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School of Economics and Management

THE LINK BETWEEN EQUITY RETURNS AND CDS SPREADS IN SUB-INVEST GRADE COMPANIES

-A study of the European iTraxx indices

Supervisor:
Måns Kjellsson

Authors:
Peter Dreijer
Magnus Töndevold

Abstract

Title:	**T**he Link Between Equity Returns and CDS Spreads in Sub-Investment Grade Companies - *A study of the European iTraxx indices*
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Authors:	Peter Dreijer Magnus Töndevold
Advisor:	Måns Kjellsson
Key words:	Credit default swap index, iTraxx, Equity index return, CDS spread, Merton's model, Sub-investment grade
Purpose:	The purpose is to investigate whether the correlation between equity returns and changes in CDS spreads is stronger for sub-investment grade companies than for investment grade companies in the European iTraxx indices.
Method:	CDS spreads and the equity returns for the companies represented in the iTraxx indices are monitored over a period of approximately six years. The nature of the study is quantitative and the approach is deductive. Equity indices are constructed based on average returns for the companies represented in the iTraxx indices and compared to corresponding CDS spreads by simple linear regression to uncover potential correlations.
Empirical foundation:	The data collection, comprised by the iTraxx indices and corresponding equity indices, is imported into the statistical programs SPSS and Minitab, which are used to perform the statistical analyses.
Theoretical perspectives:	The theoretical selection presents the theories and research articles that have shaped the construction of the hypothesis.
Conclusions:	The research has found significant correlation between equity return and changes in CDS spreads in iTraxx Europe and iTraxx Crossover. However, we have not been able to prove that the correlation is stronger for sub-investment grade companies than for investment grade companies, since no correlation was found when analyzing iTraxx Crossover.

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Peter Dreijer
peter.dreijer@gmail.com

Magnus Töndevold
magto527@gmail.com

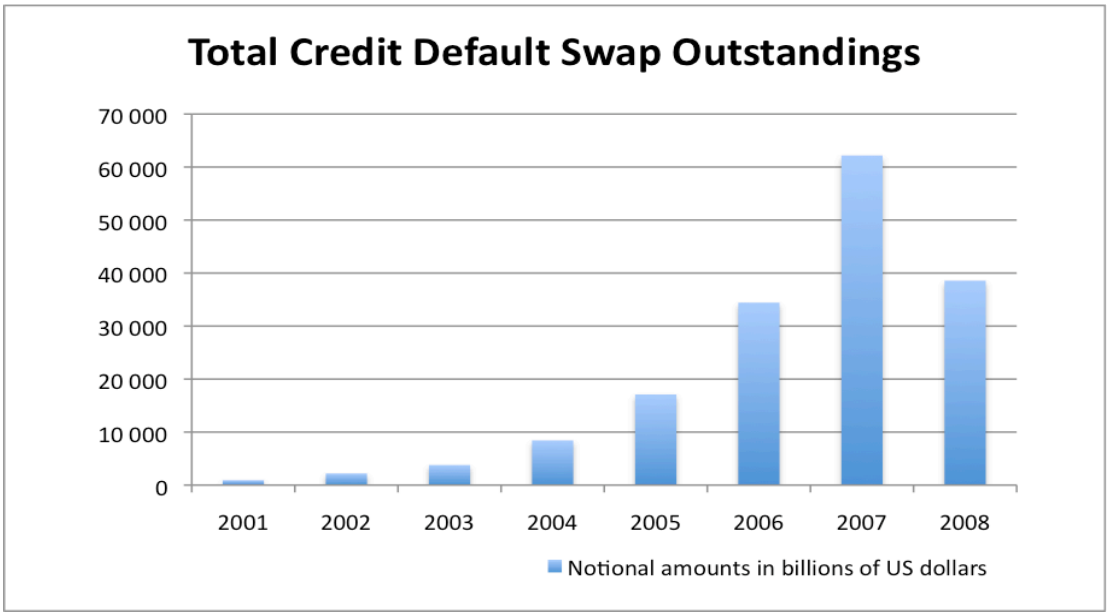
1 INTRODUCTION

In this first chapter we present the background that awoke our interest in conducting this study. We explain the purpose of the study and present our problem discussion, where we also position our work to earlier studies. We also explain our delimitations in carrying out the study.

1.1 BACKGROUND

Credit Default Swaps or CDS contracts are one of the most important developments regarding financial market instruments during the last two decades. These instruments allow investors to trade and hedge credit risk on single name companies and indices in a way previously impossible. The growth of such markets during the last years has been tremendous. In 2001, the notional value of total credit default swaps outstandings was USD 919 billion but in 2007, the amount had grown to a staggering USD 62 173 billion. In 2008, however, following the impact of the financial crisis, the value had decreased to roughly USD 38 564 billion (www.isda.org).

Exhibit 1.1



Source: www.isda.org

A market of this size and growth is bound to raise questions and the CDS instrument has become much discussed and debated since it concerns speculating in assets that you potentially do not own. For example, in the 2002 annual report of Berkshire Hathaway Inc, Warren Buffet stated in the letter to the shareholders his opinion that credit derivatives are:

> *"[...] financial weapons of mass destruction, carrying dangers that, while now latent, are potentially lethal."* (Berkshire Hathaway Inc., Annual Report 2002, p. 15)

The prohibition of variants of such instruments is now being suggested in both Europe and the USA (Kopecki & Harrington, 2009-07-24)(Moshinsky & Kirchfeld, 2010-03-11). It has also induced academic research regarding the impact and influence of the credit market on the equity market and vice versa.

Credit risk, which basically is the foundation when it comes to pricing CDS contracts, is the risk of loss of principal or interest due to a borrower's failure to repay a loan or otherwise fall short under the contractual obligations (www.freddiemac.com). It arises when a borrower uses future cash flows to repay current debt, i.e. through different types of loans. Creditors who are willing to assume this risk are compensated through interest payments from the borrower (www.investopedia.com). Credit risk is not a new concept, though. It has been around since the beginning of commerce when merchants suspected that their counterparts could default on their obligations. The academic research on the correlation between credit risk and equity is, however, a fairly new field of study. Earlier studies and the results of these will be presented in coming sections.

During the last two decades credit derivatives have become one of the major sources for banks and institutions for handling credit risk with an aggressive rise during the last decade. Since the introduction of the Basel accords, which are a number of regulations on bank supervision that specifies the minimum capital requirements for banks and institutions with the goal of securing liquidity (www.bis.org), banks can easily use credit derivatives to shift credit risk to a third party without selling the underlying reference entity, hence improving the economic capital ratios (www.riksbank.com). These relatively new instruments offer creditors an entirely new degree of flexibility when dealing with credit risk (Culp, 2006).

Credit derivatives are tradable contracts whose value is linked to the credit status of a specific company or a pool of companies and they have been available since 1992 (www.credit-

deriv.com). The most popular instruments in the credit derivatives family are Credit Linked Notes, Collateral Debt Obligations, other portfolio protection products and Credit Default Swaps. The development of these instruments has transformed a relatively small market in the 1990's in to a multi trillion-dollar market in 2010. The use of these contracts has been transformed during the last decade and especially after the dot.com crash of 2001, up until to the credit crisis we are currently facing (Culp, 2006).

The use of credit derivatives has also increased dramatically during this period, and not only due to the BASEL 1 and 2 accords, but also due to new instruments for hedging and speculation purposes. The size of the credit default swap market is estimated to USD 25 trillion in 2010 out of the much larger total value of the over-the-counter derivative market, commonly referred to as the OTC market, which is estimated to an amount of USD 605 trillion world wide (www.nasdaq.com).

Since the credit market has played a major role in the recent financial crisis with all of its repercussions on the equity market, it is clearly evident that a thorough understanding of the link between the two is imperative for anyone engaged in risk management, hedging, speculating, trading or arbitrage deals in the CDS market.

For the reader, it is important to have a clear notion of what a CDS is, in order to fully comprehend the components of this study. It is also important to be familiar with the various indices studied in the process of making this study. As such, a brief presentation of the credit default swap and the iTraxx indices is given in coming sections.

1.1.1 Credit Default Swaps

The most actively traded credit derivative is the single name credit default swap, or CDS, single name indicating that they have one single reference entity. Even though it carries the name swap, the CDS is more similar to an option where the contract pays off in the event of a default on the underlying reference entity, usually a bond. In some cases CDS contracts are also traded with a loan as reference entity (Culp, 2006).

As stated earlier the CDS market has grown rapidly over the past decade, despite being an OTC market as opposed to an exchange-traded market where most options and futures are traded and cleared. Even so, the CDS market has proven to be relatively liquid (Culp, 2006).

The single name CDS more or less functions in the same way as a credit insurance or a financial guarantee where the seller of credit protection receives fixed payments, often quarterly, for assuming the credit risk of the underlying reference entity. In the event of default, the seller makes a payment to the protection buyer equal to the notional amount. Depending on if the CDS is cash or physically settled, the seller will either receive the underlying reference in exchange for cash or simply pay the difference between the notional and market value at default (Culp, 2006).

The pricing of CDS contracts, or credit derivatives in general is based on the probability of default for the reference entity in the future, usually 3, 5 or 10 years. There are CDS contracts currently trading on reference entities without outstanding debt e.g. sovereigns such as Norway where pricing is based on other factors. For companies with publicly traded equity the pricing of the CDS is usually done with data from the financial markets as well as credit ratings. Probably one of the most well known approaches of calculating these probabilities using equity market information is the Merton model, further discussed in coming sections. (Byström, 2005).

1.1.2 The iTraxx Indices

Since different variants of iTraxx indices are one of the main sources of data in this study, this section will briefly present and describe this index family. In 2004, the merger between the CDS indices iBoxx and Trac-x took place and Dow Jones iTraxx was constructed. This has created a more liquid marketplace where it is easier to buy credit protection on a portfolio of underlying entities. The index is managed by the International Index Company, IIC, which is owned by Markit, a UK market data vendor (www.finextra.com). IIC is also responsible for licensing market makers.

The iTraxx indices consist of index products covering regions of Europe, Australia, Japan and non-Japan Asia. There are also different indices for entities characterized by investment grade or high yield. For Europe there is iTraxx Europe, which represents the top 125 names in terms of CDS volume traded in the last six months. This index is also the most liquid and the reference entities are chosen through a poll of dealers based on the volume traded over the past six months. iTraxx Europe HiVol, later referred to as iTraxx HiVol, represents the top 30 highest spread names in iTraxx Europe and iTraxx Europe Crossover, later referred to as iTraxx Crossover, represents exposure to 50 European sub-investment grade entities (www.indexco.com).

These indices allow investors to transfer credit risk in a more efficient way rather than grouping single name CDS contracts. The contracts within the iTraxx indices are standardized and exchange traded as opposed to single name CDS contracts, and the underlying reference entities constitute a fixed composition of CDS contracts with similar characteristics (www.eurobondline.com).

1.2 PROBLEM DISCUSSION

Credit derivatives have become an extensive market which plays a great role in managing credit risk for banks, especially now under the new Basel 2 accord. The major players in the credit derivatives market include banks, brokers, asset managers, hedge funds as well as non-financial corporations. Banks are by far the biggest seller of credit protection and in 2003, banks accounted for 80% of the market (Culp, 2006).

The link between the CDS market and the equity market is a relatively new field of research. When investigating this link, one must keep in mind that the CDS is an instrument that primarily deals with the downside of an underlying entity. To some extent, there have been earlier studies conducted on the link between CDS spreads and equity. These studies have looked at the link between CDS spreads and equity returns as well as volatilities in the iTraxx market (Byström, 2005) and the relationship between Asian sovereign credit default swap markets and equity markets (Chan, Fung & Zhang, 2008). Hafer and Dnes (2008) researched the relationship between CDS spreads and equity market volume and volatility with respect to credit events for single name CDS's within CDX.NA.IG Index. The Bank for International Settlements has published a working paper explaining CDS spreads with equity volatility and jump risks of individual firms (Zhang, Zhou & Zhu, 2008).

However, earlier studies have not been able to show that the correlation between the credit market and the equity market is as strong as theoretically suggested by Merton (1974). Based on his work, it is reasonable to expect a strong correlation since both debt and equity can be considered as contingent claims on a firm's underlying assets. Testing of this hypothesis has been carried out by many, some of them mentioned in the previous paragraph. Another example is Collin-Dufresne, Goldstein and Martin (2001), who investigated the correlation between monthly changes in credit spreads and equity returns. When it comes to the particular relationship between CDS spreads and equity returns in iTraxx Europe, Byström (2005)

shows upon a negative correlation, however low, and points out that there are tendencies that the CDS spread decreases as equity price moves up and vice versa.

When it comes to pricing CDS contracts, the most important factor is the probability of default of the underlying entity and according to Merton's model this probability should be correlated to the equity valuation of the same entity as well as the equity return volatility (Byström, 2005). This implies that there should be a higher correlation between debt and equity for high-yield firms, for which the default probability is higher. Hence, in theory there should be a greater negative correlation between equity returns and CDS spreads for sub-investment grade firms than investment grade firms. Due to this relationship we believe that the CDS spreads will tighten when equity returns increase, and vice versa. This relationship should also prove greater for companies with high debt loads such as the firms represented in iTraxx Crossover.

Moving on, we have found studies that seek to answer the question as to why previous researchers have found it difficult to empirically prove the strong correlation suggested by Merton (1974). Such a study is currently being carried out by Kapadia and Pu (2010), who use factors such as limits to arbitrage, informational sensitivity and risky debt to explain the low correlation of previous studies. As they see it, a greater amount of risky debt leads to an underlying entity becoming more informationally sensitive, which impacts on the limits to arbitrage across equity and credit markets. They expect the link between credit and equity to grow stronger as debt becomes more risky.

This brings us to the core of this study, whether it is possible to prove that the correlation between equity returns and changes in CDS spreads is stronger for sub-investment grade companies than for investment grade companies.

We will test this by investigating the link between iTraxx Europe and the reference equity returns as well as conducting a study of iTraxx Crossover in order to see whether there is a higher correlation between changes in CDS spreads and equity returns for sub-investment grade companies, since they are characterized by a higher amount of risky debt. We have also chosen to investigate a middle-point, concerning the riskiness of the instrument through the use of iTraxx HiVol.

In order to conduct this analysis we will build three indices based on the equity of the reference entities in iTraxx Europe, iTraxx HiVol and iTraxx Crossover. The entities in

iTraxx Europe are 125 investment grade companies. iTraxx HiVol constitutes the 30 names with the highest spreads in iTraxx Europe prior to the roll and the Crossover index is based on 50 sub investment grade companies. To our knowledge, we are the first to investigate the correlation between these three indices and their reference equity as well as conducting a comparison analysis of these three iTraxx indices.

We believe this study to be interesting due to the possibility of validating the theories of Merton's model, regarding equity and debt correlation, on a relatively new credit market.

1.3 PURPOSE

The purpose is to investigate whether the correlation between equity returns and changes in CDS spreads is stronger for sub-investment grade companies than for investment grade companies in the European iTraxx indices.

1.4 DELIMITATIONS

This study aims to test the differences in correlation, due to variations in amount of risky debt, between investment grade and sub-investment grade companies. Our intent is to conduct a consistent and coherent study and as such, limitations must be introduced because of the time factor and also the extent of the study.

First and foremost, we have been forced to make delimitations due to the non-existence of various data. For example, we have used CDS indices and not over-the-counter contracts since information regarding the latter has proven difficult if not impossible to acquire. Furthermore, the time-period examined begins in 2004 and this is also a result of the supply of data since iTraxx was introduced in 2004. We have also chosen not to focus on other geographical markets than Europe or to differentiate among business sectors. The first delimitation is a result of choosing iTraxx Europe as our subject of research and the reason as to why we choose not to look at different sectors, e.g. like Byström (2005) is that we which to investigate if the link is stronger for sub-investment grade companies on an overall level, regardless of business sector. In order to focus on our core issue we have also decided not to include occurrence of arbitrage as a variable in our statistical analysis even though it is much discussed in related studies.

2 METHOD

This chapter describes the overall methods as well as the specific approach used to conduct the study. The purpose of the chapter is to provide a more thorough understanding of the various decisions made when carrying out the study, and also to clarify how the data has been interpreted and processed.

2.1 OVERALL APPROACH

A structured and well-defined study requires coherent planning in terms of method. Our intention in the coming sections is to outline the options available and also motivate our chosen method.

2.1.1 Deductive Method

It is of course imperative to decide upon a method that is suitable for the purpose and problem definition that is being examined. We have chosen a quantitative procedure, further discussed in the next section, and we believe the deductive method to be the most suitable for this study. The principle of a deductive approach is a study in which an initial assessment is made to uncover the present scientific knowledge on the subject and to present already existing theories. These theories are subsequently applied to a specific empirical issue (Jacobsen, 2002). Our intention is thus to initially examine the current theoretical aspects on the correlation between changes in CDS spreads and equity returns and then to gather the empirical data, consisting of a large number of equity price observations and CDS spreads.

It is, however, imperative to keep in mind that in such a study, it can be difficult to attain pure and objective knowledge, since the individual conducting the analysis chooses preferences and variables from theories that seem relevant to the author (Jacobsen, 2002). Even if the person considers himself to be open-minded to the fact that reality can differ from theory,

there can still be preconceived perceptions about how the reality should appear. The potential result of this can be loss or absence of certain empirical data, giving the study a lower quality.

Through processing the observations of equity returns and CDS spreads in iTraxx Europe, iTraxx HiVol and iTraxx Crossover, our hope is to find statistical evidence of a stronger correlation between equity returns and changes in CDS spreads in high-risk markets. The next task is to try analyze our statistical results in relation to existing theories, hopefully providing new insights and further knowledge on the subject. Our method when making observations and processing these is further discussed in the coming sections of this chapter.

An alternative approach that has been considered in the process of conducting this study is the inductive method, which is executed in the opposite way. The method is characterized by an initial gathering of empirical data, which is subsequently interpreted with the purpose of forming a new theory on the subject, or to add contributions to already existing theories. This procedure is preferably conducted before gathering substantial amounts of theories. An all too extensive theoretical framework can potentially hinder new and innovative thoughts and ideas, intentionally or unintentionally making the study proceed in a certain direction (Bryman & Bell, 2005)

2.1.2 Quantitative Approach

The quantitative approach, which is the one we have chosen to use, is suitable when having a problem definition of an extensive character and a procedure that implies testing. In such a case, the intention is to perform a broad study by examining a large number of observations or units, but with fewer angles or features (Jacobsen, 2002). Since this thesis is a study over time, with a large number of observations, our method is hence quantitative. Focus will be placed on finding and evaluating statistical results that correspond to our assumptions.

An alternate process is the qualitative approach, which is based on an explorative problem definition and in which case a multifaceted depth study is performed, rather than a broad one. Such a study often includes fewer observations or variables and results are more open for interpretation (Rienecker & Jörgensen, 2002). In our opinion, such an approach would not be suitable for the study that we are conducting, since the connections that we are looking for are hard to find without a statistical examination with many observations, making qualitative measures inadequate.

2.1.3 Reliability and Validity

Having a high level of reliability means that examinations and calculations are done according to recognized rules and methods. Through implementing a quantitative statistic process, executed in a regular fashion, factors such as subjectivity are hence minimized. The data is allowed to speak for itself. Total objectivity is on the other hand hard to achieve since the data used is chosen by a person. The general principle, however, is that the study must be able to be replicated, giving the same result in another similar survey. Another aspect is that of random errors. When handling large quantities of data, random errors can occur in number of ways, namely:

- Through misprint in information derived from various sources
- Through mistakes when feeding the data
- Through imperfect handling of the data and/or errors in calculations and formulas

It is, however, our intention to always be observant of such errors and regularly control data and calculations to minimize such risk, even though it is impossible to guarantee the total absence of it (Bryman & Bell, 2005).

Validity concerns the authenticity and relevance of the empiric data (Jacobsen, 2002). There are a number of criteria used when assessing the quality of a study. Firstly, there is the level of what is referred to as theoretical validity. This means that the study must be focused on the phenomenon one wishes to examine (Bryman & Bell, 2005). Furthermore, the criteria of internal validity must be met. This refers to the correctness of causal relationships between two or several variables. To put it in a more illustrative way, one must be sure that the change in variable Y really is a result of a change in variable X, not the other way around and not due to another external variable.

Concerning this study, we have, for example, experienced a fall-off of data in most series of the iTraxx Crossover index. However, we focus on establishing a high validity by crosschecking the regressions through various methods, further discussed in coming sections of this chapter and in Chapter 4.

2.2 PRACTICAL PROCEDURE

2.2.1 Quantitative Data Analysis

Our procedure is composed of three sections; gathering of data, constructing indices, analysis and interpretation of the results. In this part of the chapter, we will explain further how these sections are practically executed.

2.2.1.1 Collection of Data

In conducting this study, gathering and making compilations of various types of data has been required. The CDS data is gathered from the Bloomberg Terminal where we have been able to get daily closing spreads for 5-year CDS spreads concerning iTraxx Europe, iTraxx HiVol and iTraxx Crossover. The companies included in iTraxx Europe are mostly large international corporations with their equity traded on the market. There are, however, exceptions such as Vattenfall AB, a Swedish public sector company. The index also includes some companies subject to mergers or acquisitions during recent years as well as private companies financing themselves through the capital market, hence they have outstanding bonds but no traded equity. This leads to a certain degree of fall-off of data. For iTraxx Europe, the fall-off is, however, never greater than 5,6%, but the average fall-off for the entire time series is approximately 4%. For iTraxx HiVol the same ratio has an average of 3%. If one is to compare with similar studies, such as Byström (2005), this is significantly less. On the other hand, when it comes to iTraxx Crossover, the same ratio is considerably higher, due to a greater amount of privately owned companies. Depending on which roll, the fall-off ranges from 0% to 33%, with an average of approximately 20%.

Most of the equities of the underlying entities are traded in Euros, even though there are exceptions. The equities that are traded in other currencies have been converted into Euros using appropriate daily exchange rates retrieved from Thomson Reuters Datastream.

The indices roll every six months, shifting underlying entities based on their situation, and the entities represented in the index are decided through a dealer poll. Information regarding underlying entities included in different time periods from 2004 until today was gathered from the Markit website where historical index compositions are stored (www.markit.com).

Moreover, we have gathered data in the form of daily closing equity price observations for the firms represented in the different indices. We have then constructed three rolling equity

indices based on the reference entities in iTraxx Europe, iTraxx HiVol and iTraxx Crossover, further discussed in the next section. The equity data has been gathered from Thomson Reuters Datastream. The time period that is investigated in this study is between June 22, 2004 and March 19, 2010. Since the introduction of the iTraxx dates back to 2004, it is not possible to further extend the time period of this study. We do, however, consider the period to be sufficient since the substantial amount of data gives us an adequate statistical selection.

Furthermore, since the constructed equity index for iTraxx Crossover contains shortcomings due to the fall-off, we have also chosen to study the first series of iTraxx Crossover separately to investigate whether the fall-off in other rolls affects the statistical results considerably. This series, for which there is no fall-off, represents the time period between 2004-06-22 and 2004-09-17.

Finally, we have also chosen to look at certain aspects of liquidity in the iTraxx indices mainly through Fitch Liquidity Scores on Reuters 3000 Xtra. Our analysis has been conducted by gathering individual liquidity scores for all entities incorporated in the indices and creating an overview of their dispersion in order to get a rough estimate of the liquidity in the different indices and the potential difference among iTraxx Europe, iTraxx HiVol and iTraxx Crossover. This has been done in order to evaluate whether liquidity differences could potentially be a factor when it comes to differences in correlation between the CDS spreads and equity returns.

2.2.1.2 Constructing Indices

The iTraxx indices are based on different entities, which are rolling every 6 months, and the entities are determined through a dealer poll based on volume traded for each entity. As mentioned before, iTraxx Europe is based on the most liquid 125 CDS contracts referencing European investment grade credits. The iTraxx Hivol index is based on the 30 entities of iTraxx Europe with the highest spreads i.e. the entities with the highest perceived risk out of the 125 companies included in the iTraxx Europe index. Itraxx Crossover on the other hand is constructed in a similar way but it is built using 50 European sub investment grade credits.

We have used the historical schedules for each roll when constructing our equity indices. This means that each index is based on 12 rolling indices of 6 months each. We have constructed our equity indices based on the same entities and “rolled” it every 6 months. For iTraxx

Europe, this gives us a data set of daily closing quotes for 125 equities for a 6 year period which rolls every 6 months. This means that the iTraxx Europe equity index is constructed from approximately 2,250 million observations. We have then built an index for each roll where the equity returns have been equally weighted, as they are in the iTraxx indices. These 12 rolls have later been put in a following time series, which has given us a rolling equity index for June 2004 until March 2010. This procedure has been repeated for the three CDS indices used in this study, and also for the fourth index based on the first roll of iTraxx Crossover.

2.2.1.3 Analyzing Data

To conduct the analysis of the gathered data, we have chosen to use SPSS and Minitab, since we have some previous experience of working with these programs and we also have access to guidance literature in the event of any uncertainty.

Regression Analysis – The type of regression used in this study is simple linear and the equation for this can be defined as follows:

$$\Delta CDS\ spreads_t = \alpha + \beta \cdot \%\,Equity\ returns_t + \varepsilon_t \qquad (2.1)$$

where α represents the intercept estimate and β represents the coefficient estimate. The residual, ε_t, shows the deviation from the expected value $\alpha + \beta\,\%Equity\ returns$ at time *t* (i.e. from the regression line) and is also a random variable with the expected value of zero. The value that the residual assumes for a certain character can be interpreted as the total effect of other factors influencing $\Delta\,CDS\ spreads$ (Körner & Wahlgren, 2000). It should also be mentioned that $\Delta\,CDS\ spreads$, as according to equation (2.1), is the dependent variable and that *%Equity returns* is the independent variable.

Correlation Analysis – As a complement, a correlation analysis will be performed in SPSS for the main indices, further explained in Chapter 4, in which Pearson's method will be applied since this estimates the "customary" correlation coefficient, also known as the product-moment correlation coefficient (Wahlgren, 2008).

2.3 CRITICISM OF SOURCES

2.3.1 Criticism of Statistical Selection and Data

When gathering extensive amounts of data, one must always prepare for a certain fall-off, due to imperfect of fragmentary access to information.

We encountered some fall-off mainly while creating the iTraxx Crossover index. The primary reason for this is that these companies do not have listed equity but they do finance themselves through the debt markets and thus have traded bonds. In order to account for this, we have also analyzed the first series of iTraxx Crossover where there was no fall-off which gives us a complete selection.

Another aspect that was discussed in the process of conducting this study is the liquidity of various CDS indices. Attempts have been made to retrieve historical data regarding the liquidity of these. However, we have only been able to find information on this concerning the present situation through Fitch Liquidity Scores. It should also be mentioned that this information is not in the form of data, leaving us only with the ability to draw logical, and potentially subjective conclusions on the subject.

2.3.2 Criticism of Articles and Literature

An important aspect when conducting a study such as this is first and foremost the reliability of the sources of information that are examined. Secondly, the information must be relevant and consistent with the purpose of the study. The sources referred to in the first part of the introductory chapter primarily focus on attracting attention and creating an interest. These references are thus not used as sources when it comes to constructing a theoretical hypothesis and do not affect the outcome of this study. We are well aware that for working papers, such as Kapadia & Pu (2010) the results are still not published and acknowledged. Otherwise, the reference literature and articles used for the methodical and theoretical sections in this study come from highly recognized and recommended authors and researchers and we consider our sources in this case to be highly reliable.

3 Theory

In this chapter we present the theories and models that we consider relevant and valuable to our study. We also motivate the relevance of these theories to the continuous work of this thesis.

3.1 SELECTING THEORETICAL APPROACH

As mentioned earlier, this study is carried out with a deductive method. The purpose of this chapter is hence to present the theoretical background that has led to our hypothesis and overall purpose. The link between equity and CDS markets, and the factors that impact the strength of this link, is a relatively new field of study. When it comes to the choice of theories in this thesis, one can also see that there is a more empirical approach in recent studies.

3.2 MERTON'S MODEL

In our research, we have found several articles that state some kind of relation between credit and equity pricing. One of the very first and prominent studies to investigate this was Merton (1974). His model, which in effect is initiated from the Black-Scholes option-pricing model (Byström, 2003), defines the credit risk as the default probability of an entity. He also looks upon a firm's equity as a call option on its assets where the firm has an amount of zero coupon debt that will come due at a future time, T. If the assets are valued at less than the debt the company will default. The firm's equity is viewed as a call option on the assets with maturity at time T and the strike price of the option is valued equally to the notional of the debt (Hull, Nelken & White, 2004). Furthermore, Merton shows that the risk associated with the debt of a firm can never be greater than the risk associated with the firm as a whole. As a consequence, the risk associated with the equity of a levered firm can never be smaller than the risk associated with the firm as a whole, see Exhibit 3.1 (Merton, 1974).

Exhibit 3.1

This relationship indicates that there should be a correlation between credit and equity markets, since the two of them are closely linked (Kapadia & Pu, 2010). Merton's model is important to this study since it theoretically suggest the correlation that we are attempting to prove for sub-investment grade companies.

3.3 CREDIT DEFAULT SWAPS AND EQUITY PRICES

Byström (2005) studies the specific relationship between credit default swaps and equity prices, where he investigates the correlation between equity returns and the iTraxx Europe index including the seven sector indices of iTraxx Europe: industrials, autos, energy, technology media and telecom (TMT), consumers, senior financials and subordinated financials. Byström also investigates the time lag and auto-correlation within iTraxx Europe as well as the link between equity volatilities and CDS spreads.

Byström (2005) draws his theories from Merton's model on the link between equity and debt and presents some early evidence of the correlation between the two markets. The study reveals significant correlation between iTraxx CDS spreads and equity returns and that CDS spreads tends to tighten when equity returns rise, and vise versa. The results are similar for all sectors with one exception, which is that the study found a higher correlation between equities and the subordinated financials CDS index than for the senior index. This also connects to our study since we are investigating the correlation for sub-investment grade companies. Byström believes that this result is due to the fact that subordinated CDS contracts acts more like equity due to their status in the pecking order hierarchy.

Other findings consist of indications that the CDS markets react more strongly to worsening credits than improvements, compared to the equity markets. This conclusion is drawn from the observation that the largest positive jumps in CDS spreads, i.e. increasing spreads, can be up to ten times as large as corresponding equity returns from day-to-day. This is not always the case for the most extreme negative day-to-day movements when comparing the two markets (Byström, 2005).

Byström(2005) also finds inefficiencies within iTraxx Europe since all sector indices demonstrate positive autocorrelation i.e. one historical observable pattern will likely be repeated in the future, which potentially could lead to large profit opportunities for market participants. Further, if firm specific information, especially private information, is not priced into the equity and CDS market simultaneously a time-lag between the two will become evident. The study also finds that firm specific information is priced into the equities before the CDS markets, which creates a time-lag between the two markets. This is another example where Byström points out inefficiencies within the CDS markets.

3.4 LIMITS TO ARBITRAGE, RISKY DEBT & INFORMATIONAL SENSITIVITY

Kapadia and Pu (2010) conduct a study, which attempts to explain the imperfections of Merton's model and why the market does not act as theoretically described, i.e. equity and credit markets being highly correlated. They do, however, have an original and new approach to the problem. As customary, they reflect upon the results of earlier studies, e.g. Byström (2005) who finds indications of the CDS spreads increasing as equity prices move down, and then take this one step further. They carry out a study in which they state, with reference to Merton (1974), that one should consider it reasonable to expect a strong correlation between credit and equity markets. There is a tight theoretical connection between the two since both bonds and equity can be viewed as conditional claims on a company's assets. Hence, a changing equity return should also be reflected in the credit spreads.

Further on, the authors argue that earlier studies have come up with surprisingly low correlation in their results and try to explain this with the level of occurrence of arbitrage opportunities or limits to arbitrage. The general idea is that arbitrageurs, engaged in credit-equity deals, seldom enters into markets with a low degree of risky debt, since such a market calls for substantial noise trading and equity price fluctuations to have the similar effect on the bond price. As debt becomes more risky, the underlying entity of a CDS contract becomes more informationally sensitive, fluctuating more easily, and the private and specialized knowledge of the arbitrageur becomes highly relevant and conclusive.

The authors also argue that another key factor, when looking at limits to arbitrage is the liquidity of both equity and credit markets. Illiquidity in a market increases limits to arbitrage since the perceived profits appear smaller or out of reach. They also state that the co-movement of equity and CDS spreads becomes more similar to theory as time-horizon

increases and that co-movement for sub-investment graded firms, on average, also is closer to theory to some extent.

To summarize this line of arguments, the authors state that a larger amount of risky debt leads to a higher level of informational sensitivity. This will increase perceived profits, leading to fewer limits to arbitrage. An increase in arbitrage activity will subsequently force the two markets together. In other words, the authors find that the credit and equity markets to become more correlated as debt or equity becomes more risky and informationally sensitive (Kapadia & Pu, 2010).

3.5 HYPOTHESIS

Based on the theory and research articles examined in this study, our hypothesis is that:

> *The correlation between equity returns and changes in CDS spreads is stronger for sub-investment grade companies than for investment grade companies.*

4 Empirical Study

This chapter presents the results of the empirical study, based upon the statistical processing of the publicly obtained data.

4.1 DESCRIBING DATA

Before presenting the outcome of the statistical analysis, it is beneficial to have an overall knowledge about how to interpret the results and what information is given in the tables. The results presented in this chapter is a summary based on various regression and correlation models which are further discussed later in this chapter.

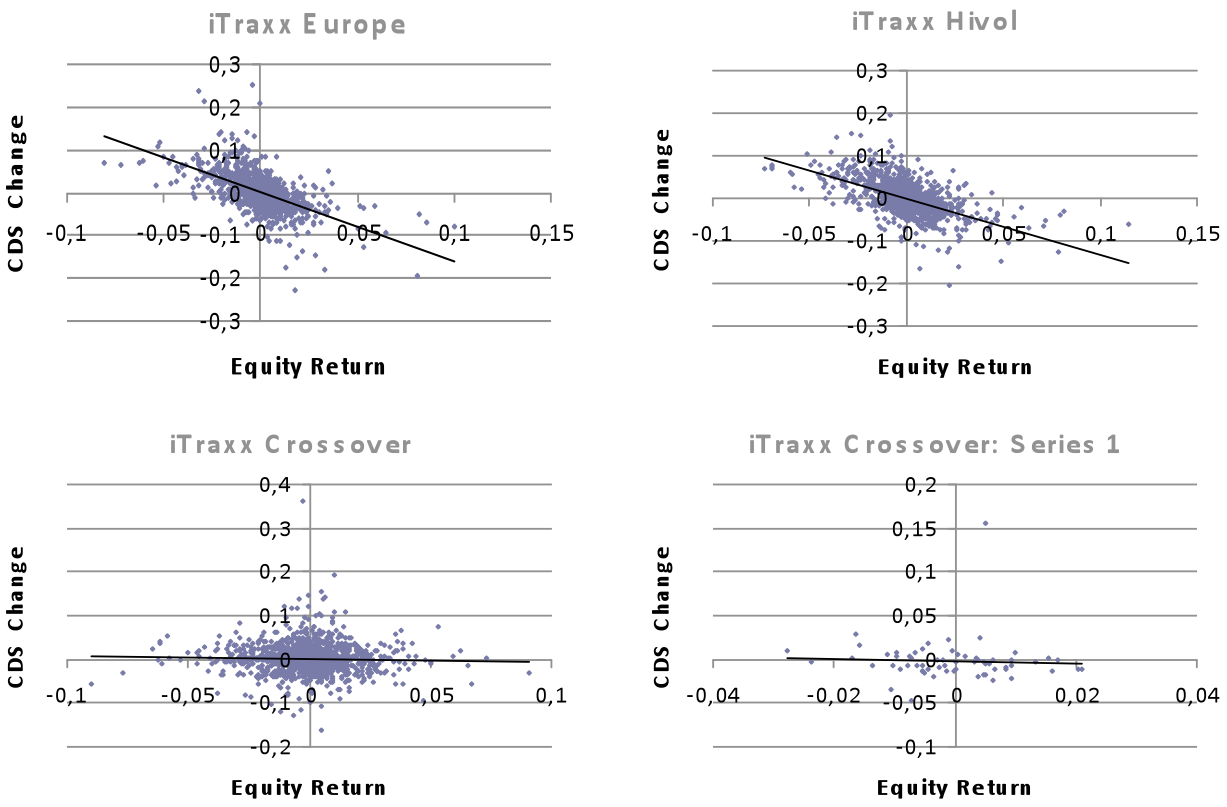
Linear Regression: In a linear regression, a linear equation is fitted to the observed data with the purpose of modeling the relationship between two variables. In doing so, one tries to display a relationship of causality where an independent variable, or predictor, affects a dependent variable (www.stat.yale.edu: 1). In this study, we have used ΔCDS spreads as the dependent variable and %Equity returns as the independent variable since we want to analyze how equity returns affect the CDS spreads in the different iTraxx indices. The formula for the single linear regression used in this study is according to equation (2.1).

Correlation Analysis: The correlation analysis quantifies the extent to which changes in one variable are associated with changes in the other (www.stat.yale.edu: 2). As shown in Exhibits 4.2-4.5, as well as in the scatter plot diagrams, we have found a significant correlation between equity returns and changes in CDS spreads in iTraxx Europe and iTraxx HiVol. We have not found any significant relationship between the two in iTraxx Crossover or iTraxx Crossover: Series 1.

Scatter Plot: The scatter plot graph is used to discover associations between two variables used in a regression model. The graph helps to visualize the relationship between two sets of data (www.stat.yale.edu: 3), in our case, %Equity returns and ΔCDS Spreads. The two data sets in iTraxx Europe and iTraxx Hivol have a negative relationship, i.e. a negative slope, which indicates a negative correlation between equity returns and changes in CDS spreads. This is not observed in our study of iTraxx Crossover for which we have not found a

significant relationship, see Exhibit 4.1.

Exhibit 4.1



4.2 CORRELATIONS AND REGRESSIONS WITH CDS CHANGE AS DEPENDENT VARIABLE

This section presents and describes the results of the regression and correlation analyses, which are conducted on the data gathered for changes in CDS spreads and equity returns. In addition to the analyses made on the three original indices, we also present the analysis on the first roll of the otherwise imperfect iTraxx Crossover index. Hence, the distribution is as follows:

- Analysis 1: iTraxx Europe
- Analysis 2: iTraxx HiVol
- Analysis 3: iTraxx Crossover
- Analysis 4: iTraxx Crossover: Series 1 & Series 1-2

With reference to Byström's (2005) discussions regarding a time lag on the CDS market, we have also made corresponding regressions with both one, two and three days lag for the CDS data on all indices, including iTraxx Crossover: Series 1. Furthermore, also with reference to

Byström (2005), who states that possibility of positive CDS spread jumps being more severe than negative jumps in relation to the underlying equity, we have also conducted individual regressions where positive and negative movements have been separated. This will allow us to observe possible differences in correlation between positive and negative jumps. Since it seems reasonable to expect that positive movements occur more frequently and strongly for sub-investment grade companies, due to the constant risk level, these regressions are only conducted for iTraxx Crossover in attempting to explain the non-existence of correlation in this very index. Due to the earlier mentioned fall-off in this index, we have also performed such a regression individually on the series 1-2 combined, for which the fall-off consist of only one underlying reference equity. The reason as to why we chose both series 1 and 2 is that there would be an inadequate number of observations if we were to run the regressions on only series 1.

The time span of our data collection is rather vast, from 2004 to 2010, and in order to take this time aspect into consideration, we have conducted additional regression for all individual series for all indices, i.e. twelve series for every index. This will allow us to see how the correlation changes over time and which years account for the strongest correlation. Further, this is also done in order to see if any of the twelve series in iTraxx Crossover demonstrate any correlation.

In order to determine whether liquidity could be a factor of impact to the correlation between equity returns and CDS spreads we have used the Fitch Solution Liquidity Scores on Reuters 3000 Xtra. By comparing the distribution of the liquidity scores between iTraxx Europe, iTraxx HiVol and iTraxx Crossover we will be able to see if there is any major differences as well as draw some rough conclusions on whether liquidity could be a factor determining the correlation between equity returns and CDS spreads for iTraxx Crossover.

The liquidity model is based on several factors such as the number of market participants, bid-ask spread levels, dispersion of mid-quotes across dealers as well as CDS quotes. The model is updated daily based on closing CDS mid and bid-ask quotes and the model also includes different variables that incorporate the market's view of liquidity (Reuters 3000 Xtra). The formula is summarized as follows:

$$Liquidity\ Score = Function\left[Inactivity\ On\ Name,\ Bid - Ask\ Spread, Spread - Dispersion\right] \quad (4.1)$$

It is however important to be aware of the fact that these estimates only represent the liquidity for one day, namely 2010-05-20. This is why we use the estimates merely as indications of historical liquidity and not as empirical evidence when further discussing liquidity as an impacting factor on correlation.

4.2.1 iTraxx Europe

The first regressions are conducted on changes in CDS spreads for iTraxx Europe and the average percentage return of the equity for the companies represented in iTraxx Europe. The number of observations in the regressions varies, since the lag reduces the amount with one for every lag day. The regressions for the individual series are also fewer due to the reduced number of business days in the selection. The regression is conducted according to equation (2.1), and the results are presented in Exhibit 4.2.

Exhibit 4.2

iTraxx Europe					
Series specification	**Pearsons Corralation**	**R-square**	**P-value**	**Residual Variance**	**No of observations**
All Series: No lag	-0,583	33,9%	0,000	2,966%	1485
All Series: 1 days lag		0,3%	0,031	3,644%	1484
All Series: 2 days lag		0,0%	0,897	3,651%	1483
All Series: 3 days lag		0,1%	0,198	3,651%	1482
Series 1		8,9%	0,017	1,304%	64
Series 2		23,5%	0,000	1,272%	129
Series 3		29,9%	0,000	2,528%	130
Series 4		19,5%	0,000	0,873%	128
Series 5		40,8%	0,000	1,485%	131
Series 6		36,0%	0,000	1,482%	127
Series 7		42,8%	0,000	4,636%	131
Series 8		41,4%	0,000	4,042%	129
Series 9		46,5%	0,000	4,064%	134
Series 10		53,9%	0,000	2,803%	123
Series 11		40,7%	0,000	2,447%	130
Series 12		49,1%	0,000	2,101%	129

As shown in Exhibit 4.2, the regression results for all series without any lag is presented in the first row. This shows that the Pearsons Correlation coefficient for the entire selection is -58,3% and that the coefficient of determination, R-square, is 33,9%. This implies that the equity returns correlate negatively with the changes in CDS spreads at a 58,3% basis. The coefficient of determination shows that 33,9% of the total variation for the changes in CDS spreads is explained by the association with equity returns. The residual variance is 2,966% and describes the dispersion around the regression line. The correlation is also highly significant, as the P-value is 0,000.

When looking at the regressions with a time lag, Exhibit 4.2 shows that there is no or very little correlation when compensating for either one, two or three days, allowing us to disregard the time lag factor for iTraxx Europe.

Furthermore, when examining the results for the individual series, it shows that the correlation grows stronger during the second half of all series. The strongest correlation, with an R-square of 53,9%, is found in Series 10, whereas the weakest correlation, with an R-square of 8,9%, is found in Series 1. It should be mentioned, though, that Series 1 contains fewer observation since it only represents three months.

4.2.2 iTraxx HiVol

The second group of regressions is conducted on changes in CDS spreads for iTraxx HiVol and the average percentage return of the equity for the companies represented in iTraxx HiVol. The regression is conducted according to equation (2.1), and the results are presented in Exhibit 4.3.

Exhibit 4.3

iTraxx HiVol					
Series specification	Pearsons Corralation	R-square	P-value	Residual Variance	No of observations
All Series: No lag	-0,578	33,4%	0,000	2,795%	1485
All Series: 1 days lag		0,8%	0,000	3,411%	1484
All Series: 2 days lag		0,0%	0,414	3,426%	1483
All Series: 3 days lag		0,0%	0,635	3,428%	1482
Series 1		12,4%	0,004	1,499%	64
Series 2		19,4%	0,000	1,368%	129
Series 3		30,5%	0,000	2,850%	130
Series 4		17,6%	0,000	1,021%	128
Series 5		33,0%	0,000	1,710%	131
Series 6		36,9%	0,000	1,557%	127
Series 7		39,1%	0,000	3,832%	131
Series 8		35,4%	0,000	3,700%	129
Series 9		38,6%	0,000	3,878%	134
Series 10		52,1%	0,000	2,958%	123
Series 11		36,3%	0,000	2,650%	130
Series 12		48,9%	0,000	2,287%	129

As shown in Exhibit 4.3, the regression results for all series without any lag is presented in the first row. This shows that the Pearsons Correlation coefficient for the entire selection is -57,8% and that the coefficient of determination, R-square, is 33,4%. This implies that the equity returns correlate negatively with the changes in CDS spreads at a 57,8% basis. The coefficient of determination shows that 33,4% of the total variation for the changes in CDS

spreads is explained by the association with equity returns. The residual variance is 2,795% and describes the dispersion around the regression line. The correlation is also highly significant, as the P-value is 0,000.

When looking at the regressions with a time lag, Exhibit 4.3 shows that there is no or very little correlation when compensating for either one, two or three days, allowing us to disregard the time lag factor for iTraxx HiVol.

Similar to the individual series for iTraxx Europe, the correlation in iTraxx HiVol grows stronger during the second half of all series. The strongest correlation, with an R-square of 52,1%, is found in Series 10, whereas the weakest correlation, with an R-square of 12,4%, is found in Series 1. However, as for all indices, Series 1 includes fewer observations.

4.2.3 iTraxx Crossover

The third group of regressions is conducted on changes in CDS spreads for iTraxx Crossover and the average percentage return of the equity for the companies represented in iTraxx Crossover. The regression is conducted according to equation (2.1), and the results are presented in Exhibit 4.4.

Exhibit 4.4

iTraxx Crossover					
Series specification	Pearsons Corralation	R-square	P-value	Residual Variance	No of observations
All Series: No lag	-0,030	0,1%	0,241	3,131%	1485
All Series: 1 days lag		0,0%	0,516	3,133%	1484
All Series: 2 days lag		0,0%	0,774	3,135%	1483
All Series: 3 days lag		0,0%	0,997	3,136%	1482
Series 1		0,3%	0,691	2,407%	64
Series 2		0,4%	0,472	4,325%	129
Series 3		1,0%	0,251	3,352%	130
Series 4		4,2%	0,020	2,026%	128
Series 5		0,5%	0,446	2,438%	131
Series 6		0,4%	0,495	2,839%	127
Series 7		0,0%	0,917	4,254%	131
Series 8		0,3%	0,571	3,077%	129
Series 9		0,0%	0,885	3,163%	134
Series 10		0,8%	0,330	3,378%	123
Series 11		1,6%	0,149	2,625%	130
Series 12		0,2%	0,574	2,494%	129
All Series: Positive CDS Change		0,0%	0,901	2,786%	670
All Series: Negative CDS Change		0,0%	0,928	1,877%	809
All Series: Positive Equity Change		0,1%	0,508	3,006%	764
All Series: Negative Equity Change		0,0%	0,931	3,282%	707

As shown in Exhibit 4.4, the regression results for all series without any lag is presented in the first row. This shows that the Pearsons Correlation coefficient for the entire selection is -3,0% and that the coefficient of determination, R-square, is 0,1%. This implies that the equity returns correlate negatively with the changes in CDS spreads at a 3,0% basis. The coefficient of determination shows that 0,1% of the total variation for the changes in CDS spreads is explained by the association with equity returns. The residual variance is 3,131% and describes the dispersion around the regression line. The correlation is however not significant, as the P-value is 0,241, which is greater than 0,1.

When looking at the regressions with a time lag, Exhibit 4.4 shows that there is no correlation when compensating for either one, two or three days, allowing us to disregard the time lag factor for iTraxx Crossover.

While looking at the individual series, it shows that none of them demonstrate any significant correlation, except Series 4, which has an R-square of 4,2% and is significant as the P-value is 0,020.

As mentioned earlier, we have also looked at positive and negative returns separately for iTraxx Crossover. The results, however, do not display any evidence for the correlation being stronger for either positive or negative jumps, whether it be jumps in equity returns or CDS spreads.

4.2.4 iTraxx Crossover: Series 1 & Series 1-2

The fourth group of regressions is conducted on changes in CDS spreads for iTraxx Crossover: Series 1 and Series 1-2, and the average percentage return of the equity for the companies represented in these series of iTraxx Crossover. The regression is conducted according to equation (2.1), and the results are presented in Exhibit 4.4. These regression are conducted as a complement in order to validate the results from regressions on the entire collection of data for iTraxx Crossover.

Exhibit 4.5

iTraxx Crossover: Series 1					
Series specification	Pearsons Corralation	R-square	P-value	Residual Variance	No of observations
No lag	-0,051	0,3%	0,691	2,407%	64
1 days lag		1,0%	0,446	2,412%	63
2 days lag		0,3%	0,657	2,439%	62
3 days lag		2,6%	0,212	2,431%	61

iTraxx Crossover: Series 1-2					
Series specification	Pearsons Corralation	R-square	P-value	Residual Variance	No of observations
Positive CDS Change		0,0%	0,985	4,649%	76
Negative CDS Change		0,0%	0,934	1,777%	117
Positive Equity Change		0,0%	0,921	3,033%	103
Negative Equity Change		0,3%	0,638	4,510%	90

As shown in Exhibit 4.5, the regression results for Series 1 without any lag is presented in the first row. This shows that the Pearsons Correlation coefficient for the entire selection is -5,1% and that the coefficient of determination, R-square, is 0,3%. This implies that the equity returns correlate negatively with the changes in CDS spreads at a 5,1% basis. The coefficient of determination shows that 0,3% of the total variation for the changes in CDS spreads is explained by the association with equity returns. The residual variance is 2,407% and describes the dispersion around the regression line. The correlation is however not significant, as the P-value is 0,691, which is greater than 0,1. With the information retrieved from this analysis we can thus say that the fall-off in iTraxx Crossover does not seem to impact on the result considerably.

When looking at the regressions with a time lag, Exhibit 4.5 shows that there is no significant correlation when compensating for either one, two or three days, allowing us to disregard the time lag factor for iTraxx Crossover: Series 1.

Furthermore, when looking at positive and negative return separately for iTraxx Crossover, the results do not display any evidence for the correlation being stronger for either positive or negative jumps, whether it be jumps in equity returns or CDS spreads.

4.3 iTRAXX LIQUIDITY MEASUREMENTS

As mentioned earlier, theory suggest that the liquidity of the CDS market can be an impacting factor when measuring the correlation between changes in CDS spreads and equity returns. Since historical data has proven difficult to retrieve, we have looked at recent liquidity

measurements in order to obtain an insight to the liquidity in the market. These measurements have been retrieved from Reuters 3000 Xtra and are stated to have been estimated according to equation (4.1).

As shown in Exhibit 4.6, all indices demonstrate a fairly high grade of liquidity on the date of observation. When looking at the distribution of entities, one can see that most of them account for high or very high liquidity in all indices. iTraxx HiVol is the index that clearly stands out, with 100% of the entities within the scale of very high liquidity. Moreover, one can also see that a greater percentage within iTraxx Crossover accounts for very high liquidity than in iTraxx Europe. In Exhibit 4.7, the distribution is presented in a bar graph that illustrates the percentage share of each liquidity group. However, drawing conclusion regarding historical correlation based on these recent liquidity measurements is hardly recommendable. What we can say is that the correlation for the last series, given that this high liquidity applies for this, is more or less as weak as for the first series, indicating that liquidity does not appear to impact on the correlation considerably.

Exhibit 4.6

Distribution based on Fitch Liquidity Scores

iTraxx Europe

Liquidity	Distribution of Entities
Very High	35,2%
High	48,0%
Medium	16,0%
Low	0,8%
Very Low	0%

Source: Reuters 3000 Xtra, 2010-05-20

iTraxx HiVol

Liquidity	Distribution of Entities
Very High	100%
High	0%
Medium	0%
Low	0%
Very Low	0%

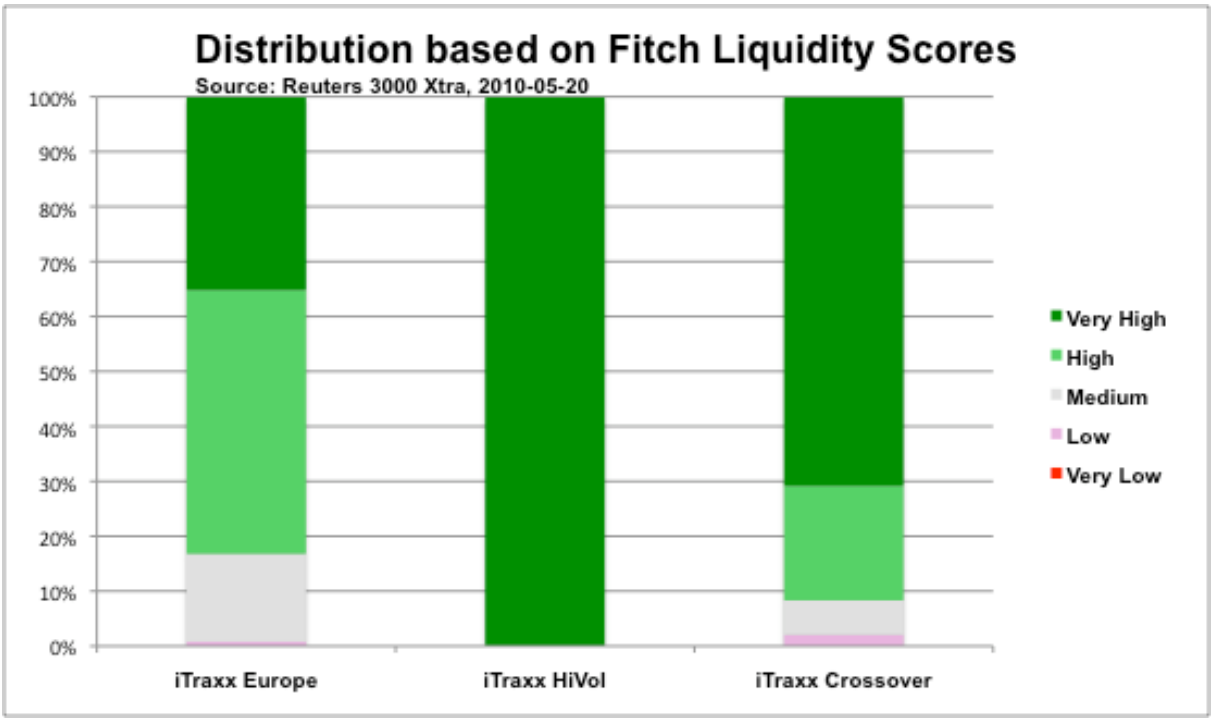
Source: Reuters 3000 Xtra, 2010-05-20

iTraxx Crossover

Liquidity	Distribution of Entities
Very High	70,83%
High	20,8%
Medium	6,3%
Low	2,1%
Very Low	0%

Source: Reuters 3000 Xtra, 2010-05-20

Exhibit 4.7



5 Analysis

This chapter covers, interprets and discusses the empirical results presented in earlier sections.

This study started of with the aim of investigating the relationship between debt and equity. After reading various relevant research reports on the subject, we noticed that most researchers founded their hypothesis based on Merton's model. Since research articles investigating Merton's model argue that high-risk debt correlates more closely to equity, we wanted to investigate this relationship on the more liquid credit markets of today where more data is available. The CDS market hence seemed to be an appropriate subject, since it is still represents a fairly new field of research.

In order to conduct our analysis, we chose to compare the high-risk market i.e. iTraxx Crossover to the investment grade index iTraxx Europe and using iTraxx Hivol as a middle point. We expected to find that the sub-investment grade CDS contracts would correlate more closely with their underlying equity than the investment grade entities. We based our theoretical approach on the results of Merton's model and various other studies on the subject. Even so, we believe this to be the first study conducting a comparison analysis of iTraxx Europe, Crossover and HiVol. We performed an empirical study in order to validate the model on the CDS markets and our results are discussed below.

5.1 RESULT DISCUSSION

The results of the statistical analysis gave us the insight that there is a significant correlation between changes in CDS spreads and equity returns for iTraxx Europe and iTraxx Crossover, which is also fairly consistent with the results of other studies, such as Byström (2005). The fact that the correlations, when comparing iTraxx HiVol and iTraxx Europe, are almost identical is however not surprising, since iTraxx HiVol represent a selection of firms, included in iTraxx Europe, that have the highest spreads in the index. On the other hand, the slightly lower correlation in iTraxx HiVol stands in contrast to the theory that higher liquidity

should induce a stronger correlation, since liquidity in this index has shown to be extremely high at the present. The situation in this case is, however, the same as previously mentioned, that the liquidity measurements are not in form of historical data, and can thus not be used to draw conclusion about the past. Even so, it can be used as an indication of liquidity, at least for the last series, and the results for the last series are consistent with the overall results when comparing iTraxx Europe and iTraxx HiVol. The recent liquidity measurements are also high for iTraxx Crossover, for which the correlation is also consistent, however low or non-existing, throughout the entire selection of series. According to these results, we find no evidence of liquidity being an impacting factor on the correlation between equity returns and changes in CDS spreads.

Furthermore, in the examination of iTraxx Crossover, we found no significant correlation (See Exhibit 5.1). Bearing in mind that our data concerning iTraxx Crossover was periodically affected by serious fall-off, we also conducted a second regression for the first series of the index, for which there was no fall-off. The intention in this case was to investigate whether the fall-off in other series affected the results considerably, thus providing a false reflection of the correlation. If the first series had shown a different result than the overall analysis, it would have been reasonable to question the original results, since the fall-off would have appeared to be a critical factor. This, however, was not the case since the analysis of the first series did not demonstrate any significant correlation, hence confirming that our previous results were correct and in fact represented the connection between changes in CDS spreads and equity returns for iTraxx Crossover.

Exhibit 5.1

Index	Pearson Correlation	R^2	P-value
iTraxx Europe	-0,583	0,339	0,000
iTraxx HiVol	-0,578	0,334	0,000
iTraxx Crossover	-0,030	0,001	0,241
iTraxx Crossover: Series 1	-0,051	0,003	0,691

5.1.2 Time lag aspect

We also explored the possibilities of a time lag, as suggested by Byström (2005), and made control regression with one, two and three days lag on the CDS spreads. The reason for such a time lag would be that specific information is suggested to be priced into equity earlier, and more efficient, than into the credit market, making the CDS spreads react more slowly. We

conducted these control regression for all three indices and also for the first series of iTraxx Crossover separately. However, none of the collections of data examined demonstrated any improvements in terms of higher significant correlation. Both iTraxx Europe and iTraxx Crossover retained a significant correlation with one days lag, but this correlation was significantly lower than the original. For iTraxx Crossover and iTraxx Crossover: Series 1, we found no significant correlation at all, when adjusting for the potential time lag factor. These results allow us to disregard the time lag factor, for all indices.

5.1.3 Individual Series

Since the time period of our data collection extends from 2004 until 2010, we also examined the differences in correlation between different series, in order to take this time aspect into consideration. We made separate regression for each individual series, which showed us how the correlation in the indices changed over time and which series that accounted for the strongest correlation. The result of this was that the correlation appeared to grow stronger in the second half of the series for iTraxx Europe and iTraxx HiVol, which is interesting since the second half is marked by more a severe business environment with decreasing liquidity and worsening credit worthiness among companies. This could be a reason for the increased correlation due to increasing risk aversion in the market, which could force a more correct pricing of CDS spreads. Even so, this is merely speculation.

For iTraxx Crossover, there was no significant correlation in any of the series except for Series 4, where a significant correlation, however low, was found. Nevertheless, we do believe that this result is subject to coincidence since this is not found in any of the other series.

To summarize, we found nothing that indicates that the relation between indices, in terms of differences in correlation, would be anything unlike our previous results.

5.1.4 Positive versus Negative Changes

With reference to the possibility of positive jumps in CDS spreads being stronger than negative movements, or recovery, in relation to the movements of the underlying equity, we conducted additional regressions where positive and negative movement were separated. This possibility, mentioned by Byström (2005), combined with the fact that debt holders generally

have more access to company information than equity holders, could have proven to be one reason as to why we do not see the same, or as strong, correlation for sub investment grade companies. Since iTraxx Crossover is an index for high risk credits, and in which the entities are updated every six months with the highest volume traded sub-investment graded firms, it makes sense to assume that positive spreads jumps occur more often than negative jumps, and thus making our results subject to these imperfections. We performed an analysis, regarding iTraxx Crossover, on positive and negative CDS spread changes with corresponding equity movements separately, and also positive and negative equity returns with corresponding CDS spread changes. Additionally, we performed an isolated analysis on iTraxx Crossover: Series 1-2, since we wanted to test this on a collection of data with little fall-off.

The result of this breakdown analysis showed that neither iTraxx Crossover nor iTraxx Crossover: Series 1-2 demonstrated any significant correlation with the underlying reference equity, which allows us to disregard the factor of positive versus negative jumps.

5.2 ANALYSIS SUMMARY

The hypothesis tested in conducting this study was that:

> *The correlation between equity returns and changes in CDS spreads is stronger for sub-investment grade companies than for investment grade companies.*

After having carried out multiple analyses, we haven not been able to prove that such is the case. However, since data concerning historical liquidity has proven unattainable, we can neither draw the conclusion that such is not the case. What we can state, is that the low correlation found in iTraxx Crossover, is not due to time lag, imbalance in positive versus negative spread jumps, or severe differences in individual time series.

6. Conclusion

This chapter connects the results to our purpose and presents the conclusions of the study.

The purpose of this thesis is:

To investigate whether the correlation between equity returns and changes in CDS spreads is stronger for sub-investment grade companies than for investment grade companies in the European iTraxx indices.

We believe this study to be interesting since the credit market has played a major role in the recent financial turmoil with all of its repercussions on the equity market. Understanding the link between the credit and equity markets is also interesting for anyone engaged in risk management, hedging, speculating, trading or arbitrage deals in the CDS market.

We have found significant correlation between equity returns and changes in CDS spreads for investment grade firms within the iTraxx Europe and iTraxx HiVol indices. We have also found that the correlation has increased over time, especially during the last half of the observed period, which stretches from June 2004 until March 2010.

We have not been able to prove any significant correlation between equity returns and changes in CDS spreads for sub-investment grade entities within the iTraxx Crossover index. We have performed regressions on the full selection of series, series by series as well as analysing positive and negative returns separately and we have not been able to empirically prove the theoretical foundation of our study that correlation between equity returns and changes in CDS spreads for sub-investment grade companies is stronger than for investment-grade companies.

We have also been able to discard the proposed factor that equity markets would react faster to changing market conditions than the CDS market, creating a time-lag between the two markets.

Other factors such as liquidity cannot be discarded, but we have found no evidence that differences in liquidity between the indices would strengthen or weaken the correlation between equity returns and CDS spread changes.

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