicit spread for CDS can be calculated. The following formulas give an overview on how the credit default swap spreads are estimated. The first step of the estimation is done separately for each bond to find daily bond's 1-year default rate.

$$(1) \quad bdi_{1y} = \frac{Si}{(1 - RR)} \times \frac{1}{10000}$$

Where:

bdi_{1y} = daily implicit 1-year bond default rate

Si = daily bond spread

RR = recovery rate, fixed at 40%

i = daily observations (from January 1 2010 to March 28 2015)

Since some bonds showed negative yields during certain periods, the negative 1-year bond default rates are replaced with zero. The negative bond z-spreads indicate that the bond yields less than the virtually safe government bonds with the same maturity. If bonds can have negative spreads and yields, then the negative default rate on bonds or

corporates is not possible. After that, the average 1-year corporate default rate is calculated by finding the average of implicit 1-year bond default rates for each company.

$$(2) \quad cdi_{1y} = \frac{\sum bdi_{1y}}{k}$$

Where:

cdi_{1y} = daily implicit 1-year corporate default rate

bdi_{1y} = daily implicit 1-year bond default rate

k = number of bonds with available spread data per corporation

As the next step, the 1-year corporate default rates are transformed into 5-year bond default rates. The 5-year corporate default rate needs to be calculated in order to match the tenor of 5-year actual CDS spreads. The estimation of 5-year CDS spreads is done with the 5-year default rates.

$$(3) \quad cdi_{5y} = 1 - e^{-5 \times cdi_{1y}}$$

Where:

cdi_{5y} = daily implicit 5-year corporate default rate

cdi_{1y} = daily implicit 1-year corporate default rate

After this, the daily estimated CDS spreads can be calculated. The main components of the formula are the previously calculated daily implicit 5-year corporate default rate and the recovery rate, which has been fixed at an average historical level of 40%. The formula is exhibited below.

$$(4) \quad CDSi_e = -\ln(1 - di_{5y}) \times (1 - RR) \times 2000$$

Where:

$CDSi_e$ = daily estimated credit default swap spreads

di_{5y} = daily implicit 5-year corporate default rate

RR = recovery rate, fixed at 40%

Next the model estimated CDS spread and actual CDS spread are tested for cointegration. Two nonstationary time series are cointegrated if they tend to move together through time. Previous empirical studies (Blanco *et al* 2005, Delis and Mylonidis 2011) suggest that CDS spreads and bond spreads are linked and move together in time. The results also indicate that CDS spreads almost uniformly Granger-cause bond spreads, especially after the start of the financial crisis. Feedback causality is detected during periods of financial and economic turmoil, thereby indicating the high risk aversion, which tends to perplex the transmission mechanism between CDS prices and bond spreads.

In order to carry out the analysis, the individual time series need to contain a unit root. The null hypothesis is that the variable contains a unit root, and the alternative hypothesis states that the variable is either stationary or trend-stationary. Trend-stationary implies that the time series' variance is constant in time meanwhile the mean doesn't have to be constant (in the case of stationary time series both the variance and mean are stationary). The test is done using Phillips-Perron test, which uses Newey-West standard errors to account for serial correlation. The Phillips-Perron test involves fitting the regression model by ordinary least squares, and the results are used to calculate the test statistics. The test has been conducted for all the three industry sectors for both actual and model estimated CDS spreads. In total each dataset has 1913 daily observations from January 2010 to March 2015. Because the data does not exhibit a clear upward trend over time, the trend option has been excluded. Results at 1%, 5% and 10% critical value are presented below in table 2.3.

Table 2.3. Phillips-Perron test for unit root.

Industry sector	CDS Spreads	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Industrials	Actual	-1.47	-3.43	-2.86	-2.57
	Calculated	-2.20	-3.43	-2.86	-2.57
Paper & Pulp	Actual	-2.77	-3.43	-2.86	-2.57
	Calculated	-2.27	-3.43	-2.86	-2.57
Utilities	Actual	-1.95	-3.43	-2.86	-2.57
	Calculated	-2.57	-3.43	-2.86	-2.57

Source: (Author's calculations)

The table 2.3 contains the results for the interpolated critical values for $Z(t)$. If the test statistic is greater than its critical value, then the null hypothesis can't be rejected and the time series contains a unit root. Both industrials actual (-1.47) and calculated (-2.20) CDS spread test statistic is greater than its 1% (-3.43), 5% (-2.86) and 10% (-2.57) critical value, which means the null hypothesis stands and they contain a unit root. Paper & pulp actual CDS spread test statistic of -2.77 is smaller than its 10% critical value of -2.57, indicating that at 10% confidence level the series was created by a stationary process. Still though at 1% and 5% confidence level the null hypothesis can't be rejected. Meanwhile paper & pulp calculated CDS spread test statistic at -2.27 is greater than all the critical values (at 1%, 5% and 10%), allowing to accept the null hypothesis. Utilities actual CDS spread test statistic of -1.95 exceeds its critical values at all levels. The null hypothesis has to be rejected for utilities calculated CDS spread dataset at 10% confidence level as well, because the test statistic of -2.57 is equal to its 10% critical value of -2.57.

By concluding the unit root test results, all the six datasets have a unit root at 5% confidence level. The test statistic exceeded all of its critical values for four datasets, indicating the existence of a unit root at 10% confidence level. Overall the prerequisites for the upcoming cointegration tests are met at 5% confidence level, which is sufficient for the completion of the analysis. The Phillips-Perron test results prove that all the time series included in the analysis are non-stationary.

To test for the Johansen cointegration, an appropriate number of lags need to be chosen. Based on the nature of the data, a number of 12 maximum lag orders have been included in the test. The results of the lag order selection are presented below in table 2.4.

Table 2.4. Lag order selection statistics (preestimation).

Industry sector	Number of lags suggested by criteria				Consensus
	FPE	AIC	HQIC	SBIC	
Industrials	9	9	5	1	1, 5, 9
Paper & Pulp	10	10	10	10	10
Utilities	7	7	2	2	7 or 2

Source: (Author's calculations)

The FPE (final prediction error) and AIC (Akaike's information criterion) estimate that nine lags should be included, while HQIC (Hannan and Quinn information criterion) estimate the inclusion of five lags and SBIC (Schwarz Bayesian information criterion) estimate the inclusion of one lag for the industrials industry sector. The result is clearer for paper & pulp sector, where all four likelihood-ratio tests suggest the inclusion of 10 lags for the cointegration test. The test results for the utilities industry sector are split: FPE and AIC suggest the inclusion of seven lags, while HQIC and SBIC suggest the inclusion of two lags. Thus the optimal number of lags for industrials is either one, five or nine, paper & pulp 10, and utilities two or seven (all cases of lags should be analyzed separately).

Whether the cointegration relationships should include trend and constant, should usually be tested with an ordinary linear regression. The dependent variable should be CDS estimated spreads and independent variables actual CDS spreads and time. If time is statistically significant, the cointegration relationship should also include trend and constant. Even though the test results indicate that time is statistically significant ($p=0.00$) for all the industry sectors, the trend and constant should not be included in the further analysis. The connection between the two time series analyzed, the actual CDS spreads and calculated CDS spreads, is estimated by using the calculated spreads to estimate their ability to forecast the actual value of the credit default swap spreads. By switching the trend or constant into the equation, it would in essence allow a systematic error when calculating the estimated credit default swap spreads. Thus the further analyses have been conducted without the inclusion of trend and constant.

The cointegration is tested with *Johansen test for cointegration*. Independent variables are model estimated CDS spreads and actual CDS spreads, and maximum number of lags included is specified in table 2.4. The whole period from January 2010 to March 2015 is included in the test. The test results are presented in table 2.5.

Table 2.5. Johansen test for cointegration for full period.

Industry sector	Maximum rank	Eigenvalue	Trace statistic	5% critical value
Industrials	0	-	7.64*	12.53
Lags=1	1	0.00	0.51	3.84
1.2010-3.2015	2	0.00	-	-
Industrials	0	-	5.25*	12.53
Lags=5	1	0.00	0.48	3.84
1.2010-3.2015	2	0.00	-	-
Industrials	0	-	4.42*	12.53
Lags=9	1	0.00	0.51	3.84
1.2010-3.2015	2	0.00	-	-
Paper & Pulp	0	-	19.47	12.53
Lags=10	1	0.01	0.25*	3.84
1.2010-3.2015	2	0.00	-	-
Utilities	0	-	12.88	12.53
Lags=2	1	0.00	0.09*	3.84
1.2010-3.2015	2	0.00	-	-
Utilities	0	-	8.10*	12.53
Lags=7	1	0.00	0.02	3.84
1.2010-3.2015	2	0.00	-	-

Source: (Author's calculations)

Johansen test for cointegration tests whether there are 0, 1 or 2 cointegration relationships. For any given value of r (rank) when the value of trace statistic is larger than the 5% critical value, is evidence against the null hypothesis that there is r or fewer cointegrating relations in the vector error-correction model. The “*” by the trace statistic indicates that this is the value of r selected by Johansen's multiple-trace test procedure. The eigenvalue shown in the last line of table 2.4 is used to compute the trace statistic in the preceding line. The hypotheses of the trace statistics are:

- H0: There are no more than r cointegrating relations.
- H1: There are more than r cointegrating relations.

In the case of industrials, the trace statistic at $r = 0$ of 7.64 for one lag is below its critical value of 12.53 which means the null hypothesis can't be rejected. The trace statistic is also below its critical value for five lags (5.25) and nine lags (4.42). Thus model estimates the industrial CDS spreads and actual CDS spreads are not cointegrated. On the other hand, the paper & pulp trace statistic at $r = 0$ of 19.47 is

above its critical value of 12.53, the null hypothesis will be rejected. Therefore the model estimated paper & pulp CDS spreads and actual CDS spreads are cointegrated and the alternative hypothesis is accepted. Also the utilities' trace statistic at $r = 0$ of 12.88 exceeds its critical value of 12.53, so the null hypothesis of no cointegrating equations is rejected for two lags. In the case of seven lags, the utilities' null hypothesis cannot be rejected as the trace statistic at $r = 0$ of 8.10 is below its critical value of 12.53.

Because Johansen's method for estimating r is to accept the first r for which the null hypothesis is not rejected, the $r = 1$ is accepted as the estimated number of cointegrating equations between paper & pulp model estimated CDS spreads and actual CDS spreads with 10 lags and between utilities' estimated spreads and actual spreads with two lags. It's also worth to note that paper & pulp sector had cointegration relationships for all the lags between 1 and 10, while industrials had cointegration relationships up to two lags. The number of lags usually also affect the value of trace statistic. Less lags used in the analysis usually equals to higher value of trace statistic, which indicates a stronger cointegration relationship. In this case a switch to less lags did not cause any major changes in the strength of relationship, so the optimal number of lags are used. Meanwhile industrials industry sector has no cointegrating equations in the whole sample period for all suggested one, five and nine lags, thus the null hypothesis is not rejected at $r = 0$.

Next the cointegration for industrials is tested for two sub-periods extracted from the whole period. The sub-periods chosen for industrials are from January 2010 to July 2011 and from January 2013 to March 2015. The choice of the time periods was made by examining figure 2.5 to find for periods of interest. The time periods and the results of the lag order selection are presented below in table 2.6.

Table 2.6. Lag order selection statistics (preestimation) for industrials sub-samples.

Industry sector	Time period	Number of lags suggested by criteria				Consensus
		FPE	AIC	HQIC	SBIC	
Industrials	1.2010-7.2011	9	9	2	2	9 or 2
	1.2013-3.2015	4	4	1	1	4 or 1

Source: (Author's calculations)

For the period of January 2010 to July 2011, the cointegration for industrials has been tested for both two lags and nine lags. In the case of two lags, the trace statistic at $r = 0$ of 12.64 exceeds its critical value of 12.53, so the null hypothesis is rejected. For the same period with 9 lags the null hypothesis can't be rejected as the trace statistic is below its critical value. The second sub-period, from January 2013 to March 2015, comprised also a choice between two number of lags, 4 and 1. Testing cointegration for both cases resulted in the acceptance of the null hypothesis for four lags, but was rejected for one lag: the trace statistic of 12.84 at $r = 0$ for one lag exceeded its critical value of 12.53. Thus the null hypothesis for both sub-samples with two and one lags was rejected and there is one or fewer cointegrating equation. The results of the tests for industrials sub-periods can be found in table 2.7.

Table 2.7. Johansen test for cointegration for industrials sub-periods.

Industry sector	Maximum rank	Eigenvalue	Trace statistic	5% critical value
Industrials	0	-	12.64	12.53
Lags=2	1	0.00	0.51*	3.84
1.2010-7.2011	2	0.00	-	-
Industrials	0	-	12.87	12.53
Lags=1	1	0.00	0.48*	3.84
1.2013-3.2015	2	0.00	-	-

Source: (Author's calculations)

As previous results indicate, the cointegration relationships exist for all the sectors, but not for the same periods. Utilities and paper & pulp were the two industry sector which had a cointegrating relationship for the whole period. Industrials failed to show significant results for the whole period. Nevertheless two sub-periods from industrials have been analyzed separately, which show relevant results. The sub-periods span from January 2010 to July 2011 and from January 2013 to July 2015.

Vector error-correction models (VECM) are used to model the stationary relationships between multiple time series that contain unit roots. VECM implements Johansen's approach for estimating the parameters. Since the two credit spreads in an industry sector are cointegrated, albeit on different time periods, the parameters of a bivariate VECM with one cointegrating relationship are estimated. The estimation can only be done for time periods with cointegrating relationships, which are listed previously

through this paragraph. The estimated parameters of bivariate vector error-correction models with one cointegrating relationship are presented below in table 2.8.

Table 2.8. Parameters estimated by vector error-correction model.

Sector	Variables	Coefficient	Std. Err.	z	P> z
Industrials 1.2010-7.2011 Lags=2, r=1	Actual CDS spreads	1	-	-	-
	Calculated CDS spreads	-1.11	0.06	-16.38	0.00
Industrials 1.2013-3.2015 Lags=1, r=1	Actual CDS spreads	1	-	-	-
	Calculated CDS spreads	-0.86	0.03	-25.81	0.00
Paper & Pulp 1.2010-3.2015 Lags=10, r=1	Actual CDS spreads	1	-	-	-
	Calculated CDS spreads	-1.18	0.03	-29.77	0.00
Utilities 1.2010-3.2015 Lags=2, r=1	Actual CDS spreads	1	-	-	-
	Calculated CDS spreads	-0.99	0.44	-22.06	0.00

Source: (Author's calculations)

The coefficients found in the VECM show how deviations from the long-run relationship affect the changes in the variable in the next period. In the case of paper & pulp, the long term cointegrating relationship can be expressed as:

- Actual CDS spreads – 1.18 × Calculated CDS spreads = 0; or
- Actual CDS spreads = 1.18 × Calculated CDS spreads.

When the coefficient' value is smaller than -1, the estimated gap between the actual CDS spreads and estimated CDS spreads will be greater relative to the value that emerges from the measured gap, and when the coefficient's value is greater than -1, the estimated gap would be smaller. So the results forecast a slight increase in credit spread difference in the next period for paper & pulp. For utilities, the long term cointegrating relationship coefficient of -0.99 estimates a quite similar movement for actual CDS spreads based on estimated CDS spreads. No major surprises in long term relationship for industrials can also be detected: for the period from January 2010 to July 2011 the long term relationship coefficient of -1.11 estimates some increase in credit spread difference, and for the period from January 2013 to March 2015 the VECM coefficient of -0.86 estimates a slight decrease in the credit spreads in the next period.

The previous sub-chapter explained the model used to calculate the estimated credit default swap spreads. In essence, the model estimates 1-year bond default rates, which are transformed into 5-year corporate default rates and finally the credit default swaps can be estimated. Phillips-Perron test confirmed that all the six time series used in the analysis contain a unit root and therefore are nonstationary. In order to test for cointegrating relationships between the sector spreads, a number of appropriate lags were chosen. Cointegration itself determines long-run relationships between the variables. The Johansen test for cointegration revealed a cointegrating relationship for the whole period of January 2010 – March 2015 for paper & pulp and utilities industry sectors. For industrials, a cointegrating relationship was found for two sub-samples, spanning from January 2010 to July 2011 and January 2013 to March 2015. Finally, vector error-correction model was used to show how deviations from the long-run relationship affect the changes in the next period. For paper & pulp the spread gap is expected to widen in the next period, while for utilities it is estimated to stay the same. Industrials spread gap is expected to converge even more in the next period. The graphs portraying the historical actual and estimated spreads for three industry sectors can be found in the next sub-chapter.

2.3. Model estimated and actual credit default swaps across three industry sectors

The final sub-chapter discusses the difference between market pricing of credit default swaps and the implicit spread, which are in principle governed by bond pricing. After that the results arising from the spread differences are discussed, and finally concluding remarks are presented.

The risk sentiment has remained quite stable in the Nordic CDS universe in the past few years. Compared to the European CDS indices, the Nordic high yield and investment grade credit default swap spreads have followed different trends. The figure 2.4 shows that before 2013 the risk sentiment in the Nordic investment grade companies has generally stayed below the European average, then after 2013 the Nordic IG CDS spread has started to converge with the iTraxx Main index. The iTraxx Main (Markit iTraxx Europe index) comprises 125 equally weighted credit default swaps on investment grade European corporate entities. This illustrates lower perceived risk in the years 2010-2013 in the Nordic investment grade companies compared to the other European entities. Thereafter the credit default swap spreads have started to converge and remain nearly identical.

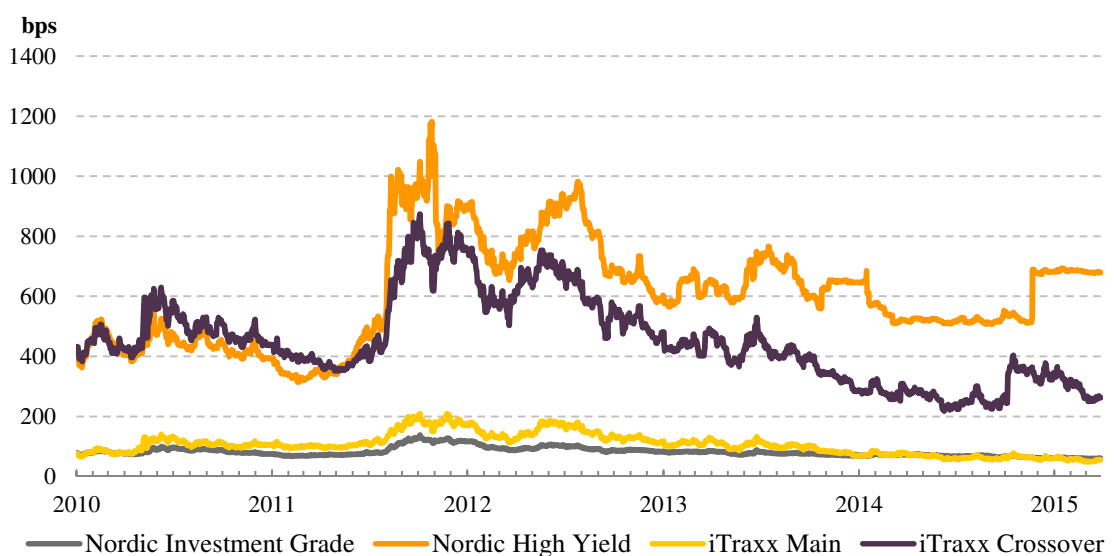


Figure 2.4. Nordic investment grade and high yield corporates CDS spreads in comparison to market indices (Compiled by the author).

Nordic high yield CDS spreads have moved in an opposite manner to Nordic investment grade CDS spreads compared to market indices. The spreads moved together at a roughly same level until mid-2011, when the Nordic high yield CDS spreads overreacted to the combination of sovereign debt crisis and the ECB actions. According to iTraxx Crossover index, the increased risk in the other European high yield companies was seen smaller than in the Nordic countries. The iTraxx Crossover (Markit iTraxx Europe Crossover) index comprises 75 equally weighted credit default swaps on the most liquid sub-investment grade European entities. Since 2012, the Nordic high yield CDS spread detached from the iTraxx Crossover index and has remained above 500 bps, whereas the iTraxx index indicates that the risk sentiment in the other European high yield entities is significantly lower than in the Nordic high yield entities.

The following actual CDS spreads and model estimated CDS spreads have been analyzed for credit risk over- and underestimation. Statistically significant conclusions can be drawn upon the cointegrated time series, which were determined in the previous sub-chapter. As can be seen on the figure 2.5, the industrials model estimated CDS spread has deviated to a great extent from the actual CDS spread. The both spreads started at roughly 90 bps in the beginning of 2010, after which the estimated CDS spread gradually dropped to a significantly lower level. Until July 2011, the difference between market pricing of CDS and the calculated implicit CDS spread has been getting wider. The period of January 2010 to July 2011 can be regarded as post-crisis economic recovery, during which the economy in Europe regained its ground and achieved higher levels of output. The spread difference indicates the much lower investor's risk perception during the period. It can be assumed that investors saw Nordic investment grade industrial corporate bonds a safe place to place their funds. Meanwhile banks had a different view on the credit risk, as the credit default swaps which they sold were relatively more expensive than in the investor's view. The phenomenon can partially be explained by the recovering economic situation after the global financial crisis in 2008-2009, during which industrials suffered slightly more than companies in other industry sectors due to diminishing orders and demand.

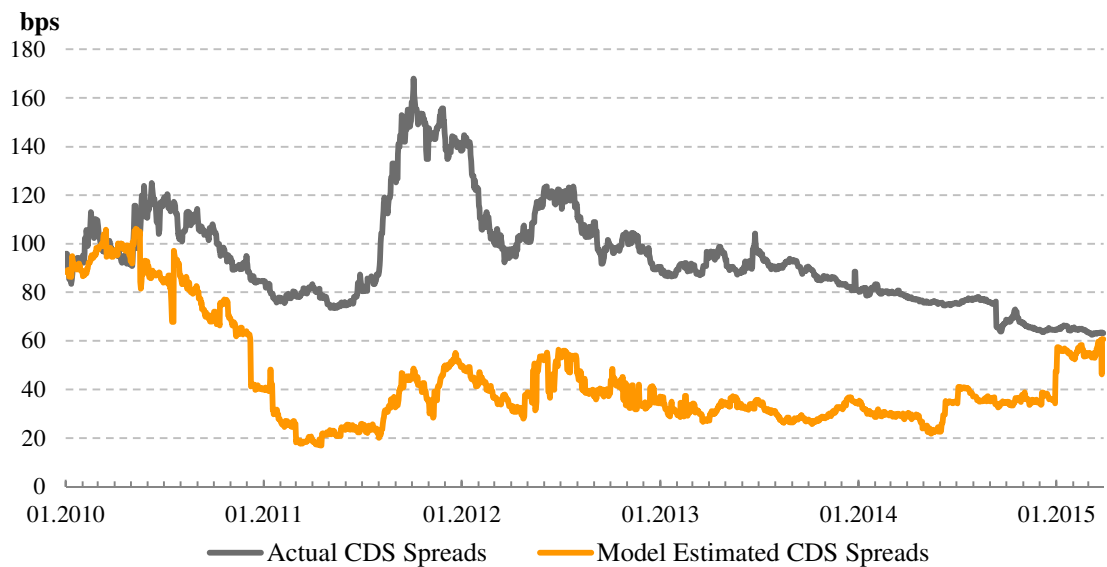


Figure 2.5. Industrials actual and model estimated CDS spreads (Compiled by the author).

In April 2011, the European Central Bank raised interest rates for the first time since 2008 from 1% to 1.25% and in July further to 1.50%. A few months later, the European sovereign debt crisis, mainly caused by Greece, Spain, Portugal, Ireland and Italy, escalated. The rise in actual CDS spreads by more than 70 bps can be best explained by the combination of the two previously mentioned events. It is also clear that the increase of spreads in estimated credit default swaps did not react this much to this news, indicating investors' clear confidence in the Nordic industrials bonds.

After the sovereign debt crisis in the end of 2011, the industrials actual credit default swap spreads have been gradually declining from 140 bps in January 2012 to 60 bps in March 2015, while the estimated credit default swap spreads have historically from December 2010 stayed between 20 bps and 60 bps. From 2013 January, the difference between estimated and actual spreads is starting to decrease. What is more, a convergence between the market pricing of CDS and implicit estimated spread can be observed. The investor's credit risk underestimation between January 2013 and March 2015 still exists, albeit from January 2015 the market pricing of CDS and the investor's implicit spread can be viewed to be roughly at the same level. What is more, the parameter estimated by vector error-correction model also confirms a slight convergence of the two spreads in the next period. This may indicate that investor's

confidence in this industry sector is getting weaker, while the market and banks are gradually lowering their risk perception associated with Nordic industrial companies.

Unlike in the industrials industry sector, model estimated CDS spreads in paper & pulp sector (see figure 2.6) have followed the actual CDS spreads relatively well in line until the credit event caused by a combination of European sovereign debt crisis and ECB actions. The market priced credit default swap spreads and implicit estimated credit default swap spreads share a common stochastic drift in the period from January 2010 to March 2015, as proven by the cointegration analysis. During the period from January 2010 to mid-2011 the model estimates that investors share a common level of risk perception with the market and the banks issuing credit default swaps. No serious under-or overestimation of credit risk can be detected.

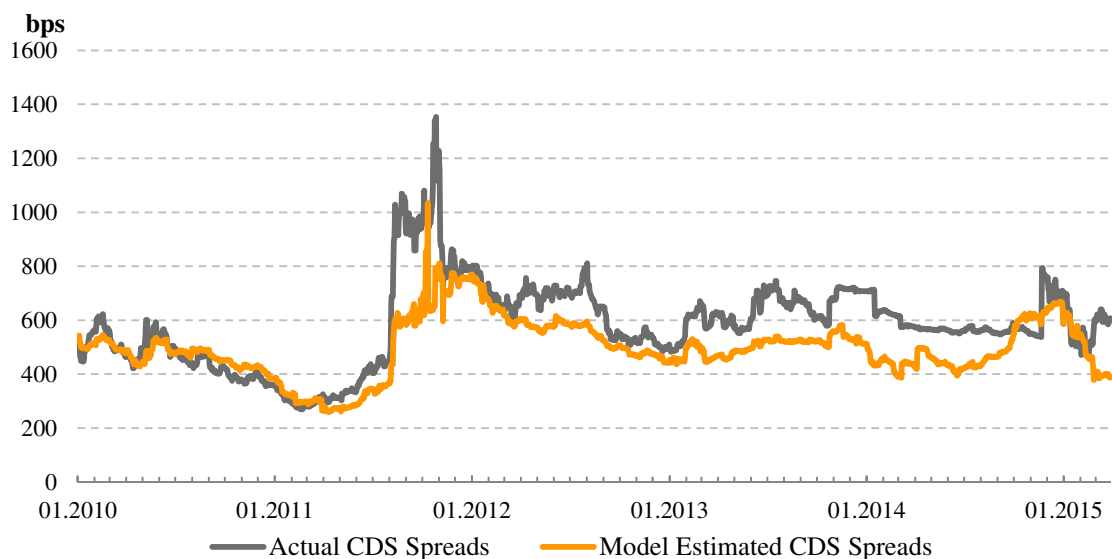


Figure 2.6. Paper & Pulp actual and model estimated CDS spreads (Compiled by the author).

Paper & pulp, being the only speculative grade sector out of the three industry sectors, offers the greatest yield possibilities, but at the cost of an increased risk of default. During mid-2011, the actual CDS spreads increased by more than 100% to 1000 bps, showing the sectors high volatility response to negative credit events. The difference in reaction between the bond market and the CDS market show a clear variance in risk perception to market affecting credit events. What is more, the bond market did not react to the credit event so dramatically, while banks viewed the credit risk a few

notches higher. Thus the investors perceived the increase of credit risk smaller than was viewed by the market.

From mid-2012 a slight difference between market pricing of CDS and implicit estimated spread can be found in paper & pulp spreads. The spread difference persists and can still be noticed three years later in March 2015. The relatively constant three-year spread difference indicates a slight long-term investor's credit risk underestimation against the risk level priced by the CDS market. According to the results of VECM, the gap between the actual CDS spreads and estimated CDS spreads is expected to increase in the next period. It can be assumed that in the long term the investors are satisfied with bond returns and performance in the paper & pulp sector and they are willing to sacrifice some safety for the increased yield, ignoring the actual higher risk level dictated by the CDS market. Overall the theoretical implicit spread and actual CDS spread are well aligned indicating that the fairly high risk is priced in in this cyclical and low rated sector.

Utilities, the industry sector with the lowest spreads in the analysis, show also the least volatility in the five year period. As seen on figure 2.7, the actual CDS spread and model estimated CDS spread start at the same level around 50 bps from January 2010. The market priced CDS and the implicit estimated spread follow approximately the same trend until mid-2011, where the difference in reaction to the negative credit event is noticeable. Bond market shows signs of credit risk underestimation compared to the credit risk interpreted by the CDS market. What is interesting is that all the three industry sectors bond markets view of credit risk during the credit event caused by the combination of European sovereign debt and ECB actions is lower than the risk perceived by the CDS market. So in general CDS market prices the credit risk higher during credit events, while bond market remains less affected by the events. Thus the investors underestimate the level of credit risk, which is governed by banks.

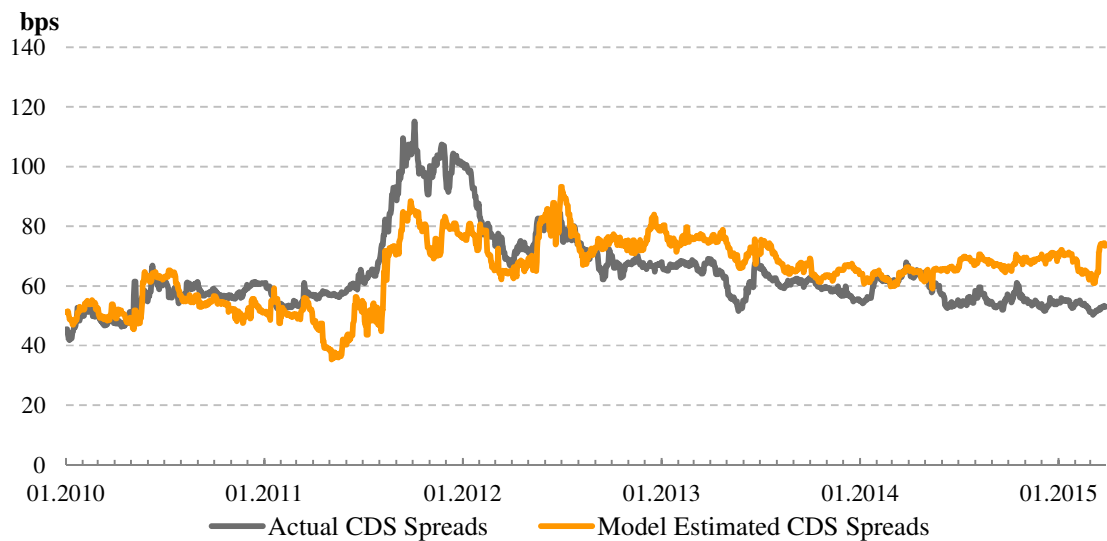


Figure 2.7. Utilities actual and model estimated CDS spreads (Compiled by the author).

Utilities was one of two industry sectors with a cointegrating relationship between the estimated and actual CDS spreads for the whole period of analysis, spanning from January 2010 to March 2015. From mid-2012, the difference between market pricing of CDS and implicit estimated spread is starting to expand. The bond market perceives the credit risk one notch higher than it is perceived by the CDS market. While the actual CDS spreads gradually slowly decline from 80 bps to 55 bps in the 3-year period from mid-2012 to March 2015, the estimated CDS spreads show a slight upward trend from the start of 2014. The divergence continues to a spread difference of 20 bps at the end of March 2015. For some reason, bond market slightly overestimates the credit risk in the utilities industry sector during the three year period from mid-2012 to March 2015. The gap between the actual CDS spreads and estimated CDS spreads is estimated to remain unchanged also in the next period, as can be judged by the results of the vector error-correction model in the previous sub-chapter. In conclusion, the implicit estimated spread being above the market priced CDS spread indict a slightly above actual risk sentiment among investors in this stable, non-cyclical sector. Utilities are perceived to be the industry sector with the lowest risk of default besides the “risk-free” government sector, providing relatively low yield on the bonds compared to other industry sectors.

To sum it up, the results have been aggregated into a table for a better overview. Relevant conclusions have been drawn in line with the cointegrated samples determined

in the previous sub-chapter. The overview of investor's risk sentiment in the Nordic countries can be found in table 2.9.

Table 2.9. Summary of the investor's risk sentiment in the Nordic countries.

Industry Sector	Sample period	Conclusions
Industrials	1.2010-7.2011	The gradually widening credit spread difference indicates the bond market's underestimation of the credit risk perceived by the CDS market.
	1.2013-3.2015	Noticeable credit risk underestimation by investors, albeit the convergence of spreads between the bond market and the CDS market towards 2015 show signs of integration of the risk sentiment.
Paper & Pulp	1.2010-3.2015	Implicit estimated spreads well in line with market pricing of CDS, showing no signs of noticeable credit risk underestimation until mid-2011. From mid-2012, a relatively constant difference in reaction to credit risk between the bond market and the CDS market imply a slight long-term investor's credit risk underestimation against the risk level priced by the CDS market.
Utilities	1.2010-3.2015	Until mid-2011 the market priced CDS and the implicit estimated spread follow approximately the same trend, indicating similar risk sentiment between investors and banks. From mid-2012 the difference between the spreads starts to expand, with bond market slightly overestimating the level of credit risk priced by the CDS market.

Source: (Compiled by the author).

The analysis concludes that some investor credit risk under- and overestimation exists in the Nordic bond market. The biggest difference between market pricing of CDS and implicit estimated spread exists in industrials, where the investor's risk perception is much lower than it is considered by the CDS market dictated by banks. Statistically significant investor credit risk underestimation exists during the period of economic recovery (January 2010 – July 2011) and from January 2013 to March 2015, although a convergence of the spreads can be seen towards the first quarter of 2015 in the second period. The reaction to credit risk between the bond market and the CDS market is relatively in line for paper & pulp during the period of economic recovery. However from mid-2012 a relatively constant difference in credit spreads is noticeable, which implies a slight long-term investor's credit risk underestimation against the risk sentiment in the CDS market. In the utilities industry sector, the market pricing of CDS

and the implicit estimated spreads exhibit investor's slight overestimation of credit risk from mid-2012 onwards. The difference in spreads show signs of widening towards the first quarter of 2015, hinting at investor's continuing underestimation of credit risk in the relatively safe utilities industry sector.

It's also worth noting that the bond market is more regional and the CDS market is "London" based. Due to this, the investors view on the credit risk in local bond market might differ from the risks perceived by banks issuing credit default swaps. Investors risk sentiment covers mainly the region where the bond is issued, whereas banks usually price credit risk taking into consideration also the broader economic situation. Thus the differences in risk perception can partly be explained by the regionality of the bond market in the Nordic countries, while CDS trading takes mainly place in London.

In conclusion, the evidence to investor's credit risk underestimation was discovered. In addition, a case of credit risk overestimation was also found. The industrials industry sector, comprising of six investment grade Nordic companies, shows clear signs of investor's credit risk underestimation in comparison to the view of CDS market. Paper & pulp sector, the only sub-investment grade sector in the analysis comprising of five companies, display signs of long-term investor's credit risk underestimation against the risk level priced by the CDS market. Evidence to significant credit risk overestimation was found only in the utilities industry sector, which consists of five investment grade companies in the Nordic countries.

CONCLUSION

This paper has found evidence to investor's underestimation of credit risk in the Nordic countries between the period of January 2010 and March 2015. The specific results have been summarized for three different industry sectors, which are industrials, paper & pulp and utilities. Thus the main purpose of the thesis has been achieved. The results indicate that credit risk underestimation exists for:

- Industrials (between January 2010 and July 2011), where the widening credit spread difference indicate the bond market's underestimation of the credit risk perceived by the CDS market;
- Industrials (between January 2013 and March 2015), where credit risk is noticeably underestimated by investors, albeit the convergence of spreads between the bond market and the CDS market towards 2015 show signs of integration of the risk sentiment;
- Paper & pulp (from mid-2012 onwards), where relatively constant difference in reaction to credit risk between the bond market and the CDS market imply a slight long-term investor's credit risk underestimation against the risk level priced by the CDS market.

Evidence to credit risk overestimation was found for the utilities industry sector, in which investors overestimated the credit risk from mid-2012 as the difference between the spreads started to expand, with bond market slightly overestimating the level of credit risk priced by the CDS market.

In order to reach the main purpose of the thesis, six research tasks were formed in the introduction. The research tasks helped to reach the paper's main goal and are outlined in the following paragraphs.

First, a comparative overview of high grade and low grade bonds was given. Low grade bonds, which have an issuer credit rating below BBB-, are usually issued by firms

smaller in size or acting in an uncertain environment. Compared to high grade bonds, low grade bonds are smaller in issue size, less liquid and bear more risk. Investors are thus compensated with a higher yield spread to offset the higher risk of default. In addition the low grade bonds are more likely to become illiquid and the spread volatility is significantly higher than in high grade bonds. Due to the increased risk the low grade bonds yield, the chance of default is considerably higher than in high grade bonds, which in turn forces issuers to include restrictive covenants to protect investors.

Secondly, the concept of credit default swaps was explained and the different credit default swap pricing models were compared. A credit default swap is a derivative contract aimed at transferring default risk of an underlying bond from one market participant to another. Credit default swaps can have financial benefits on the firms issuing bonds: they increase transparency, lower credit spreads and increase volatility, especially for firms which are issuing bonds for the first time. The pricing of credit default swaps can be mainly done with two different types of models: structural and reduced form. Structural models assume that a firm defaults when its asset value drops below a certain threshold, while reduced form models determine credit risk by the occurrence of default and the amount recovered at default.

After that, credit spreads were analyzed in detail and an overview of the credit risk underestimation literature was given. The theory suggested that there is a distinctive link between credit default swap spreads and bond spreads, with credit default swap spreads often leading the bond spreads. This means that credit default swap spreads reflect changes in credit risk more accurately and quicker than corporate bond yield spreads, being an important measure of credit risk. Credit risk underestimation can have severe consequences on the economy as whole, as happened in the United States prior to the financial crisis of 2008-2009. The reasons for credit risk underestimation on bond market, among others, can be caused by wrong estimation of bond's liquidity and firm's debt maturity structures. Also the literature suggests that risk neutral investors are more likely to underestimate credit risk than risk averse investors during the period before default. In addition, the time period sub-samples were analyzed to see how different authors segment their samples. The findings suggested that the choice of time period sub-samples and their splitting depends on the source of the data and the author's

interpretation of the important credit events, e.g. the recent global financial crisis of 2008-2009.

The first empirical sub-chapter explained the market background and gave an overview of the companies included in the analysis. The 3 month Euribor index has never been as low as it currently stands, which has created an interesting economic situation for the corporate debt market. The negative interbank offered rates in euro area, Sweden and Denmark have created a situation where floating rate bonds can yield a negative interest, meaning theoretically the investor has to pay the bond issuer for holding their bonds. The companies included in the analysis originated all from the Nordic countries and were analyzed in three industry sectors: industrials, paper & pulp and utilities. In total a number of 16 companies and 440 bonds with maturities from January 2010 were included in the analysis.

Thereafter the model estimated credit default swap spreads and actual credit default swap spreads were analyzed across three industry sectors in the Nordic countries. The model used to estimate the CDS spreads was decomposed for a better understanding of the process. Phillips-Perron test concluded that all the six time series contain unit root, which enabled to test for cointegrating relationships between the actual and estimated CDS spreads for each industry sector. Cointegrating relationships were found for all the industry sectors, albeit on different sample periods. After that, the relationships were analyzed with vector error-correction model in order to model the stationary relationships between the time series. The coefficients found in the vector error-correction model show how deviations from the long-run relationship affect the changes in the variable in the next period.

Finally, the results were presented, analyzed and summarized. The analysis suggested that investor's credit risk underestimation exists in the Nordic bond market. In addition, some overestimation of credit risk can be found as well. The biggest difference between market pricing of CDS and implicit estimated spread existed in industrials, where the spread difference indicated the much lower investor's risk perception during the period. Meanwhile banks had a different view on the credit risk and did not view Nordic industrials as safe as investors did. The model estimated CDS spreads in paper & pulp sector followed the actual CDS spreads relatively well in line until mid-2011. The

relatively constant three-year spread difference from mid-2012 indicated a slight long-term investor's credit risk underestimation against the risk level priced by the CDS market. Utilities were perceived to be the industry sector with the lowest risk of default and the analysis concluded that investors slightly overestimated the credit risk priced by banks.

The conclusions reached in this paper can help investors better understand the historical bond and CDS market development of the three industry sectors. In addition, the results may help investors to reach better investment decisions by advising them to avoid industry sectors with underestimated credit risk (industrials and paper & pulp) and to give considerations to look into industry sectors with overestimated credit risk (utilities). Though each investor has a different risk sentiment, the industrials and utilities are both in the same rating category. When the choice of bond purchase comes down to choosing between a Nordic industrial and a Nordic utilities company, the author suggests investing in utilities sector, as the overestimated credit risk offers better yield capabilities for the bonds. The limitations of the analysis include the shorter-than-planned period of analysis due to the lack of available bond spread data between 2005 and 2010 for Nordic corporations. In addition, the future papers could develop the analysis further by including additional industry sectors for a better overview of the Nordic market, or by conducting a deeper, more thorough analysis of two industry sectors.

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RESÜMEE

INVESTORI KREDIIRISKI ALAHINDAMINE PÕHJAMAADES

Taavi Jürgenson

Ülemaailmne finantskriis aastatel 2008-2009 tõstis esile krediidiriski hindamise tähtsuse. Ameerika Ühendriikidest alguse saanud finantsinstitutsioonide kokkukukkumine mõjutas negatiivselt ka ülejäänud maailma. Investorid olid maandanud oma võlakirjade riske krediidiriski vahetustehingutega (*credit default swap* – *CDS*), kuid vahetustehingute müüjate ebakompetentse riski hindamise tõttu ei suutnud need oma funktsiooni täita. Sellele vaatamata on pärast finantskriisi krediidiriski vahetustehingute turg ja võlakirjaturg jõudsalt kasvanud. Negatiivsete stsenaariumite kordumise vältimiseks peaksid investorid olema suutelised õigesti hindama võlakirjade alusvara krediidiriski. See on tähtis nii võlakirjaportfellide riskijuhtimiseks kui ka keskpankuritele, kellele annaks see täpsemat informatsiooni finantsturu hoiakute kohta.

Alusvara krediidiriskiga kursis olemise üheks põhjuseks on, et ei korduks finantskriisile eelnenud aastatel aset leidnud krediidiriski alahindamine. Krediidiriski alahindamise põhjustena saab välja tuua näiteks võlakirjade likviidsuse ja ettevõtte võlastruktuuri küpsuse vale hindamise. Seetõttu tuleks analüüsida investorite riskitaluvust pärast ülemaailmset finantskriisi. Võlakirjade krediidiriski marginaalide (samaväärsete korporatsioonide ja valitsuse võlakirjade tootluse erinevus) ja krediidiriski vahetustehingute marginaalide vaheline tugev side annab aluse investorite krediidiriski üle- või alahindamise uurimiseks. Ühelt poolt määravad krediidiriski hinnataseme pangad (krediidiriski vahetustehingud) ja teiselt poolt investorid (võlakirjad). Õige riski hindamine ei oma tähtsust mitte ainult investorite seas, vaid ka majanduses tervikuna. Märkimisväärsed erinevused krediidiriski taseme tajus võivad krediidikvaliteeti

mõjutavate sündmuste ajendil põhjustada erinevatele osapooltele suuri kahjusid, mida saaks vältida.

Käesoleva magistritöö eesmärgiks on leida tõendeid investorite krediidiriski alahindamise kohta, võrreldes hinnatud krediidiriski vahetustehingute marginaale tegelike krediidiriski vahetustehingute marginaalidega. Hinnatud krediidiriski vahetustehingute marginaalid on arvatud võlakirjade marginaalide põhjal, mis omakorda on oluline investori riskitunnetuse näitaja.

Eesmärgini jõudmiseks on püstitatud kuus uurimisülesannet. Järgnevad uurimisülesanded annavad kiire ülevaate käesoleva töö struktuurist ning aitavad jõuda töö eesmärgini. Uurimisülesanneteks on:

1. Anda võrdlev ülevaade kõrge ja madala reitinguga võlakirjadest;
2. Seletada lahti krediidiriski vahetustehingute kontseptsioon ja võrrelda krediidiriski vahetustehingute hindamise mudelid;
3. Võtta kokku krediidiriski marginaalide analüüsimise meetodid ja tulemused ning anda ülevaade investori krediidiriski alahindamise käsitlustest;
4. Anda ülevaade praegusest turusituatsioonist ja analüüsi kaasatud ettevõtetest;
5. Analüüsida hinnatud ja tegelikke krediidiriski vahetustehingute marginaale Põhjamaades kolme sektori lõikes;
6. Esitada kokkuvõtvalt analüüsi tulemused krediidiriski alahindamise kohta.

Analüüsi kaasatud 16 ettevõtet on kõik pärit Põhjamaadest: 8 Rootsist, 5 Soomest, 2 Norrast ning 1 Taanist. Need on jaotatud kolme erinevasse sektorisse: tööstusettevõtted, paberit ja tselluloosi tootvad ettevõtted ning kommunaalettevõtted. Analüüsis käsitletakse ajaperioodi jaanuar 2010 kuni märts 2015. Igal analüüsi kaasatud ettevõttel on vähemalt kolm eelnimetatud perioodil käibelolevat võlakirja. Võlakirjade ja krediidiriski vahetustehingute marginaalide andmed on saadud Bloombergi andmebaasist päevakaupa (k.a. nädalavahetused), mis teeb kokku 1913 võimalikku vaatlust iga võlakirja kohta.

Krediidiriski vahetustehing on riski ülekande eesmärgil põhinev tuletistehing kahe osapoole vahel. Krediidiriski vahetustehinguid ostavad võlakirjade investorid pankadelt,

et kaitsta end võlakirju emiteerinud ettevõtte pankroti või sarnase krediitkvaliteeti mõjutava sündmuse eest. Krediidiriski vahetustehingud on loonud likviidse turu krediidiriski ülekandeks ja kauplemiseks ning seetõttu omavad nad suurt väärtust ka majandusele tervikuna.

Töö põhiosa on jaotatud kaheks peatükiks: teoreetiline ja empiiriline. Teoreetiline osa koosneb kolmest alapeatükist, mis annavad ülevaate võlakirjadest, krediidiriski vahetustehingute hindamise mudelitest ja krediidiriski alahindamisest. Empiiriline osa kirjeldab turu hetkelist taustolukorda ja annab ülevaate töös käsitletud ettevõtetest. Lisaks sellele analüüsitakse aegriidide sektoritesisest kointegratsiooni ning esitletakse tulemused. Järgnevalt on välja toodud lühikesed ülevaated töö põhiosadest.

Esimene alapeatükk annab võrdleva ülevaate kõrge ja madala reitinguga võlakirjadest. Madala reitinguga võlakirju ehk rämpsivõlakirju, mille reiting on madalam kui BBB-, emiteerivad põhiliselt väiksema bilansimahuga või ebakindlas keskkonnas tegutsevad ettevõtted. Rämpsivõlakirjad on võrreldes kõrge reitinguga võlakirjadega (krediidireiting BBB- või kõrgem) väiksema emiteerimismahuga, madalama likviidsusega ning kannavad suuremat riski. Rämpsivõlakirjadesse investeringu teinud investoreid premeeritakse kõrgema tootlusega, et tasakaalustada kõrgemat alusvara maksejõuetuse riski. Lisaks on rämpsivõlakirjadel suurem tõenäosus muutuda mittelikviidseks ning marginaali volatiilsus on tunduvalt suurem. Tänu kõrgemale maksejõuetuse riskile on rämpsivõlakirjade emitendid sunnitud lisama võlakirjadele kitsendavaid tingimusi investorite huvide kaitseks.

Teisena seletatakse lahti krediidiriski vahetustehingute kontseptsioon ning võrreldakse nende hinnastamise mudeleid. Krediidiriski vahetustehingud, mille ülesandeks on krediidiriski ülekande investorilt pangale, avaldavad positiivset mõju võlakirju emiteerivatele firmadele. Nad suurendavad ettevõtte võlastruktuuri läbipaistvust, alandavad krediidiriski marginaale ja tõstavad volatiilsust. Eriti just firmade puhul, kes emiteerivad võlakirju esmakordselt. Krediidiriski vahetustehingute hinnastamiseks on teaduskirjandus välja pakkunud kaks peamist mudelit: struktuuriline ja taandatud vormi mudel. Struktuurilised mudelid eeldavad, et ettevõttel tekib maksejõuetus, kui selle varade väärtus langeb allapoole kindlat taset. Taandatud vormi mudelid mõõdavad

krediidiriski peamiselt maksejõuetuse tõenäosuse ja pankroti puhul investorile hüvitatava määra kaudu.

Järgmisena analüüsitakse krediidiriski marginaale (*credit spread*) ning antakse ülevaade krediidiriski alahindamise käsitlustest. Teaduskirjandusest selgub, et krediidiriski vahetustehingute marginaalide ja võlakirjade marginaalide vahel on märgatav seos, mida enamasti juhivad krediidiriski vahetustehingute marginaalid. See tähendab, et krediidiriski vahetustehingute marginaalid suudavad muutusi krediidiriskis peegeldada palju täpsemalt ja kiiremini kui korporatsioonide võlakirjade marginaalid. Teisisõnu on krediidiriski vahetustehingute marginaalid krediidiriski olulised mõõdikud.

Empiirilise osa esimene alapeatükk kirjeldab praegust turusituatsiooni ning annab ülevaate analüüsi kaasatud ettevõtetest. Kolme kuu Euribor pole kunagi nii madalal olnud, mistõttu on võlakirjaturul tekkinud vastuoluline olukord. Kolme kuu negatiivsed intressimäärad euroalas, Rootsis ja Taanis on esile kutsunud situatsiooni, mis teeb võimalikuks ujuva intressigamääraga võlakirjade negatiivse tootluse. Seega teoreetiliselt peaks investor maksma ettevõttele või valitsusele võlakirjade omamise eest. Reaalselt pole vastupidises suunas makseid Põhjamaades veel toimunud. Analüüsis on ettevõtted jaotatud kolme sektorisse (tööstusettevõtted, paberit ja tselluloosi tootvad ettevõtted ning kommunaalettevõtted), kaasatud on eelnimetatud ettevõtete 440 võlakirja, mille lõputähtaeg on hilisem kui jaanuar 2010.

Töö viiendas alapeatükis analüüsitakse hinnatud ja tegelikke krediidiriski vahetustehingute marginaale kolme sektori lõikes. Esiteks kirjeldatakse krediidiriski vahetustehingute marginaalide hindamise mudelit, tuues välja hindamise protsessi sammud ja valemid. Seejärel tõendatakse Phillips-Perroni testiga aegridades ühikjuure olemasolu, mis on üheks eelduseks kointegratsioonianalüüsi läbiviimiseks. Kointegratsiooniseosed ilmnesid kõikide sektorite puhul: paberit ja tselluloosi tootvate ettevõtete ja kommunaalettevõtete puhul kogu valimi lõikes ning tööstusettevõtete puhul kahe osavalimi lõikes. Pärast seda analüüsitakse neid seoseid vektori veaparandusmudeliga, et modelleerida aegridade statsionaarseid suhteid. Vektori veaparandusmudeliga leitud koefitsiendid näitavad, kuidas on kõrvalekalded hinnatud ja tegelike krediidiriski vahetustehingute marginaalide pikaajalistes suhetes mõjutavad tegelike marginaalide kõverat järgmisel perioodil.

Viimases alapeatükis teostatakse hinnatud ja tegelike marginaalide graafikute põhjal tulemuste ülevaade. Analüüsi tulemusena võib kinnitada, et perioodil jaanuar 2010 kuni märts 2015 leidis Põhjamaades aset investorite krediidiriski alahindamine. Analüüsi tulemuste kohaselt esineb krediidiriski alahindamist järgnevatel juhtudel:

- Tööstusettevõtetes (vahemikus jaanuar 2010 kuni juuli 2011), kus laienev krediidiriski marginaal tähistab võlakirjaturu krediidiriski alahindamist võrreldes krediidiriski vahetustehingute turuga;
- Tööstusettevõtetes (vahemikus jaanuar 2013 kuni märts 2015), kus investorid märgatavalt alahindavad krediidiriski, kuigi nende marginaalide järk-järguline ühinemine perioodi lõpu poole näitab märke riskitunnuse ühildumisest;
- Paberit ja tselluloosi tootvates ettevõtetes (alates 2012 keskpaigast), kus on suhteliselt konstantne krediidiriski taju erinevus võlakirja- ja krediidiriski vahetustehingute turu vahel. See vihjab mõningasele investorite pikaajalisele krediidiriski alahindamisele võrreldes pankade poolt krediidiriski vahetustehingute turu hinnastatud riskitasemega.

Lisaks krediidiriski alahindamisele leitakse tõendeid ka krediidiriski ülehindamisest kommunaalettevõtete sektori puhul. Hinnatud ja tegelike krediidiriski marginaalide üha laienev vahe alates 2012 keskpaigast näitab, et võlakirjaturg ülehindab natuke krediidiriski taset võrreldes krediidiriski vahetustehingute turu hinnastatud riskitasemega.

Käesolevas magistritöös leitud tulemused saaksid aidata Põhjamaade võlakirjadesse investeerivatel investoritel paremini mõista võlakirja- ja krediidiriski vahetustehingute turu arengut aastatel 2010 kuni 2015 kolmes sektoris: tööstusettevõtted, paberit ja tselluloosi tootvad ettevõtted ja kommunaalettevõtted. Lisaks sellele võivad tulemused aidata investoritel teha võlakirjade puhul paremaid investeerimisotsuseid. Nimelt tuleks investoritel vältida alahinnatud krediidiriskiga sektoreid, nagu seda on tööstusettevõtete ning paberit ja tselluloosi tootvate ettevõtete sektor. Investeerimisotsuseid tehes tuleks eelistada ülehinnatud krediidiriskiga sektoreid, nagu seda on kommunaalettevõtete sektor. Investorite erinevat riskitaluvuse taset silmas pidades asetsevad tööstusettevõtted ja kommunaalettevõtted samas reitingukategoorias. Seega kui investoril oleks valida võlakirjade ostuks eelnimetatud kaks sektorit Põhjamaades, soovitaks autor teha

võlakirjainvesteeringud kommunaalteenustesse, kuna sealne ülehinnatud krediidirisk pakub soodsamat võlakirjade tootluse ja maksejõuetuse tõenäosuse suhet.

Töö piirangutena toob autor välja planeeritud lühema analüüsiperioodi, kuna vahemikus 2005 ja 2010 on Põhjamaade võlakirjade marginaalide andmestik puudulik. Samuti on selles vahemikus Põhjamaades emiteeritud võlakirjade maht tunduvalt väiksem, kui seda on viimase viie aasta jooksul.

Tulevased tööd selles vallas võiksid kaasata analüüsi suurema arvu sektoreid, mis võimaldaks anda parema ülevaate Põhjamaade võlakirjaturust ja ajaloolisest krediidiriski tasemest. Alternatiivina võiks keskenduda ainult ühele sektorile ja viia läbi süvaanalüüs võrdluses sama sektoriga Lääne-Euroopas, kus saaks krediidiriski analüüsimisel arvesse võtta ka iga olulise finantsturgu mõjutanud sündmuse. See võimaldaks teostada võrdleva analüüsi investori riskitunnetuse kohta kahes Euroopa regioonis.

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