Företagsekonomiska institutionen
EKONOMIHÖGSKOLAN VID
LUNDS UNIVERSITET

Master Thesis, Finance
Business Economy
Fall 2008

The relationship between CDS spreads and bond spreads – an empirical comparison

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Sammanfattning

Examensarbetets titel: The relationship between CDS spreads and bond spreads – an empirical comparison

Seminariedatum: 2008-01-15.

Ämne/kurs: Företagsekonomi, finansiering, 15 p, Examensarbete på magisternivå.

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Handledare: Göran Anderson

Fem nyckelord: credit default swap, prissättning av kreditrisk, bond spread, arbitrage, kointegration

Syfte: Syftet är att undersöka sambandet mellan CDS-spreaden och bond-spreaden, samt att jämföra dessa över tid. Detta genomförs genom att testa för ett kointegrationssamband samt Granger-kausalitet mellan CDS-spreaden och bond-spreaden för varje enhet som ingår i urvalet, och för olika perioder. Också deskriptiv statistik används.

Metod: Kvantitativ metod: Augmented Dickey-Fuller test, KPSS, Engle-Granger test, Johansen-test, Granger-kausalitet

Teoretiska perspektiv: Prissättningsmodeller för kreditrisk. Arbitragesamband.

Empiri: Bond-spread och CDS-spread för 29 st företag (klassificerade som *financials*) från S&P 350 och S&P 500. Tidsperiod: 2004-01-01 till 2008-11-24.

Slutsatser: Undersökningen visar på att de undersökta företagens CDS- respektive bond-spread uppvisar varierande grad av kointegration under de olika tidsperioderna som undersökts. Därmed är det svårt dra några egentliga slutsatser av de tvetydiga resultaten. Däremot står det att finna i materialet att både den genomsnittliga CDS-spreaden, genomsnittliga bond-spreaden och den genomsnittliga skillnaden dem emellan ökar markant under undersökningens sista 17 månader, vilka är präglade av finansiell oro.

Summary in English

Title: The relationship between CDS spreads and bond spreads – an empirical comparison

Seminar date: 2008-01-15.

Course: Master thesis in business administration (finance), 15 University Credit Points (15 ECTS).

Authors: Carl-Johan Berggren & Nina Mattsson

Advisor/s: Göran Anderson

Five key words: credit default swap, credit risk pricing, bond spread, arbitrage, cointegration

Purpose: The purpose of the thesis is to investigate the relationship between the CDS spreads and bond spreads, and to compare this relationship over time. This will be performed through testing for a cointegration relationship and Granger causality between the CDS spread and bond spreads of the entities studied, for different time periods, combined with the aid of descriptive statistics. Also the change in CDS spread and bond spread over time will be studied.

Methodology: Quantitative method: Augmented Dickey-Fuller test, KPSS, Engle-Granger test, Johansen-test, Granger causality

Theoretical perspectives: Pricing models for credit risk. Arbitrage relationship.

Empirical foundation: The relationship between the bond spread and CDS spread for 29 corporates (classified as *financials*) from S&P 350 och S&P 500 are investigated. Time period: 2004-01-01 to 2008-11-24.

Conclusions: The tests shows that the CDS spread and the bond spread of the entities investigated exhibit various degrees of cointegration, during the different periods investigated. It is difficult to draw any specific conclusions from the ambivalent results. However, the material shows a higher average CDS spread, average bond spread, and average credit spread in the last app. 16 months of the period investigated, which are characterised by financial turmoil

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Glossary

Bond spread – the yield to maturity of a certain bond, minus the risk free rate (in this investigation the swap rate is used as a proxy for risk free rate).

CDS – Credit Default Swap. The most common type of credit derivate. Functions as an insurance to avoid the default risk of a bond issuer. Can be used for both hedging and speculation.

CDS spread – The price of the CDS, expressed in basis points of the contract's notional value.

CDS premium – see *CDS spread.*

CDS price – see *CDS spread*.

Credit event – the event that triggers the payment from the seller to the buyer of a CDS contract, for example default.

Credit spread – the difference between the *CDS spread* and the *Bond spread.*

Notional amount – the face value of the bond connected to a CDS contract. It can also relate to the amount covered by the CDS contract, in case it differs from the bond's notional value.

Reference entity – the issuer of the underlying bond in a CDS contract.

S&P 350 – Standard & Poor's index which contains 350 leading companies in Europe, spanning 17 exchanges. It is also a component of S&P Global 1200.

S&P 500 – Standard & Poor's index which contains 500 leading companies in leading industries of the U.S. economy. It is also a component of S&P Global 1200.

Introduction and Background

The background contains a description of the history and characteristics of Credit Default Swaps (CDSs). Thereafter some of the organisations influencing the documentation and clearing/settlement process will be presented. The background also provides a depiction of the development of the current credit crisis. The experienced reader may skip to the section of the problem discussion.

Credit Default Swaps

Credit Default Swaps were invented in the mid/late nineties and are derivative instruments based on underlying fixed income securities such as corporate or government bonds.[1] A CDS could be said to provide "insurance" against a credit event destroying value in an entity's (a corporation's or a financial institution's) debt, e.g. a bond. The buyer of the CDS pays a premium (usually quarterly or semi annually) over a fixed time period to the seller. These periodic payments are usually expressed as a percentage (in basis points) of the bond's notional value, and are called the CDS spread (or the CDS premium).[2] The payments are done either until the CDS contract matures, or a credit event occurs, i.e. the bond issuer can't fulfil its obligations (within the life of the contract). The credit events are defined in the documentation; see the section about ISDA for further examples. If such an event occurs, the seller of the CDS provides compensation to the buyer, who will suffer no loss.[3] Credit Default Swaps are privately negotiated contracts traded on over-the-counter markets, hence there is no exchange for CDSs.[4]

In the figure below, the cash flows for the buyer and seller of a CDS are shown (they are naturally inverted). As can be seen, the cash flows are comparable to the cash flows of the two parties in a normal insurance agreement.

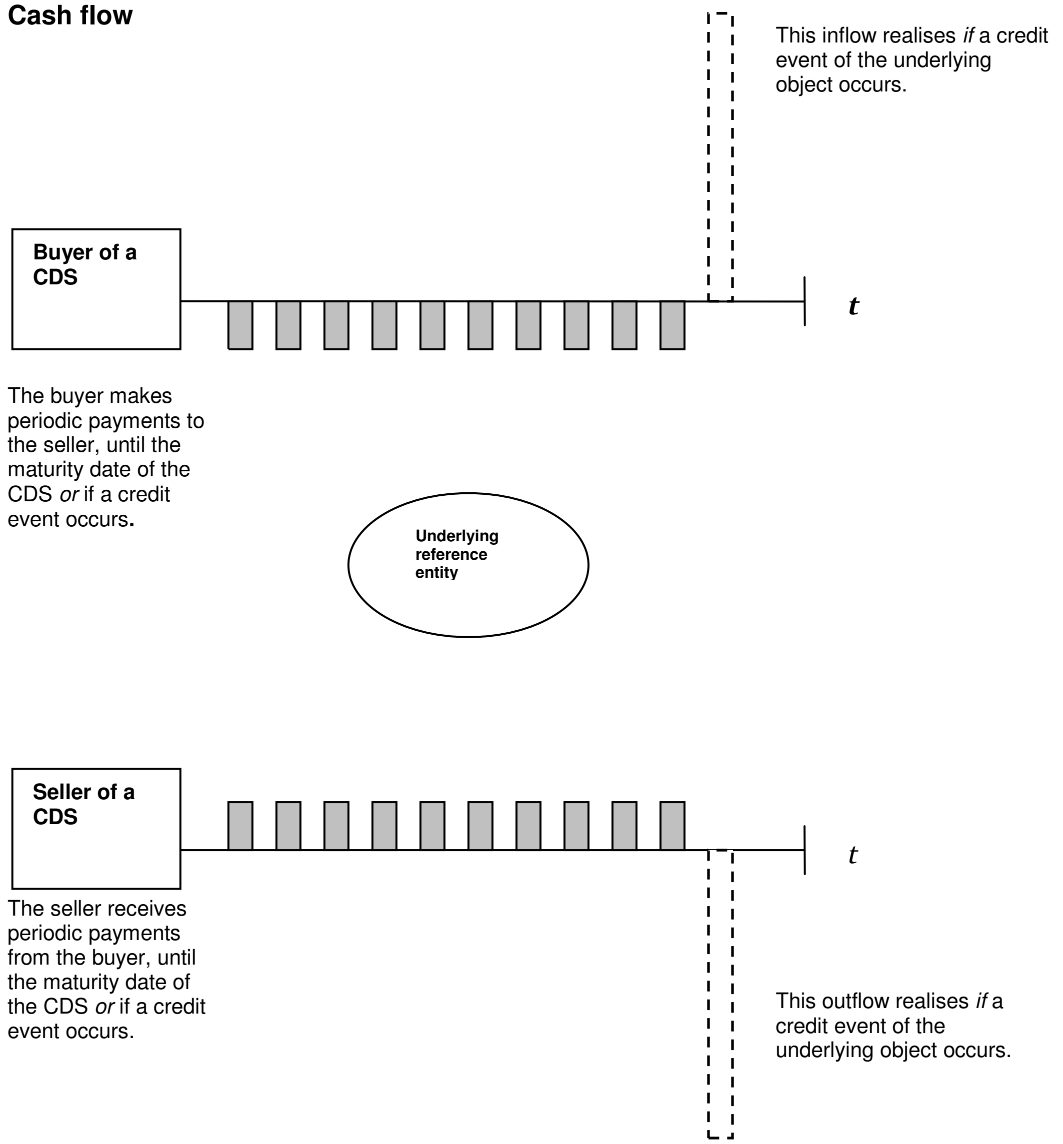
1 Berndt Antje; Jarrow, Robert A.; Kang, ChoongOh, "Restructuring risk in credit default swaps: An empirical analysis", Stochastic Processes and their Applications, 2007:11, p. 1724-1749. It should be noted that there are some different conceptions of the exact year for invention, but all sources state years between 1995 and 1997.

2 Zhu, Haibin "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235

3 Berndt et al "Restructuring risk in credit default swaps: An empirical analysis", Stochastic Processes and their Applications, 2007:11, p. 1724-1749.

4 "A Reuters guide to Credit Default Swaps", available at http://about.reuters.com/productinfo/s/credit_default_swaps/

Figure 1: Cash flows that arise from a CDS contract



The CDS could be seen as an insurance product, but with the difference that the buyer of protection is not obliged to hold the underlying asset (in this case normally a bond). The CDS makes it possible to separate the risk is from the underlying debt and transfer the credit risk from one party to another.[5] Hence, credit default swaps could be used both for hedging, as well as speculation.

The trade in the instrument has grown rapidly, almost exponentially. As an example, the notional amount outstanding of credit default swaps was $57.9 trillion in Q2 2008, compared to only $4.6 trillion end 2004.[6]

5 Chan –Lau, Jorge A. "Anticipating Credit Events Using Credit Default Swaps, with an Application to Sovereign Debt Crises", IMF Working Paper, May 2003 (WP/03/106)

6 "Regular OTC Derivatives Market Statistics", statistics from Bank of International Settlements (BIS), available at http://www.bis.org/publ/otc_hy0811.htm

If a credit event occurs, the contract could be settled either through *physical settlement* or *cash settlement*. If physical settlement is agreed upon, the buyer delivers the reference security, or an equivalent, to the seller and receives in return the notional value. If cash settlement is used, the buyer receives the difference between the par value of the reference instrument and the market value at the time of the default event occurring.[7]

The term "swap" derives from the view that the CDS could be seen as "a swap of a default-free floating-rate note for a defaultable floating-rate note".[8]

The market prices of the CDSs (CDS spread) should reflect market assessments of the likelihood of the credit event and the expected value of the reference security after the credit event.[9] The CDS spread thereby provides an alternative market price of credit risk.[10] In this sense, the instrument works as a key indicator of the credit quality of corporates, banks and sovereigns.[11]

As most terms and conditions of a CDS contract, also the maturity is negotiable, and the maturity for the CDS is not necessarily the same as for the reference entity. There are maturities from a few months up to 10 years, but most CDSs are quoted for a benchmark time-to-maturity of 5 years.[12]

CDSs are OTC-products (over-the-counter), hence there are no traditional regulated exchange markets for CDSs. However, the major part of all CDSs are cleared and settled through the organisation DTCC, please see description below.

Most contracts are based on ISDA documentation, see below.

ISDA

ISDA, the International Swaps and Derivatives Association, is the largest global financial trade association (by number of member firms), and represents participants in the privately negotiated derivatives industry. ISDA has developed documentation and international contractual standards governing privately negotiated derivatives transactions, and most of the largest market participants use ISDA's documentation e.g. "ISDA Master Agreement" as a legal base for trading of derivatives. According to this agreement there are six "credit events".[13]

Credit events according to ISDA:
Bankruptcy. The definition of bankruptcy includes insolvency events such as winding up, administration and receivership.

7 "CDS – Physical Vs Cash Settlement", Derivatives Week, January 16, 2006

8 Duffie, D, "Credit Swap Valuation" Financial Analysts Journal, 1999:1, p. 73-87.

9 Chan –Lau, Jorge A. "Anticipating Credit Events Using Credit Default Swaps, with an Application to Sovereign Debt Crises", IMF Working Paper, May 2003 (WP/03/106)

10 Zhu, Haibin "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235

11 Dötz, Niko, "Time-varying contributions by the corporate bond and CDS markets to credit risk price discovery", Discussion Paper: series 2: Banking and Financial Studies, no 08/2007, published by Deutsche Bundesbank.

12 Daniels, Kenneth N.; Jensen, Malene Shin, "The Effect of Credit Ratings on Credit Default Swap Spreads and Credit Spreads", The Journal of Fixed Income, 2005:12, vol. 15, p. 16-35.

13 2002 ISDA Master Agreement.

Failure to pay. This event covers the reference entity failing to make a payment of principal or interest. A minimum threshold amount is normally nominated in the confirmation that must be exceeded before this event is triggered.

Obligation acceleration. This event covers a reference entity's debt obligation being accelerated by reason of an event of default. A minimum threshold amount is normally nominated in the confirmation that must be exceeded before this event is triggered.

Obligation default. This event covers the reference entity defaulting on one of its debts obligations.

Repudiation/moratorium. This event covers the reference entity repudiating all or some of its debts or declaring a moratorium over all or some of its debts.

Restructuring. This event covers the reference entity arranging for some or all of its debts to be restructured causing a material adverse change in their creditworthiness.

These events are "triggers" for the CDSs, as described above, in the sense that when one of these occurs, the seller's obligation to compensate the buyer is realized. However, since CDSs are not publicly traded, there are no obligations to publicly present information about when a credit event has occurred.

DTCC

The Depository Trust & Clearing Corporation (DTCC) provides clearing and settlements of a wide range of financial products, including CDSs. In November 2006 an electronic central registry for credit default was established by DTCC, where the vast majority of credit default swaps traded is registered. To meet market concerns of transparency, DTCC has recently decided to publish the outstanding gross and net notional values of CDSs, with effect from 2008-11-04.[14] This will hopefully improve information availability for future research.

Credit Crisis (of 2007–2008)

The current credit crisis is also referred to as the "credit crunch" and its full effect is probably not yet seen. Naturally, from a scientific perspective it is difficult to define an exact start date of the crisis. Still, 9 August 2007 is often referred to as a pivotal date[15], since it is the day that the European Central Bank injected 95 billion Euros into the European market, and the Federal Reserve injected 24 billion USD in the American market.[16] But let us start from the beginning. (The description below is based on Kashyap et al[17], and Milne[18], which are both in line with the general view of the course of events.)

14 "DTCC to Provide CDS Data from Trade Information Warehouse", Press release from DTCC, 31 Oct, 2008.

15 See for example: "Timeline: Global Credit Crunch", BBC News, updated November 14, 2008 , "Credit crisis - how it all began", Guardian.co.uk, August 15, 2008, or Tett, Gillian,"The big freeze: A year that shook faith in finance", Financial Times, August 3, 2008

16 "Kadoya, Tamawa Fed's $24 bln money shot pales against ECB move", Reuters August 9, 2007

17 Kashyap, Anil; Rajan, Raghuram Stein Jeremy, "The Global Roots of the Current Financial Crisis and its Implications for Regulation" Conference Paper published by ECB.

18 Milne, Frank, "Anatomy of the Credit Crisis: The Role of Faulty Risk Management Systems" Howe Institute Commentary, No. 269, July 2008, available at www.cdhowe.org/pdf/commentary_269.pdf

The current credit crisis is, by Kashyap, Milne and many others, argued to have started in the US mortgage market.[19] Due to among other things low price on risk, and inadequate credit risk assessment, housing loans were approved also to people without proper repayment capacity (so called subprime loans). The mortgage loans were then bundled into CDOs (collateral debt obligations), ABSs (Asset backed securities) and other instruments, which were often divided in tranches with different seniority and sold further on the international loan market. Due to the complexity and low transparency of these products, the parties involved did not judge the risks properly. The rating agencies' risk assessment of these produces has also been criticised. One problem is that the rating agencies are paid by the actual entity that is rated, which probably results in a potential principal/agent problem. Another related problem was that institutions did not investigate the details of the underlying collateral, since they assessed the credit rating as guarantee enough.

However, when the US property and home market began to decline, and the loans started to default, the problems started. It also turned out that default risk on the complex instruments was higher than expected, since they had far less diversification of the assets than originally thought. When investors became aware of this, it resulted in two things: first, the mortgage backed securities decreased in value, and secondly, almost nobody was willing to lend against them as security. Thereby it became difficult for the banks to raise liquidity and funding problems emerged. Furthermore, it was difficult to know exactly how exposed each bank was.

All this became clear to the market in the late summer/early autumn of 2007 and resulted in an extremely low inter-bank confidence, an almost “frozen” inter-bank market, and exceptionally high inter-bank interest rates. To mitigate this, many national banks went in with capital injections and guarantees.

One of the first victims of the crisis was Northern Rock that received capital injections from Bank of England in September 2007,[20] and was nationalized in February 2008.[21] Also Bear Stearns experienced financial problems and was acquired by JP Morgan in May 2008.[22]

After the summer of 2008, the crisis that had started in 2007 as a “subprime crisis” and developed into a “liquidity crisis” or “credit crunch”, had spread to become a whole scale “financial crisis”. The US mortgage lenders Fannie May and Freddie Mac were put under governmental control in September 2008.[23] The same month the investment bank Lehman Brothers announced its bankruptcy.[24] In October 2008, further a number of banks and financial institutions had financial problems and were nationalized (sometimes partly), restructured, or overtaken.

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19 Kashyap, Anil; Rajan, Raghuram Stein Jeremy, “The Global Roots of the Current Financial Crisis and its Implications for Regulation” Conference Paper published by ECB. Milne, Frank, ”Anatomy of the Credit Crisis: The Role of Faulty Risk Management Systems” Howe Institute Commentary, No. 269, July 2008, available at www.cdhowe.org/pdf/commentary_269.pdf

20 “Liquidity Support Facility for Northern Rock plc”, news release from Bank of England, September 14, 2007.

21 “Northern Rock to be Nationalised”, BBC News, February 17, 2008

22 “Bear Stearns passes into Wall Street history”, Financial Times, May 29, 2008

23 “America’s government takes control of Freddie Mac and Fannie Mae”, The Economist, September 8, 2008.

24 “Lehman Brothers Holdings Inc announces it intends to file chapter 11 bankruptcy petition”, Press release from Lehman Brothers, September 15, 2008.

From now on, we refer to the current credit crisis as the period from August 2007 until present.[25] When referring to statistical data, our investigation contains figures until 2008-11-24.

It has been argued that the large amount of outstanding CDSs had exacerbated the current crisis.[26] For example, the discussion goes, if it were not so easy to mitigate the risk of the earlier mentioned sub-prime mortgages by CDSs, investors might have been forced to have better risk management systems, and been more cautious to take on risk.[27] It has also been argued that the descent of AIG, (previously the world's largest insurance company) was triggered by losses on its CDS contracts.[28]

It is still unclear how the financial situation will progress. Some debaters fear that the CDSs might cause huge problems, caused by the combination of large amount of outstanding CDS contracts that indirectly link a wide number of companies together, together with the low transparency and the fact that it is not public information how large, and which type, of exposure each entity has.[29] Due to this, voices have been raised that demand a more regulated market, providing for more transparency.[30]

It remains to be seen how the CDS market will continue to develop, and which implications it will have.

Theoretical perspectives

In this section, a background of the theoretical perspectives and the foundation for the arbitrage relationship between bonds and CDSs are presented.

Pricing models for credit risk

There are two main groups of academic credit risk pricing models: *structural models* and *reduced form models*.[31] The structural models were pioneered by Merton in the 70's[32], and are

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25 The crisis is of course not over yet, but for practical purposes the investigation does not cover information or events that derive from any point after 24 November 2008. (This is in order to avoid updating the figures during the ongoing process of analyzing and writing.)

26 See for example Laing, Jonathan, "Weapons of Mass Speculation" Barron's; May 12, 2008 available at http://online.barrons.com/article/SB121037952364682261.html

27 Dickinson, Eric "Credit Default Swaps: So Dear To Us, So Dangerous", Working paper from Fordham Law School, 20 November 2008. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1315535

28 See for example Dickinson, Eric "Credit Default Swaps: So Dear To Us, So Dangerous", Working paper from Fordham Law School, 20 November 2008. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1315535 or Varchaver, Nicholas and Benner, Katie, "The 55 trillion question" Fortune, Special report, available at http://money.cnn.com/2008/09/30/magazines/fortune/varchaver_derivatives_short.fortune/index.htm

29 See for example Varchaver, Nicholas and Benner, Katie, "The 55 trillion question" Fortune, Special report, available at http://money.cnn.com/2008/09/30/magazines/fortune/varchaver_derivatives_short.fortune/index.htm

30 See for example Linnane, Ciara et al. "Federal Reserve Pushes for Central CDS Counterparty", Reuters, Oct. 6, 2008, available at http://www.reuters.com/article/marketsNews/idUSN0655208920081006

31 Zhu, Haibin, "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235.

32 One key article is Merton, Robert C, "On the pricing of corporate debt: the risk structure of interest rates", The Journal of Finance, vol. 29, no 2, May 1974.

based on the value of the firm, and that default occurs when the value hits a given boundary.[33] This view is based on microeconomic theories, and comprises parameters such as firm value dynamics and leverage ratio.

In the reduced form models, by contrast, represented by among other Duffie & Singleton, default is treated in a more "statistical" way, in that it is seen as an "unpredictable event".[34] Credit spread is determined by risk neutral valuation under the absence of arbitrage opportunities. This view provides a framework to connect bond spreads with CDS spreads.[35] This thesis will not go further into detail of different pricing models of credit risk, but instead make use of the approximate arbitrage relation that exists between CDS spreads and bond spreads for a given reference entity.

Pricing models for Credit Default Swaps

One of the most wide-spread pricing models for CDSs is defined by Duffie.[36] This is used as foundation for the research by among others Zhu, Hull et al, Houweling & Worst, Dötz etc.[37]

The model suggests the following:

Let s be the premium that the protection buyer (the buyer of a CDS) pays, until the CDS contract matures, or the pre-defined credit event occurs. Set the yield to maturity of a corporate bond (with default) risk to y. Risk free interest rate is r. If combined, a risky bond and the protection of a CDS, could be said to create a synthetic risk free bond. The cash flow of this portfolio should be equal or close to the cash flow of a risk free bond. This indicates that the following relationship should hold approximately:

$s = y - r$

Hence, the CDS premium should be equal to the spread of the par fixed coupon bond.[38] If this relation does not hold, arbitrage possibilities arise. For example, if $y - r$ is larger than s, it would be profitable to sell the risk free bond short, and buy a corporate bond for the proceeds, and mitigate the bond's default risk through buying a CDS. If the opposite is true and s is

33 Blanco et al. "An Empirical Analysis of the Dynamic Relation between Investment-Grade Bonds and Credit Default Swaps", The Journal of Finance, Vol LX, no. 5, 2005

34 Duffie, Darrel; Singleton, Kenneth J., "Modeling Term Structures of Defaultable Bonds", The Review of Financial Studies, Vol. 12, No. 4 (1999), pp. 687-720

35 Zhu, Haibin, "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235.

36 Duffie, D, "Credit Swap Valuation" Financial Analysts Journal, 1999:1, p. 73-87.

37 Zhu, Haibin, "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235, . Hull, John; Predescu, Mirela; White Alan, "The relationship between credit default swap spreads, bond yields and credit rating announcements", Journal of Banking and Finance, 2004:28, p. 2789-2811, Houweling, Patrick; Vorst, Ton, "An Empirical Comparison of Default Swap Pricing Models", Working Paper, Erasmus University Rotterdam, 2002:6., Dötz, Niko, "Time-varying contributions by the corporate bond and CDS markets to credit risk price discovery", Discussion Paper: series 2: Banking and Financial Studies, no 08/2007, published by Deutsche Bundesbank

38 Zhu, Haibin, "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235.

larger than $y - r$, an arbitrageur could sell CDS protection, and thereby receive the CDS premium, sell the corporate bond short, and invest the proceeds in a risk free bond.[39]

However, for various reasons, this relationship does not always hold exactly. Like in most economic theories, there are a number of assumptions inherent in this reasoning. For example, factors as counterparty risk, tax effects and transaction costs are not taken into consideration. The theorem also presupposes that market players, willing to sell protection, are available, as well as providers of risk-free bonds. Furthermore, it also ignores contingent differences of the contracts, for example as regards the definition of credit event. Still, this reasoning is widely used as foundation for a number of similar investigations, for example Zhu, Dötz, Hull et al, Daniels & Jensen, to mention some of them.[40]

The *bond spread* is defined as $y - r$. One important question when determining the bond spread is the following: which interest rate should then be used as an estimate of the risk free interest rate? There are two alternatives often suggested: swap rate and treasury rate. The swap rate contains some risk, since it is based on the interbank rate (LIBOR), and is thereby normally somewhat higher than the treasury rate.[41] However, Houweling & Vorst find that a use of the treasury rate results in a "significant overestimation" of the credit risk for investment grade issuers. For speculative grade issuers the difference is smaller. Research by both Hull et al and Houweling & Vorst concludes that the former gives the best proxy.[42,43] This also seems to be the preferred choice in most cases of similar research. Therefore also this investigation uses the swap rate as a proxy for risk free interest rate.

There is also another risk type built in into the CDS contract, namely the *counterparty risk* (the risk between the protection buyer and protection seller). Hull & White has elaborated a method to value the influence of counterparty risk of a CDS spread.[44] However, they conclude that in most cases, the impact of counterparty risk is very small. One explanation to this is that if the counterparty defaults, the purchaser of a CDS can enter into a new contract with a new counterparty to regain the protection for the rest of the life of the original contract. Most similar investigations known to us chose to ignore counterparty risk, and based on this and the small impact of it on the CDS spread, hence, we will not further deal with counterparty risk in this thesis.

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39 Dötz. Niko,"Time-varying contributions by the corporate bond and CDS markets to credit risk price discovery", Discussion Paper: series 2: Banking and Financial Studies, no 08/2007, published by Deutsche Bundesbank

40 Zhu, Haibin, "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235, Hull, John; Predescu, Mirela; White Alan, "The relationship between credit default swap spreads, bond yields and credit rating announcements", Journal of Banking and Finance, 2004:28, p. 2789-2811, Daniels, Kenneth N.; Jensen, Malene Shin, "The Effect of Credit Ratings on Credit Default Swap Spreads and Credit Spreads", The Journal of Fixed Income, 2005:12, vol. 15, p. 16-35.

41 Blanco et al. "An Empirical Analysis of the Dynamic Relation between Investment-Grade Bonds and Credit Default Swaps", The Journal of Finance, Vol LX, no. 5, 2005, p. 2261

42 Hull, John; Predescu, Mirela; White Alan, "The relationship between credit default swap spreads, bond yields and credit rating announcements", Journal of Banking and Finance, 2004:28, p. 2789-2811.

43 Houweling, Patrick; Vorst, Ton, "An Empirical Comparison of Default Swap Pricing Models", Working Paper, Erasmus University Rotterdam, 2002:6.

44 Hull, John; White, Alan, "Valuing Credit Default Swaps II: Modeling Default Correlations" Journal of Derivatives, 2001, vol. 8, no. 3,

Literature review

This section provides an overview over related research.

Several independent investigations have been done in order to compare the correlation of the pricing of credit risk between the bond market and the CDS market. Some of the central articles within the field are reviewed below.

Blanco et al. test the validity of a theoretical arbitrage relation between the CDS prices to credit spreads, for a sample of 33 U.S. and European investment-grade firms, in the period 2001–2002.[45] They find that this relation holds on average over time for most companies, suggesting that the bond and CDS markets price credit risk equally. However, they note two forms of deviation from parity. First, for three of the European firms, the CDS prices are substantially higher than credit spreads for long periods of time. This might be explained by imperfections in the contract specification of the CDSs and measurement errors in computing the credit spread. Second, they notice short-lived deviations from parity for all the other companies, and subsequently show that these are a result of a clear lead for CDS prices over credit spreads in the price discovery process.

Zhu makes a similar investigation of 24 banks and corporations, between 1999–2002, and consistent with previous studies, confirms the parity between the credit spread and CDS spread. However, the two spreads can differ substantially in the short run, which is explained by their different responses to changes in the credit quality of the underlying reference entities. Like Blanco et al, Zhu finds that the derivatives market leads the cash market, both in anticipating rating events and in price discovery. He also finds that market participants seem to use swap rates rather than treasury rates as the proxy for risk-free rates.[46]

A more recent study is done by Dötz, who investigates to what extent the markets for corporate bonds and credit default swaps contribute to price discovery in credit markets, and which market dominates.[47] Unlike most previous studies, Dötz investigates only European companies (36 enterprises). The data covers 2004–2006. Like previous studies, he finds arguments that support that a cointegrating relationship between CDS spreads and bond spreads exists, and that the CDS market dominates the price discovery process slightly.

Other research has widened the scope to also include the instrument's ability of forecasting rating events, mostly based on ratings from the three largest rating agencies, Standard & Poor's, Moody's and Fitch. One of the often cited articles is by Hull et al, who examine the relationship between bond yields, credit default swaps and rating announcements among a large number of corporations and sovereigns between 1998–2002.[48] They find that CDS spreads are more efficient in anticipating negative rating events (downgrades), than positive.

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45 Blanco et al. "An Empirical Analysis of the Dynamic Relation between Investment-Grade Bonds and Credit Default Swaps", The Journal of Finance, Vol LX, no. 5, 2005

46 Zhu, Haibin, "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235.

47 Dötz, Niko, "Time-varying contributions by the corporate bond and CDS markets to credit risk price discovery", Discussion Paper: series 2: Banking and Financial Studies, no 08/2007, published by Deutsche Bundesbank,

48 Hull, John; Predescu, Mirela; White Alan, "The relationship between credit default swap spreads, bond yields and credit rating announcements", Journal of Banking and Finance, 2004:28, p. 2789-2811.

Similar conclusions are made by Daniels & Jensen who investigates the relation of CDS spreads, bond spreads and rating of 72 corporations within different industries during the time period 2000–2002.[49] They find that the curves are highly related, but that there still are differences in the way the CDS spread and corporate bonds price credit risk. They also discover that the relationship between CDS spreads and credit spreads is stronger for non-investment grade corporations, and that changes in credit ratings are anticipated by both the bond market and the CDS market.

As known to us, no research has yet been published that investigates the relation of the CDS spread and bond spread during the current financial crisis. This thesis aims to fill this gap. In order to have a basis for comparison, the period investigated date back to 2004-01-01, which gives an investigation period of almost 5 years. Most previous investigations comprises much shorter time periods.

Problem discussion

In this section the problem formulation and the purpose of the thesis are presented and explained.

As seen above, the CDS spread should theoretically show the market's pricing on credit risk.[50] However, empirical evidence shows that this is not always true.[51] In addition, the discussions about the role of the CDSs within the time frame of the current credit crisis have been heard a number of times.[52]

The thesis will investigate how well the CDS spreads of a number of financial corporations are related with their underlying bond spreads in the way that a long-run equilibrium relationship is searched for. The credit spread will also be studied to answer the question if credit risk is priced equally between derivatives market and the cash market. If it is not, it is possible that arbitrage possibilities arise. The thesis will also examine how the CDS spread has reacted (vis-à-vis the bond spread) in the current credit crisis, as well as the years before.

Problem formulation

Is credit risk priced equally in the CDS market and the bond market? Is there a long-run equilibrium relationship between the CDS spreads and bond spreads? How have the CDS spreads behaved in the current credit crisis, compared to the time before the crisis? And are there any differences in the equilibrium relationship between the CDS spread and bond spread in times of financial distress, compared to during more stable market conditions?

49 Daniels, Kenneth N.; Jensen, Malene Shin, "The Effect of Credit Ratings on Credit Default Swap Spreads and Credit Spreads", The Journal of Fixed Income, 2005:12, vol. 15, p. 16-35.

50 Zhu, Haibin, "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235.

51 See for example: "CDS goes its own merry way despite bad news", Euroweek, Apr 18, 2008

52 See for example Dickinson, Eric "Credit Default Swaps: So Dear To Us, So Dangerous", Working paper from Fordham Law School, 20 November 2008

Purpose

The purpose of the thesis is to investigate the relationship between the CDS spreads and bond spreads, and to compare this relationship over time. This will be performed through testing for a cointegration relationship and Granger causality between the CDS spread and bond spreads of the entities studied, for different time periods, combined with the aid of descriptive statistics. Also the change in CDS spread and bond spread over time will be studied.

Data

This section describes how the data was chosen and collected, and which decisions were made regarding the CDS data, bond data and the time period(s) chosen. Also the problems we faced are accounted for. Finally, the main characteristics of the data are presented, in order to facilitate the reading of the method section.

Selection of entities

This examination covers banks and financial institutions, as underlying bond issuers for which CDSs exist. The population chosen is the entities classified as "financials" from the Standard&Poor's indices S&P 500 and S&P 350.[53] The reason for choosing US companies (S&P 500) was twofold. First, as discussed above, the CDSs are argued to have played a role in the current turmoil that is also argued to have started in the US. Second, the US CDS market is very large and well developed, which makes it easy to find data for this area. Since the availability of data was too limited to construct a satisfactory amount of generic bonds, also entities from the European market (S&P 350) was chosen. Other reasons for this choice were that the crisis quickly spread to Europe, and that the availability of data was high for the entities in the index. The S&P 500 contains companies within the large-cap sector of the U.S. market and the S&P 350 index comprises corresponding European companies. The companies within the indices are considered "leading companies in leading industries".[54] The choice of a certain S&P index has the advantage in that the index is professionally checked to follow certain criteria, in order to provide a fair reflection of the market, with respect to market capitalization, public float and liquidity of the stocks.[55] As an example, the companies included in the S&P 500 cover app. 75% of the U.S. equities market, and has a market capitalization of min. 4 billion USD. The companies included in the S&P 350 cover over 70% of the European equities market. The number of "financials" within each index amounts to app. 80 per year, for each index respectively. However, since there are some changes in the constituent list from year to year, the total number of companies in the population is 219.[56]

One reason for investigating banks and financial institutions is that the financial crisis started within this sector, as described above. The CDSs were also invented, and are widely used, within this certain industry, which makes companies within this industry a suitable subject for investigation. The choice is also good for practical reasons, since there is a large CDS and bond market for this kind of enterprises.

53 The classification "financials" is based upon the GICS standard (Global Industry Classification Standard)

54 Factsheet from S&P, available at http://www2.standardandpoors.com/spf/pdf/index/SP_500_Factsheet.pdf

55 For a further description of the methodology of the index, please see "S&P U.S. Indices, Index Methodology" (21 pages) published by Standard&Poor's, available at http://www2.standardandpoors.com/spf/pdf/index/S_P_US_Indices_Methodology_Web.pdf

56 123 from S&P 500, and 96 from S&P 350.

CDS data

Thomson Datastream is used to collect time-series data, showing the mid market price of the CDSs for each company. Data for the spreads of 5-year CDSs are used, since contracts with this particular maturity are the most liquid, and are therefore considered to provide the most true market prices.[57] For the companies from S&P 500, only contracts denominated in USD was chosen, and for the companies of S&P 350, only contracts in EUR was chosen.

However, the chosen S&P indices contain many companies for which no CDSs exist. Therefore, the population has subsequently been cleared from the entities for which a CDS market either not exists, or where the data does not cover the entire period investigated.

For the vast majority of listed companies, there is no information about the CDS spread before 2004-01-01, which makes this date a natural start date of the investigation.

Bond data

To be able to compare the price of a 5-year CDS with a bond, the ideal situation would be if there was a bond issued by the same entity with exactly 5 years to maturity available for each day. For natural reasons, this is not the case. Therefore, *generic bonds* must be constructed. To do this, we use the process elaborated by Zhu, and proceed in the following manner:[58]

For each of the chosen reference entities (where data of CDS spread is available), information about all bonds outstanding during the sample period is collected. To avoid measurement errors only bond issues that satisfy the following restrictions are used:

- (i) bonds must be straight (i.e. not puttable, callable, convertible or reverse convertible)
- (ii) bonds must be denominated in the same currency as the CDS contract (USD or EUR)
- (iii) bonds must be senior
- (iv) the coupon payments must be fixed-term

First, at each date, it is checked for if there is a bond with exactly 5 years to maturity. If this is not the case, two quoted bonds are selected at each date: one whose maturity is shorter than, and another whose maturity is longer than the default swap's maturity. Their spreads are subsequently linearly interpolated. The following criteria are set:

- (i) At least one of the two bonds must have a remaining time to maturity between 3.5 years and 6.5 years.
- (ii) If no bond data are available for interpolation, but there is a quoted bond whose maturity is between 4.5 years and 5.5 years, its yield is used as an approximation for the yield of the generic bond.

57 Dötz, Niko, "Time-varying contributions by the corporate bond and CDS markets to credit risk price discovery", Discussion Paper: series 2: Banking and Financial Studies, no 08/2007, published by Deutsche Bundesbank.

58 Zhu, Haibin, "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235.

Similar methods are used by for example Blanco et al, Norden & Weber and Hull et al.[59] The population is thereby cleaned from entities whose bond issued did not fulfil the criteria for making it possible to construct generic bonds.[60] The limited accessibility of appropriate bonds is the main reason behind the reduction of the sample size.

Thomson Datastream provides data for the bond spreads. Both the yield over risk free rate (expressed as bond spread over swap rate) and information about the remaining time to maturity for each bond is compiled. (As concluded above, the swap rate is considered to give the best proxy for risk free rate.)

Time period

The period investigated is 2004-01-01 to 2008-11-24. The start date is set due to data availability (in Datastream). The first years are characterised by quite normal market conditions, and the last app. 16 months are characterised by the financial crisis, which will give a good comparison.

As a second step the time period is divided in sub-periods. Since a part of the scope is to investigate how the CDS market has reacted to the current credit crisis, one suitable sub-period is the period from the start of the crisis, until the end date of the data collected. As discussed in the chapter about the credit crisis, it is always difficult to set an exact start date of a crisis, as well as define a "crisis", and the choice easily tends to be arbitrary to a certain extent. However, based on the earlier discussion, the sub-period characterised by the crisis is set to 2007-08-09 to 2008-11-24. For the reason of comparison, also two periods before the crisis are defined, and the dates of these are set based on the criteria that the compared periods should contain the same number of days (338 trade days) as the "crisis" period. The three sub periods are the following:

Period 1: 2005-01-05 to 2006-04-21
Period 2: 2006-04-22 to 2007-08-08
Period 3: 2007-08-09 to 2008-11-24

List of reference entities

When the population (starting at 219 entities) is cleared for companies for which either no CDS data was available, or for which it was not possible to create generic bonds, 29 corporations remain: 18 from USA and 11 from Europe. The companies included in the sample are shown in figure 2.

59 Blanco et al. "An Empirical Analysis of the Dynamic Relation between Investment-Grade Bonds and Credit Default Swaps", The Journal of Finance, Vol LX, no. 5, 2005,

Norden, Lars; Weber, Martin, "Informational efficiency of credit default swap and stock markets: The impact of credit rating announcments", Journal of Banking and Finance, 2004:28, p. 2813-2843,

Hull, John; White, Alan, "Valuing Credit Default Swaps II: Modeling Default Correlations" Journal of Derivatives, 2001, vol. 8, no. 3.

60 Practically, due to the large amount of data, the generic bonds are created by running an Excel-makro written in Visual Basic.

Table 1: List of reference entities included in the sample

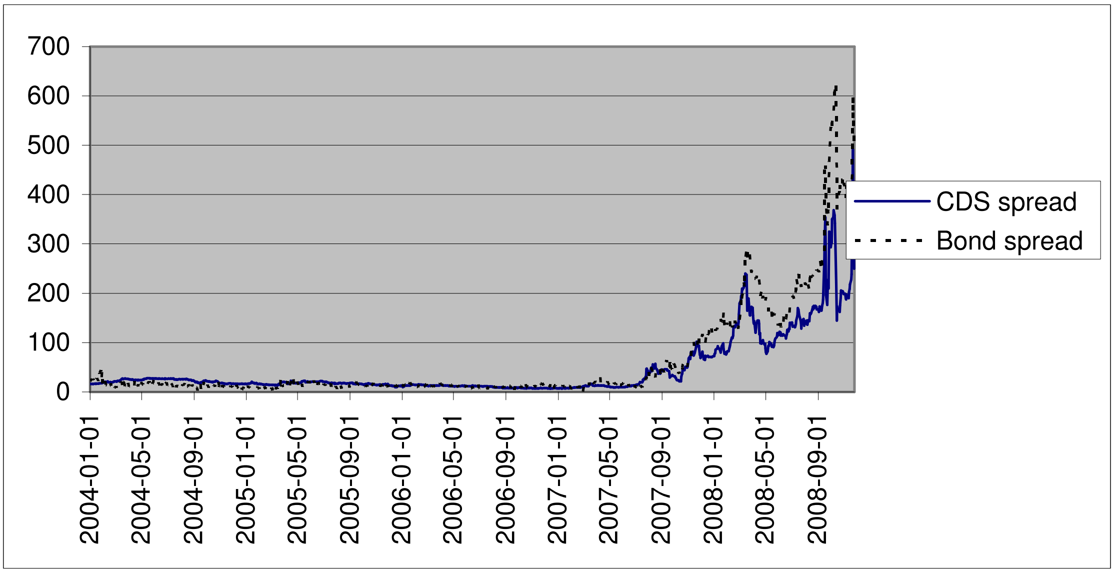
Name	Country	Index	Currency
ABN Amro Holding NV	Netherlands	S&P 350	EUR
Allstate Corp.	USA	S&P 500	USD
Avalonbay Communities	USA	S&P 500	USD
Banca Monte dei Paschi di Siena SpA	Italy	S&P 350	EUR
Banco Santander SA	Spain	S&P 350	EUR
Bank of America Corp.	USA	S&P 500	USD
Barclays	Great Britain	S&P 350	EUR
Bear Stearns	USA	S&P 500	USD
BNP Paribas SA	France	S&P 350	EUR
Citigroup Inc.	USA	S&P 500	USD
Commerzbank AG	Germany	S&P 350	EUR
Credit Agricole	France	S&P 350	EUR
Deutsche Bank	Germany	S&P 350	EUR
Developers Diversified Rlty	USA	S&P 500	USD
Fannie Mae (Federal National Mortgage Association)	USA	S&P 500	USD
Fortis Group	Belgium	S&P 350	EUR
Freddie Mac (Federal Home Loan Mortgage Corporation)	USA	S&P 500	USD
Goldman Sachs Group	USA	S&P 500	USD
Investor	Sweden	S&P 350	EUR
Kimco Realty	USA	S&P 500	USD
Lincoln National	USA	S&P 500	USD
Marsh & McLennan	USA	S&P 500	USD
Merril Lynch	USA	S&P 500	USD
Morgan Stanley	USA	S&P 500	USD
SLM Corporation	USA	S&P 500	USD
Simon Property Group	USA	S&P 500	USD
Societe Generale	France	S&P 350	EUR
Wells Fargo	USA	S&P 500	USD
Wachovia Corp.	USA	S&P 500	USD

Description of the data

In all, data for 1,278 days and for 29 entities was collected, which gives 37,602 observations of the CDS spread, and the same number of observations for the bond spread.

To give the reader an example of the characteristics of the data, the figure below shows the graph of the CDS spread and Bond spread over time, for Citigroup. Although there are exceptions, many of the entities included in the sample show similar movements in the spreads.

Figure 2: Citigroup, CDS spread and bond spread



As can be seen, the spreads, both for bonds and CDS are drastically higher in the last app. 16 month of the time period investigated. The same tendency is seen for almost all entities in the sample. As regards the CDS spread, all the entities have a higher average spread for period 3, the "during the crisis period" than for period 1 and 2. When it comes to bond spreads, the same is true for 26 of 29 entities for period 1, and 27 out of 29 entities for period 2.

The table below presents the average spreads. It can be noted that the average difference between CDS spread and bond spreads is drastically higher in period 3. The average standard deviation of the credit spread seems also to increase during the time of the crisis.

In some cases, the bond spread is negative. This is in cases where the bond yield is lower than the swap rate. This could happen at times when the risk for a certain company's bond is considered to have lower risk than the swap rate.

In Zhu's investigation, the average credit spread was 14.91 bps (and CDS spread > bond spread), but the difference between the years was large (between 1.44 and 32.2). The investigation covered 1999–2002. Dötz found that the difference was 3.6 bps.

Table 1: Summary – Average Spreads for the different periods

	Total period *2004-01-01 to 2008-11-24*	Period 1 *2005-01-05 to 2006-04-21*	Period 2 *2006-04-22 to 2007-08-08*	Period 3 *2007-08-09 to 2008-11-24*
CDS spread, arithmetic mean	52.47	21.72	19.34	136.31
Bond spread, arithmetic mean	87.52	54.03	28.69	195.03
Credit spread, arithmetic mean*	35.04	32.30	9.35	58.73
Std. deviation of the credit spread	73.41	31.39	30.62	83.26

*Credit spread = Bond spread - CDS spread

When looking at which spread is the highest, CDS or Bond, there is no strong dominance. (The complete table is presented in appendix 3.) Even though the bond spread is higher than the CDS spread in average, as shown above, this is true only for 64% of the observations for the total period. The dominance of the bond is strongest in the third period, where the bond spread is higher than the CDS spread in 70% of the observations, compared to 64% in period 2, and 59% in period 1.

Method

This section provides an overview of the method used.

As stated above, according to economic theory, an arbitrage relationship should exist between the spread of the credit default swap and the bond yield over the risk-free rate. In other words, there is to be at least a long-term relationship between the prices of both financial instruments. A way of testing for this situation is to investigate if there are any cointegrating relationships present between the two variables in the dataset. If cointegration is found, there exists a long-term equilibrium relationship between the CDS spread and bond spread.

There has been proposed that using ordinary regression techniques when studying the connection between time-series may lead to undesirable results and spurious regressions[61], thus making it interesting to investigate alternative methods to use. Granger and Engle was awarded the Nobel Memorial Prize in Economic Sciences 2003 by contributing research on cointegration[62], most of the method used in this chapter are based on this framework.

A first step is to decide if the series in the data can be classified as stationary or not. Two or more stationary series cannot be proved to cointegrate and thus do not have the relationship that is tested for in the Engle-Granger or Johansen procedures. Whether stationarity is found or not, a Granger causality test is performed on each pair of series to investigate which market may be the price-discovering one, in the way that in this market the price seems to move first (as in acting on market information) of the two. The last test also tells us if there may or not

61 Brooks, Chris, Introductory Econometrics for Finance, Cambridge University Press 2008, p. 319

62 "The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2003" available at http://nobelprize.org/nobel_prizes/economics/laureates/2003/

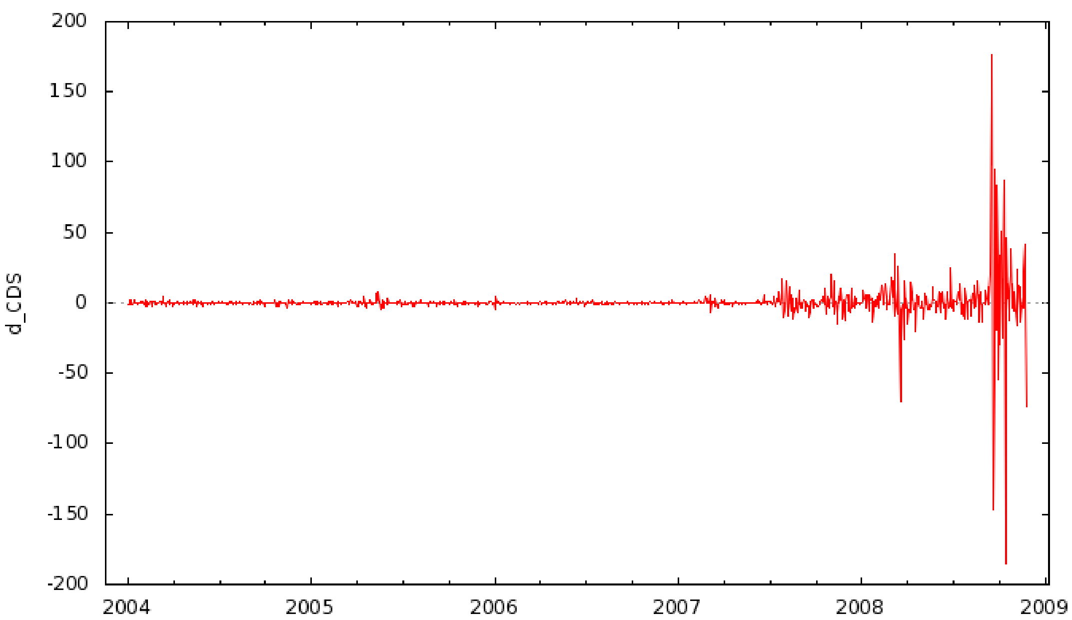
may still be a connection between the two spreads in the case where cointegration could not be proven. The Granger causality test is made in all cases, even if the presence of a cointegrating relationship would prove more valuable when searching for an equilibrium relationship.

All of the tests above are performed on the full dataset, as well as the three sub samples. This is made to try to capture the effects of the 'credit crunch' in comparison to regular market conditions. The results and analyses are given in the following chapters.

Testing for stationarity or unit root, KPSS and ADF
A first step before deciding on further testing methods is to investigate the properties of the time series data. A stationary series may be defined as one with a constant mean, constant variance and constant autovariance for each given lag of itself.[63] When subject to shocks, the change in the variable will gradually die away with time in contrast to series containing one or more unit roots, where the effect of shocks persists over time. The random walk model with drift, $y_t = \mu + y_{t-1} + u_t$, is a good illustration of this non-stationary process.

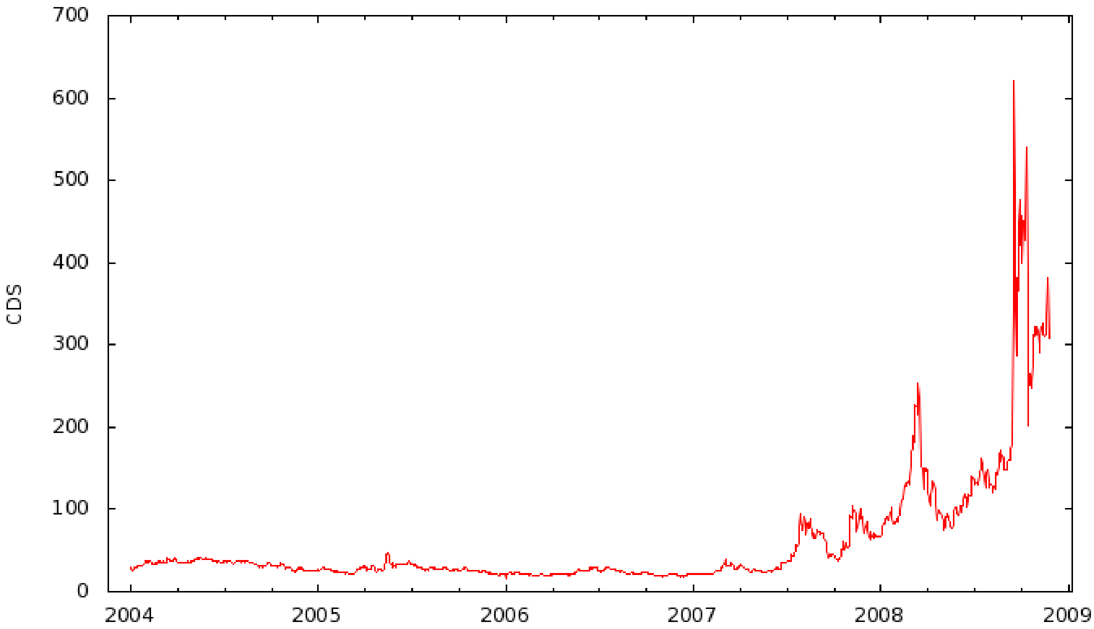
Regressing series containing unit roots may yield results not true to reality such as too high R^2 and other undesirable properties, a phenomenon also known as spurious regression. An interesting property of non-stationary series is that its first difference (or period-to-period change) is stationary, a transformation that may be of use if there is interest in formally testing its behaviour.

Figure 3: stationary I(0) time series (Goldman Sachs 1:st diff CDS spread)



63 Brooks, Chris, Introductory Econometrics for Finance, Cambridge University Press 2008, p. 318.

Figure 4: Unit root I(1) time series (Goldman Sachs CDS spread)



To decide whether the series is stationary or not, the Augmented Dickey-fuller test (ADF) and the KPSS tests are employed. The former tests for a unit root and the later for stationarity. The ADF has a null hypothesis of *Ho*: series contain a unit root and *H1*: series is stationary.

The ADF is performed by testing for $\psi = 0$ in the model: $\Delta y_t = \psi y_{t-1} + \sum_{i=1}^{p} \alpha y_{t-1} + u_t$. The test statistic is $\frac{\hat{\psi}}{(SE(\hat{\psi})\hat{)}}$, the critical values used are given by Brooks.[64]

A problem that may arise is the choice of lags in the testing procedure, In this case, 10 was somewhat arbitrarily chosen to count down from (to check for best significance of lags and the model in total) in a first step and was later complemented by the *AIC* (Akaikes Information Criterion) and *SBIC* (Schwartz Baynesian Information Criterion) in EViews. The goal is to minimize the numerical value of the information criterion with consideration to the number of lags. No longer lags are to be expected considering the price-relationship examined. Arbitrage should eliminate differences rather quickly in any liquid market.

The *AIC* is expressed as $AIC = \ln(\hat{\sigma}^2) + \frac{2k}{T}$ wherein σ^2 is the residual variance, *T* the number of observations and *k* the total numbers of parameters estimated. The *SBIC* is expressed as $SBIC = \ln(\hat{\sigma}^2) + \frac{k}{T}\ln T$ using the same parameters and variables.

However, the material did not seem to exhibit any major sensitivity to differences in the selected lag range.

64 Brooks, Chris, Introductory Econometrics for Finance, Cambridge University Press 2008, p. 623.

As a way to make the conclusions more robust, as suggested by Brooks[65], the test for a unit root is complemented by a KPSS (named after its originators: Kwiatkowski, Phillips, Schmidt and Shin) test for stationarity. Here we test for *Ho:I(0)* against *H1:I(1)*

If *y* can be illustrated as $y_t = \mu + u_t$ and u_t is a stationary process with mean zero, the sample average of y_t is a consistent estimate of and the long-run variance of u_t is a finite and well-defined number under *Ho*.

The test statistic is $\eta = \frac{\sum_{i=1}^{T} S_t^2}{T^2 \hat{\sigma}^2}$ and critical values are given in the *GRETL* software's testing procedure itself. The number of lags used in the KPSS test is the same tested and found to be optimal for the variables in each ADF test.

Cointegration and Granger causality, Engle-Granger, Johansen and Granger tests
In searching for a cointegrating relationship between two variables y_1 and y_2 that both contain an unit root *I(1)* you look for the residuals of the linear combination of the two *y*'s to have the property *I(0)*.

In the following models, the different *y*'s represent the levels of the cds and bond spreads as before.

A formal definition of cointegration by Engle and Granger follows:[66] If *w* is a *k**1 vector containing variables, the components of *w* are all integrated by the order of (*d,b*) when

- All of *w*'s components are *I(d)*
- At least one vector of coefficients α exists so $\alpha' w_t \sim I(d-d)$

If no cointegration is found, there is no indication of a long-term relationship between the tested variables.

A generalized way of describing the procedure is that with *k* variables being investigated for cointegration, the residuals u_t from the equation $y_t = \beta_1 + \beta_2 x_{2t} + \beta_3 x_{3t} + \ldots \beta_k x_{kt} + u_t$ will be *I(0)* if a cointegration relationship is present.

The test performed to find out if u_t is I(0) is using the same ADF-methodology used in testing the separate variables before, but this time a different set of critical values are used because of now testing residuals. The test is referred to as the Engle-Granger test and Brooks again gives critical values.[67] The *AIK*, *SBIC* and as a last resort the counting down method are used for choice of lags.

To provide further information considering whether a cointegrating relationship exists, the Johansen technique based on *VAR*s is used to search for a cointegrating vector connecting the two series.

A *VAR*(Vector Autoregressive model) with *g* variables and *k* lags is illustrated in *VAR* and *VECM* (Vector Error Correction Model)form by:

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65 ibid p. 331

66 Engle, R. F; Granger, C. W. J., "Co-Integration and Error Correction: Representation, Estimation and Testing, Econometrica 1987:55.

67 Brooks, Chris, Introductory Econometrics for Finance, Cambridge University Press 2008, p 628

VAR: $$y_t = \beta_1 y_{t-1} + \beta_1 y_{t-2} + ... + \beta_k y_{t-k} + u$$

VECM: $$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_1 \Delta y_{t-2} + ... + \Gamma_{k-1} \Delta y_{t-(k-1)} + u_t$$

Π is $(\sum_{i=1}^{k} \beta_i) - 1_g$ and Γ_i is $(\sum_{j=1}^{i} \beta j) - I_g$

The Johansen test examines the long-run coefficient matrix Π and its rank via the matrix Eigen values. The values are studied in ascending order were λ_1 is largest root (closest to one) and λ_g is the smallest. When no cointegration is found, the rank of Π will not significantly differ from zero.

The test statistic used is $\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1-\hat{\lambda}_i)$ and critical values are given in the EViews software used for the testing (checked against Brooks values).[68] *Ho* is that the number of cointegrating vectors are less than or equal to r against the alternative that there are more. The test is performed in a sequence. If *Ho*: *r*=0 is rejected, the null that there is one cointegrating vector (i.e. *Ho*: *r*=1) would be tested. Since *g* (number of variables) = 2 there are only *r*=1 cointegrating vectors to investigate. Brooks elaborates more on the quite intricate Johansen testing technique in his book *Introductory Econometrics for Finance*.[69]

Finally, the Granger causality between CDS spread and bond yield over the risk free rate are tested to examine if the markets not proved to have a cointegrating relationship still may move together. These tests are run on all entities.

The software runs every possible equation of the form

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + ... + \alpha_l y_{t-1} + \beta_1 x_{t-1} + ... + \beta_l x_{-l} + \varepsilon_t$$
$$x_t = \alpha_0 + \alpha_1 x_{t-1} + ... + \alpha_l x_{t-1} + \beta_1 y_{t-1} + ... + \beta_l y_{-l} + u_t$$

given every combination of *x* and *y* series in the group (where x and y are the CDS and bond spreads) including lags and then reports the F-statistics for $\beta_1 = \beta_2 = ... = \beta_l = 0$

Ho is that *x* does not G-cause *y* in the first regression and the same goes for *y* and *x* in the second. Brooks gives the critical values for the F-tests.[70]

Test results

In this section, the results of the tests are presented. First, the results for the complete period are presented, thereafter the results for the sub-periods follow.

68 Brooks, Chris, Introductory Econometrics for Finance, Cambridge University Press 2008, p 625

69 Brooks, Chris, Introductory Econometrics for Finance, Cambridge University Press 2008, p 350–355

70 Brooks, Chris, *Introductory Econometrics for Finance*, Cambridge University Press 2008, p 618

Table 2: Unit root and cointegration tests for the complete period, 2004-01-01 to 2008-11-24

Company	**Unit root and stationarity tests** ADF Test H0:I(1) KPSS Test H0:I(0)				**Cointegration tests** H0:No cointegrating equation	H0: r=1 cointegrating vector exists
	CDS Spreads		Bond Yields		Engle/Granger	Johansen
	ADF	KPSS	ADF	KPSS	ADF	Trace Stat
Allstate Corp	-	****	-	****	***	14.04399*
Amro Bank	-	****	-	****	*	0.211969
Avalon Bay	-	****	-	****	***	19.97770*
Banca Paschi	-	****	-	****	-	2.395344
Banco Santander	-	****	-	****	-	3.219033
Bank of America	-	****	-	****	-	1.036899
Barclays	-	****	-	****	-	0.003448
Bear Stearns	****	****	-	****	***	1.700480
BNP Paribas	-	****	-	****	***	1.687035
Citigroup	-	****	-	****	***	0.017730
Commerzbank	-	****	***	****	-	5.632254*
Credit Agricole	-	****	-	****	-	0.012850
Deutsche Bank	-	****	-	****	***	0.539458
Developers Dvrsf	-	****	-	****	***	38.17143*
Fannie Mae	-	****	-	****	-	0.157056
Fortis NL	-	****	-	****	-	0.887945
Freddie Mac	-	****	-	****	**	1.285915
Goldman Sachs	-	****	-	****	**	0.686447
Investor	-	****	-	****	***	1.654881
Kimco	-	****	-	****	***	20.82038*
Lincoln	-	****	-	****	-	8.444370*
Marsh McLennan	****	****	-	****	**	1.868867
Merril Lynch	-	****	-	****	***	0.799274
Morgan Stanley	-	****	-	****	***	5.031263*
Simon Property	-	****	-	****	***	55.62257*
SLM Corp	-	****	-	****	***	1.784499
Societe General	-	****	-	****	-	2.037201
Wachovia Corp	**	****	-	****	**	13.39102*
Wells Fargo	-	****	-	****	***	4.917691*
				Rejected at **** = 99% *** = 97,5% ** = 95% * = 90% - Not Rejected	Rejected at *** = 99% ** = 95% * = 90% - Not Rejected	Rejected at * = 95% level

Unit root and stationarity tests

As can be seen, the hypothesis that the data is stationary (KPSS-test), can be rejected at the 99% level for both bonds and CDS for all reference entities. However, the ADF-test for unit roots is rejected in three cases regarding the CDS spread, and one regarding the bond spread. The test results indicate that most of the data could contain a unit root, and this leads us to assume that this data is non-stationary.

Cointegration tests

The ADF test within the Engle-Granger procedure shows that for 19 out of 29 entities, the hypothesis that no cointegrating relationship exist, can be rejected (on 95% and 99% level, in most cases). The Johansen test shows that the hypothesis that a cointegrating vector exist can be rejected for 10 companies (out of 29). However, these are not necessarily the same entities, for which the hypothesis was not rejected in the ADF test.

Table 3: Unit root and cointegration tests for Period 1, 2005-01-05 to 2006-04-21

Company	**Unit root and stationarity tests** ADF Test H0:I(1) KPSS Test H0:I(0)				**Cointegration tests** H0:No cointegrating equation	H0: r=1 cointegrating vector exists
	CDS Spreads		Bond Yields		Engle/Granger	Johansen
	ADF	KPSS	ADF	KPSS	ADF	Trace Stat
Allstate Corp	-	****	*	****	-	3.138110
Amro Bank	-	****	-	****	-	2.874239
Avalon Bay	-	****	-	****	-	1.776801
Banca Paschi	-	****	-	****	-	3.406410
Banco Santander	-	****	-	****	-	3.364937
Bank of America	-	****	-	****	-	2.201524
Barclays	-	****	-	****	-	2.323694
Bear Stearns	-	****	-	****	*	2.898033
BNP Paribas	-	****	***	****	-	2.053009
Citigroup	-	****	****	***	-	2.462212
Commerzbank	-	****	-	****	-	2.351910
Credit Agricole	-	****	-	****	-	1.397390
Deutsche Bank	-	****	-	****	-	3.311334
Developers Dvrsf	**	****	-	****	**	0.617585
Fannie Mae	-	****	-	****	-	1.069649
Fortis NL	-	****	-	****	*	3.553904
Freddie Mac	-	****	-	****	-	3.409041
Goldman Sachs	-	****	-	****	**	4.532134*
Investor	*	****	*	****	**	0.296304
Kimco	-	****	-	****	-	7.161910*
Lincoln	****	****	**	****	-	7.230685*
Marsh McLennan	-	****	-	****	**	6.641594*
Merril Lynch	-	****	*	****	*	3.809953
Morgan Stanley	-	****	*	****	-	2.400940
Simon Property	-	****	***	****	-	1.536563
SLM Corp	-	****	-	****	-	1.067098
Societe General	-	****	-	****	-	2.135901
Wachovia Corp	-	****	****	****	-	3.555081
Wells Fargo	-	****	*	****	-	3.639147
				Rejected at **** = 99% *** = 97,5% ** = 95% * = 90% - Not Rejected	Rejected at *** = 99% ** = 95% * = 90% - Not Rejected	Rejected at * = 95% level

Unit root and stationarity tests

Like for the complete period, the hypothesis that the data is stationary (KPSS-test), can be rejected at the 99% level for both bonds and CDS for all reference entities. However, the ADF-test for unit roots is rejected in three cases regarding the CDS spread, and ten cases regarding the bond spread. The test results indicate that most of the data may contain a unit root, and this leads us to assume that this data is non-stationary.

Cointegration tests

The ADF test within the Engle-Granger procedure shows that for 22 out of 29 entities, the hypothesis that no cointegrating relationship exist, can not be rejected (on 95% and 99% level, in most cases). The Johansen test shows that the hypothesis that a cointegrating vector exists can be rejected for 4 companies (out of 29). However, these are not necessarily the same entities, for which the hypothesis was not rejected in the ADF test.

Table 4: Unit root and cointegration tests for Period 2, 2006-04-22 to 2007-08-08

Company	Unit root and stationarity tests ADF Test H0:I(1) KPSS Test H0:I(0)				Cointegration tests H0:No cointegrating equation	H0: r=1 cointegrating vector exists
	CDS Spreads		Bond Yields		Engle/Granger	Johansen
	ADF	KPSS	ADF	KPSS	ADF	Trace Stat
Allstate Corp	-	****	-	****	-	4.583825*
Amro Bank	-	***	-	****	-	0.162580
Avalon Bay	-	****	***	****	-	1.298320
Banca Paschi	-	**	-	****	-	3.929172*
Banco Santander	-	-	-	****	-	0.076904
Bank of America	-	****	-	****	-	1.297424
Barclays	-	**	-	****	-	3.412302
Bear Sterns	-	****	-	****	-	3.946787*
BNP Paribas	-	*	-	**	-	0.110613
Citigroup	-	****	-	****	-	1.214915
Commerzbank	-	-	-	****	-	7.802125*
Credit Agricole	-	***	-	***	-	5.112425*
Deutsche Bank	-	***	-	***	-	1.075582
Developers Dvrsf	-	****	*	****	-	1.262187
Fannie Mae	-	****	-	****	-	0.723104
Fortis NL		****		*	-	0.126226
Freddie Mac	-	****	-	****	-	1.656288
Goldman Sachs	-	****	-	*	-	0.748034
Investor	-	****	-	****	-	5.795311*
Kimco	-	****	-	****	-	1.461156
Lincoln	-	****	-	****	-	1.977424
Marsh McLennan	-	****	-	****	-	3.983803*
Merril Lynch	-	****	-	****	-	5.822345*
Morgan Stanley	-	****	-	****	-	2.015350
Simon Property	-	*	-	****	-	5.714174*
SLM Corp	-	****	-	****	***	0.746820
Societe General	-	***	****	****	-	1.405445
Wachovia Corp	-	****	-	****	-	2.542108
Wells Fargo	-	***	-	****	-	1.362294
				Rejected at **** = 99% *** = 97,5% ** = 95% * = 90% - Not Rejected	Rejected at *** = 99% ** = 95% * = 90% - Not Rejected	Rejected at * = 95% level

Unit root and stationarity tests

Like in the test for the complete period, the hypothesis that the data is stationary (KPSS-test), can be rejected, however, with lower probability, and with an exception for the CDS spread of two entities. However, the ADF-test for unit roots is rejected in three cases regarding the bond spread. As in the test for the previous test for the complete period, test results indicate that most of the data could contain a unit root, and this leads us to assume that this data is non-stationary.

Cointegration tests

The ADF test within the Engle-Granger procedure shows that for only one entity, the hypothesis that no cointegrating relationship exists can be rejected. The Johansen test shows that the hypothesis that a cointegrating vector exists can be rejected for 9 companies (out of 29).

Table 5: Unit root and cointegration tests for period 3, 2007-08-09 to 2008-11-24

Company	**Unit root and stationarity tests** ADF Test H0:I(1) KPSS Test H0:I(0)				**Cointegration tests** H0:No cointegrating equation	H0: r=1 cointegrating vector exists
	CDS Spreads		Bond Yields		Engle/Granger	Johansen
	ADF	KPSS	ADF	KPSS	ADF	Trace Stat
Allstate Corp	-	****	-	****	***	3.825213*
Amro Bank	-	****	-	***	-	3.825213
Avalon Bay	-	****	-	****	-	5.110221*
Banca Paschi	-	****	-	**	-	1.108426
Banco Santander	-	****	-	****	-	0.021239
Bank of America	-	****	-	****	-	0.019676
Barclays	-	****	-	****	-	1.136809
Bear Stearns	**	**	-	****	-	3.876437*
BNP Paribas	*	****	-	****	-	3.983305*
Citigroup	-	****	-	****	**	0.853059
Commerzbank	-	****	-	****	-	0.550813
Credit Agricole	-	****	-	****	-	0.799015
Deutsche Bank	-	****	*	****	-	6.484201*
Developers Dvrsf	-	****	-	****	-	10.24387*
Fannie Mae	-	**	-	****	-	0.007201
Fortis NL	-	****	-	****	-	0.026804
Freddie Mac	-	***	-	****	-	3.454825
Goldman Sachs	-	****	-	****	**	0.859073
Investor	-	****	-	****	-	1.872109
Kimco	-	****	-	****	-	2.957338
Lincoln	-	****	-	****	*	4.570968*
Marsh McLennan	-	**	-	****	-	1.730160
Merril Lynch	-	****	-	****	-	0.620772
Morgan Stanley	-	****	-	****	***	3.031852
Simon Property	-	****	-	****	**	16.14024*
SLM Corp	-	****	-	****	**	3.625044
Societe General	-	****	-	*	-	4.095696*
Wachovia Corp	*	****	-	****	-	8.533172*
Wells Fargo	-	****	-	****	-	0.210460
				Rejected at **** = 99% *** = 97,5% ** = 95% * = 90% - Not Rejected	Rejected at *** = 99% ** = 95% * = 90% - Not Rejected	Rejected at * = 95% level

Unit root and stationarity tests
The hypothesis that the data is stationary (KPSS-test) can be rejected with slightly higher probability than for the early period, and with slightly higher probability than for the complete period. As in the test for the complete period the ADF-test for unit roots is rejected in three cases regarding the CDS spread and one case for the bond spreads.

However, the ADF-test for unit roots is rejected in three cases regarding the bond spread. As in the test for the previous test for the complete period, test results indicate that most of the data could contain a unit root, and this leads us to assume that this data is non-stationary.

Cointegration tests
The ADF test within the Engle-Granger procedure shows that for only one entity, the hypothesis that no cointegrating relationship exists can be rejected. The Johansen test shows that the hypothesis that a cointegrating vector exists can be rejected for 9 companies (out of 29).

Granger causality tests

Table 6: Test statistics, Granger causality test, complete period

Granger causality	F-statistic CDS causes Bond	F-statistic Bond causes CDS
Allstate Corp	**45.1752**	**8.03038**
Amro Bank	**1.55822**	**2.71628**
Avalon Bay	**33.0046**	**70.6407**
Banca Paschi	**5.01141**	**2.31765**
Banco Santander	1.00733	0.14029
Bank of America	**12.5119**	**143.462**
Barclays	**1.45148**	**51.4178**
Bear Stearns	**4.18409**	**41.9074**
BNP Paribas	**1.16547**	**5.95489**
Citigroup	**17.0917**	**293.683**
Commerzbank	0.22483	0.28452
Credit Agricole	**1.25504**	**3.62902**
Deutsche Bank	**6.54483**	**12.2482**
Developers Dvrsf	**79.3743**	**1.48936**
Fannie Mae	**1.44446**	**1.21190**
Fortis NL	**3.34836**	**15.3362**
Freddie Mac	**7.36121**	**5.52683**
Goldman Sachs	**55.3745**	**2.67074**
Investor	**137.986**	**11.9998**
Kimco	**14.6181**	**18.5950**
Lincoln	**18.3346**	**29.7008**
Marsh McLennan	**19.8036**	**7.46265**
Merril Lynch	**33.8307**	**9.43593**
Morgan Stanley	**36.5079**	**20.2808**
Simon Property	**45.0592**	**21.7752**
SLM Corp	**107.645**	**24.4543**
Societe General	**5.39808**	**1.31936**
Wachovia Corp	**40.9273**	**18.2227**
Wells Fargo	**18.2945**	**6.81013**

n=602
H0: series y does not granger cause series y2
If H0 is rejected, the result is in **bold**.

For the total period, the Granger causality test indicates that for all entities except for two, there is significant evidence that CDS spread Granger-causes bond spread, and the same is valid for the contrary case.

Table 7: Granger causality test for period 1–3

	Period 1		Period 2		Period 3	
Granger causality	F-statistic CDS causes Bond	F-statistic Bond causes CDS	F-statistic CDS causes Bond	F-statistic Bond causes CDS	F-statistic CDS causes Bond	F-statistic Bond causes CDS
Allstate Corp	**1.44788**	**1.66969**	**2.01389**	**4.22921**	**7.90344**	**1.41147**
Amro Bank	0.61591	0.31170	**3.11761**	**3.77715**	**1.54977**	0.62113
Avalon Bay	**1.57150**	0.31672	**1.08995**	**2.33505**	6.18484	**18.0136**
Banca Paschi	**1.70398**	0.62427	**2.16823**	**3.63093**	2.10452	**1.07193**
Banco Santander	**0.30854**	**4.63495**	0.35265	**10.4310**	2.14279	0.72891
Bank of America	**1.08808**	**1.83025**	0.40788	**1.45100**	1.94485	0.78378
Barclays	**3.17483**	0.44066	**7.53451**	0.02732	**1.03433**	0.06720
Bear Stearns	**1.05572**	**1.04993**	**4.79581**	**1.24703**	**1.55796**	0.86034
BNP Paribas	**3.70192**	0.49175	**2.94830**	**2.10005**	**35.2447**	**1.50385**
Citigroup	**1.21845**	**1.74625**	**2.32342**	0.51547	0.54435	**1.90035**
Commerzbank	0.20099	**2.65211**	**1.70458**	**3.35001**	**26.0830**	**2.91530**
Credit Agricole	0.62741	0.99944	**1.96083**	**3.45236**	**21.1991**	**3.61003**
Deutsche Bank	0.53406	**1.15138**	**3.32739**	**1.27171**	**7.83241**	**22.4670**
Developers Dvrsf	0.63252	**1.15031**	**4.41878**	0.55566	**1.83243**	0.28292
Fannie Mae	**1.48462**	**1.31251**	**9.15286**	**3.43796**	**35.8574**	**2.24079**
Fortis NL	**3.12261**	0.36038	**29.3097**	0.38328	**1.63762**	**9.95579**
Freddie Mac	**1.93052**	0.44992	**3.43942**	0.35936	**1.22377**	0.97290
Goldman Sachs	0.31022	0.24695	0.37105	0.42469	**40.3451**	**5.07308**
Investor	**4.89452**	0.54393	0.93659	**2.29077**	**38.9791**	**3.36340**
Kimco	0.83554	**1.72924**	**3.13261**	**3.21967**	**2.71437**	**5.66591**
Lincoln	**2.09084**	**1.20666**	**1.47705**	**1.32419**	**6.43099**	**19.3780**
Marsh McLennan	**3.92880**	**2.15226**	**7.56885**	**2.52839**	**7.69628**	**5.64857**
Merril Lynch	**3.43768**	**2.78771**	**14.9796**	**18.1406**	**11.5466**	0.77328
Morgan Stanley	**1.10338**	**1.77762**	**4.60027**	**3.08679**	**58.5259**	**3.61316**
Simon Property	**3.16480**	**2.50540**	**5.35716**	**3.76069**	**12.7920**	**8.61228**
SLM Corp	**2.95566**	**1.54945**	**13.1618**	**2.09350**	**19.7205**	**4.82349**
Societe General	**2.91930**	**1.66233**	**1.56143**	0.26079	**2.93240**	**1.82726**
Wachovia Corp	**1.41125**	0.93202	**14.2114**	**3.11782**	**196.853**	**1.75143**
Wells Fargo	**1.50609**	0.71668	**3.82337**	**3.81878**	**4.77944**	**1.03064**

n=338 for each period
H0: series y does not granger cause series y2
If H0 is rejected, the result is in **bold**.

As can be seen, the hypothesis that one of the series Granger does not cause the other one can be rejected in most cases. There is slight variation in what causality occurs between the different time periods, although there is no strong trend observable. The number of entities for which both the hypothesis that "bond G-causes CDS", and "CDS G-causes bond" are rejected, is somewhat larger in the second and third period, suggesting that the Granger causality is less often to be found in periods 2 and 3. However, due to the quite small data set, the changes that have taken place are difficult to draw any general conclusions from, by looking at the results.

Blanco et al noted that the CDSs had a clear lead in the price discovery process.[71] For most of our entities a one-way causality has not been found, although for the minority of spreads where such relationship exists, the CDS are found to G-cause bonds during the separate periods.

Validity and Reliability

This section highlights the advantages and disadvantages of the study, in relation to validity and reliability.

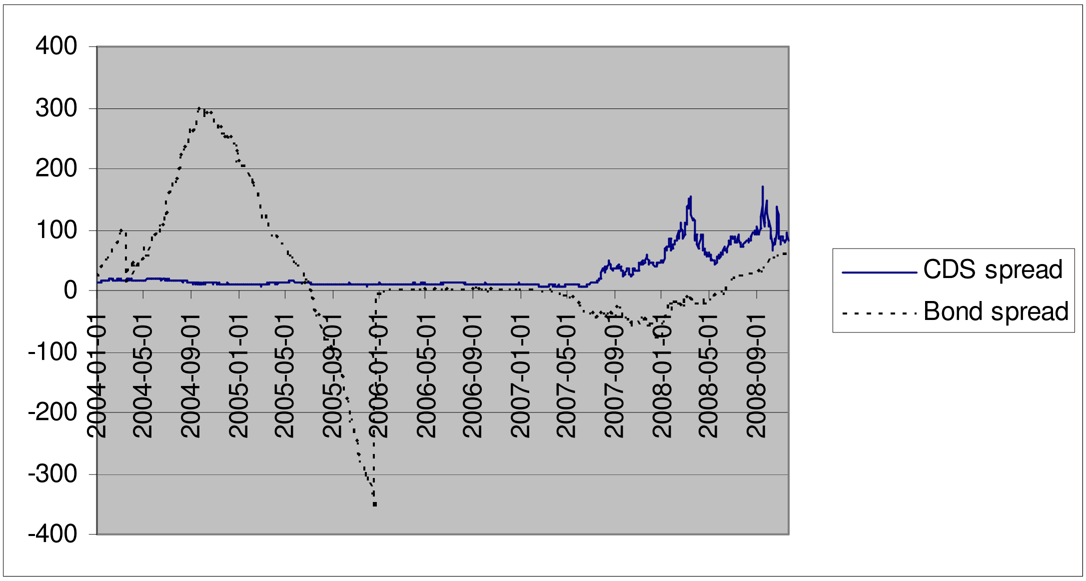
The choice of CDSs and bonds itself is based on the arbitrage formula mentioned above, $s = y - r$, and therefore deemed valid in testing the pricing of risk in each company. The S&P 350 & 500 consists of large companies believed to have a more liquid bond and CDS market than smaller entities, thus making for a good choice to study. The amount of trades and the large amount of information regarding these companies is believed to make the prices of the different financial instruments studied more likely to be correctly set by the market and thus the conclusions made by analyzing these more generalizable. Daily measurements are made because of the connection between CDSs and bonds, arbitrage should make the prices quickly adapt and therefore weekly or monthly averages would probably not be able to show this process.

Another issue is the choice of proxy for risk-free rate in the actual arbitrage relationship. It could be argued that the drastically increased interbank rates of the last year makes the swap rate, which is used here, a less good choice. However, no other alternatives, to us known, have yet been scientifically proven to give a better proxy in this actual case.

The process in the investigation most prone to creating errors may be the construction of generic bonds. A problem that in some cases have arisen is that by using limited amount of bonds to create a generic bond, sometimes untimely ’jumps’ in the generic bond series appear as illustrated below. The reason behind the phenomena is the differing spreads of the companies’ issued bonds. In most cases, the method employed gives results that seem reasonable but the big trade-off is that many companies do not have enough outstanding bonds possessing the criteria needed to create a generic bond and thus making it impossible to include the entity in the test.

Figure 1: Example of Banco Santander

71 Blanco et al. “An Empirical Analysis of the Dynamic Relation between Investment-Grade Bonds and Credit Default Swaps”, The Journal of Finance, Vol LX, no. 5, 2005.



A smaller but still relevant problem is that DataStream does not provide information from where it has received the prices of the CDSs and bond. This makes for a problem, but as Thomson DataStream is a well-known world-wide provider of financial data, often used for research purposes, there seems to be little reason to doubt the reliability of the data quality, but the validity is still difficult to judge.

The choice of time-period to investigate was largely decided by at what point the credit crunch is deemed to have started and how much information was available in total. The results show that both during and in the period before the crisis, there seems to be less of a connection between the CDS and bond spread than during the whole span of the dataset. A more proper way of choosing the time periods to investigate would have been valuable, but since there are no clear theoretical grounds to base the choice on, it would still be arbitrary. Of course the market will react to the perceived increase in risk during the crisis, but when does the market start to react? There may be other factors than the spreads themselves that might show that this is happening.

Even if the choice of method for investigating the collected material is quite textbook, there is still a problem with the choice of lags during several of the tests. When an information criterion was not possible to use in the software, manual methods were resorted to. Without theoretical guidance, shorter (0–20 days) lags were found appropriate testing considering the nature of the studied objects and the size of the periods implying no trades. More than 10 lags were never found to be the significant choice and were only resorted to for information purposes and thus no results are based on a lag number greater than 10.

Also, the Granger causality test does not, as implied by the name, exactly tell what causality may exist between the bonds and CDSs. What it actually does tell is *how* and *if* the two instruments move together over time.

Another quite puzzling find during the testing is that the ADF test on residuals and the Johansen testing procedure often give contrary results concerning the cointegrating relationships investigated. Brooks voices critique against the Engle-Granger procedure[72] although not specifically touching on why the tests in this thesis may have given such

72 Brooks, Chris, Introductory Econometrics for Finance, Cambridge University Press 2008, p 342-343

contradictory results. Brooks conclusion seems to be that the Johansen method is preferable in any case[73]. Also Zhu takes both methods results as proof of cointegration without much further elaboration[74] on whether one method gives more robust results than the other. In this thesis this mindset has been adopted, although contrasting results are commented on when found. All Johansen trace tests needs $Ho{:}r{=}0$ to be rejected and $Ho{:}r{=}1$ to not be rejected to prove cointegration.

Analysis

The section provides an analysis of the test results. Explanations of the difference between the CDS spread and the Bond spread will be suggested. Also the cointegrating relationship and different factors influencing the market will be discussed.

As seen in the presentation of data, the difference between the CDS spread and bond spread for the same reference entity is not zero in any case as the pricing model suggests. Does this mean that there are arbitrage possibilities present? Not necessarily.

The credit spread depends on both the bond spread and the CDS spread, and to explain the arbitrage relationship, both spreads must be taken into consideration. As described above, there are several factors that the arbitrage model does not account for. One example is taxes. The companies in this investigation have different tax domiciles, and thereby follow different taxation rules. As an example, yields from treasury notes are deductible from state income tax in the US. Maybe this can be one explanation behind our finding that the bond spread is averagely higher than the CDS spread in our investigated data, at least as regards the US companies (that accounts for over 50% of the companies in the sample)?

Furthermore, the theoretical arbitrage relationship holds for *floating-rate instruments*.[75]As floating rate instruments are not very wide spread, the empirical studies generally use fixed-coupon bonds[76], which also is the bond type used in this investigation. In case of default, the protection seller is obliged to pay the face value of the bond, and will in this case probably demand a higher CDS premium as compensation for a CDS on a bond quoted below par, which will cause the credit spread to increase.[77]

The size of the bond spread is obviously also affected by the choice of rate to use as a proxy for the risk free rate. As discussed earlier, the swap rate has in previous studies showed to be the best proxy for the risk free rate, but none of the investigations referred to cover a time period from after 2005. It could not be excluded that another rate might be a better proxy. The size of the bond spread is also dependent on the construction method of the synthetic bonds, which have sometimes given rise to seemingly implausible proxies for the 5-year spread.

Another factor that is unrelated to the underlying credit risk, but still most likely has influence on the prices of the two spreads, is the liquidity in the market. According to Dötz, the liquidity

73 ibid

74 Zhu, Haibin, ”An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market”, Journal of Financial Services Research, 2006:3, p. 228

75 Duffie, Darrel, “Credit Swap Valuation”, Financial Analysts Journal, 1999:1, p. 74

76 Dötz, Niko, “Time-varying contributions by the corporate bond and CDS markets to credit risk price discovery”, Discussion Paper: series, p. 7

77 ibid

in the CDS market can temporarily dry out, particularly in times of financial distress, since "the market players, whose herding behaviour, particularly in times of crisis, can strain liquidity, amplify market volatility and hamper price discovery".[78] Another reason could be that protection sellers no longer are willing to sell protection, when the credit quality of the underlying companies weakens. Zhu finds that a liquid CDS market (measured as the bid-ask spread) implies a lower bid-ask spread.[79] The last time period of our investigation is influenced by financial turmoil, and this period has also been characterised by low liquidity in the CDS market. This is probably one important explanation behind the finding that the average credit spread is substantially higher in period 3, than in the two earlier periods. We also found that the first period had a higher average credit spread than the second. One possible explanation could be that also some months in the beginning of 2005 was characterised by some turbulence, according to Dötz.[80]

Our findings imply a somewhat higher credit spread than most previous studies do. One explanation to this could be the above-mentioned suggestion that the spread increases in financial distress which the last app. 16 months of the period investigated is characterised by, and our investigation can thereby be said to support this argument. As shown in the section of the data description, both the average CDS spreads and average bond spreads, and as well as the difference between them, were significantly higher during the third period, characterised by turbulence. This is a sign of the relationship between the credit risk (which is assumed to be higher in the third period) and the CDS as well as the bond spread. Also the credit spread, as well as the standard deviation of the credit spread, was much higher during the third period.

As argued previously, the lack of regulation of the CDS market makes the exposure of the market player invisible. This could lead to information bias, and an ineffective market. Since the market players don't know how large amount of protection, and for which underlying entities protection is sold, it is difficult to assess the counterparty's risk properly. This might also affect the pricing of credit risk, albeit the effect is probably very difficult to investigate. If the ongoing debate will lead to a stricter regulation in the CDS market, this might increase transparency in the future.

One thing to bear in mind is that the CDS market is relatively new, and far from mature. It has existed for a little more than a decade, with only a small traded amount in the start, and with a rapid, almost exponential increase of the amount outstanding. This could be compared with the bond market that has existed for a few hundred years.[81] It has been argued that when the trade in futures started in the 1980's, there was a similar development, with unexpected price movements. However, as the market for futures matured, it also stabilised. It is not unlikely that a similar development will be seen in the CDS market.

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78 ibid, p. 24

79 Zhu, Haibin, "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 211-235.

80 Dötz, Niko, "Time-varying contributions by the corporate bond and CDS markets to credit risk price discovery", Discussion Paper: series 2: Banking and Financial Studies, no 08/2007, published by Deutsche Bundesbank, p. 22

81 The start year is very difficult to set, since it depends on how to definition of key concepts, as "bond", "market" and so on. But as an example, trading in government bonds began on the Frankfurt Stock Exchange, already in the end of the 17th century. "Historie: Bürger, Fürsten, Neue Börsen - 18. und 19. Jahrhundert" published by Deutsche Börse Group. http://deutsche-boerse.com/dbag/dispatch/de/kir/gdb_navigation/career/
10_The_Company/10_Deutsche_Boerse_Group/90_History?horizontal=page3

It can be concluded that there are a number of factors affecting the spreads, which not make it unlikely that the arbitrage relationship holds, even though the credit spread found is not zero. One thing that indicates that such a relationship still holds is that the test results indicate a cointegrating relationship. This relationship does not hold for each entity, for each point of time, but our tests still give support to the view that such a relationship exist in many cases.

For a theoretical arbitrage relationship to exist there has to be proven that the CDS and generic bond of the chosen entities do cointegrate during the periods investigated.
During the complete period, 2004-01-01 to 2008-11-24 there is a mixed impression of whether the instruments' spreads are connected or not, 19 of 29 entities are shown to have cointegrated CDS and bond spreads judging by the Engle-Granger ADF test. The Johansen test tells us the same number, but not for exactly the same entities. Two spread-pairs are said to not cointegrate by both tests and 11 are said to do. As will be shown, the circumstances influencing or influenced by the credit crisis may account for part of the lack of cointegration between some CDS and bonds. Still, more companies than expected are indicated to have non-cointegrated CDS and bond spreads judging by the results from the two tests.

In the first separate period of the study, few of the entities can be proven to be connected in the way suggested by theory. Seven companies show a cointegrating relationship in the Engle-Granger ADF test, even though the assumption was that this period should have the highest number of cointegrating spreads. The Johansen test gives quite the opposite answer: 25 entities show signs of a cointegrating vector. The Johansen test and the Engle-Granger ADF test gives the same result only in two cases as for when there is no cointegration and in 5 cases when there is. In the articles referenced, unfortunately no clear answer as to why this situation appears to be found. Worth noting is also that even though the Engle-Granger ADF test and Johansen tests for period 1 show less cointegrating entities, than for the total period, Granger causality is found for most of the companies, a trend noticeable for all the sub periods.

When plotting the CDS and bond series of the different companies, there is no doubt that prices has increased in the last year, which the average price confirm, thus concluding that even though spreads may not always cointegrate, both CDS and bond spread may be used as a measure of credit risk, although equilibrium between them in some instances do not exist.

In the second period, which is closest to the start of the credit crunch, the situation has changed. Only one company can be said to cointegrate by the Engle-Granger ADF (and Johansen agrees on this one) test, although Johansen implies there might be 20 cases where the theoretic relationship studied is present. The standard deviation of the CDS spread has also increased threefold. In a study by Zhu[82] the CDSs have been found to be the primary instrument of price discovery when pricing credit risk and thus could possibly anticipate the great rise in spread in the following and last observed period (period 3). A more in-debt study would be able to tell if there is a significant connection. Granger-causality seems to be just about the same as in period one although somewhat less connections are expected.

During period three oddly enough, there are signs of more companies with cointegrated spreads than during the pre-crisis second period. Six entities are showed by Engle-Granger ADF and 19 by Johansen to be cointegrated. The two tests agree on four entities being cointegrated, and eight entities not being cointegrated. One reason might be that some companies listed may have received state support and thus a better credit rating, which could

82 Zhu, Haibin, "An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market", Journal of Financial Services Research, 2006:3, p. 231

possibly stabilize the markets for CDS and bonds. Government takeovers or similar changes in the company's equity and debt structure as a result of the crisis may also contribute as stabilizing factors. A separate study of the impact of government intervention or similar would be able to provide more solid evidence.

The variance in the number of cointegrating companies during the three periods makes it hard to infer what changes over time. One thing that seems clear though is that there is less obvious cointegration in the separate sub periods (especially in the sub period during the crisis), than during the whole period. Without a test that clearly holds higher power, there is not very much that can be said of the cointegration test results, than that they in every case show less cointegration than proposed by the arbitrage relationship.

As a consequence of the higher risk perceived during different periods, fewer trades might be made and thus causing a discrepancy in the pricing of the bonds and their derivatives, which in turn leads to less of a cointegrating relationship. The information on what risk-exposure each entity has, might be seen as quite asymmetric and may thus lead to a less-than-perfect pricing situation. This may still hold but apparently is not as prominent during the crisis as in the time before, in contrast to what might seem likely.

In all, the results in the short run were not those anticipated with regards to general economic theory, although it is hard to tell if this might be a result of misspecifications in the study or economic reality. As discussed in the section on reliability, the generic bonds may have caused some erroneous results and there may also be the risk of misspecifications in the lags of the tests. More tests for cointegration might also be applied to generate more robust results.

In the long run, there seems to be somewhat better evidence of cointegration between the CDS and bond market as have been expected, although an unexpected number of entities still does not seem to cointegrate.

Conclusion

The average CDS spread, as well as the average bond spread, is drastically higher in the third period. The same is true for the credit spread and the standard deviation of the credit spread. When looking at which spread is the highest, CDS or bond, there is no strong dominance.

We also find that the relationship $s = y - r$ does not hold. The differences between the bond spread and CDS spread can at times be quite large and it is difficult to explain if these findings are due to that arbitrage possibilities actually exist (which is unlikely, considering the use of averages), or if other factors lie behind.

The existence of a theoretical arbitrage relationship is further tested for, using cointegration tests. The Johansen test is more likely to indicate cointegration for all sub-periods and has given the same result as the Engle-Granger ADF when testing the total period. The almost contradictive relationship between the two tests makes it hard to infer any conclusions from the cointegration study. It might be that the tests are sensitive to the size of the sample and thus gives different (but not necessarily correct) results when testing the total period. In any case there is less strong evidence of cointegration than expected and thus the arbitrage relationship cannot be proven to be found in many of the entities studied, although the scope of the lack of connection needs to be more thoroughly tested.

Further research

Although there already has been research done in this field, there are a wide number of question still unanswered. It would be interesting to quantify how large influence different factors have on the CDS spread?

One thing that this investigation does not examine is the liquidity issue: how does liquidity in the different markets affect the spreads? How is the traded amount influenced by the risk and price level of the instruments?

It would be also be fitting to dig even deeper into the relations between the different financial instruments studied. Constructing VAR och VECM models of each relation, imposing restrictions and performing different tests to estimate sensitivities in the variables would yield even more information.

Another thing, that this investigation does not at all cover, is the behaviour of a CDS spread before a credit event, i.e. how well the CDS spreads have been able to anticipate credit events.

The CDS as an instrument is still quite new, and the market far from mature. This will probably give rise both to changes in the market conditions, and hopefully, a wide range of future research within the field.

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Appendix

Average prices CDS spreads and Bond spreads for each entity, for each period

	TOTAL period 2004-01-01 to 2008-11-24			Period 1 2005-01-05 to 2006-04-21			Period 2 2006-04-22 to 2007-08-08			Period 3 2007-08-08 to 2008-11-24		
NAME	**Average CDS spread**	**Average Bond spread***	**Δ, Bond spread – CDS spread**	**Average CDS spread**	**Average Bond spread***	**Δ, Bond spread – CDS spread**	**Average CDS spread**	**Average Bond spread***	**Δ, Bond spread – CDS spread**	**Average CDS spread**	**Average Bond spread***	**Δ, Bond spread – CDS spread**
Allstate	37,50	48,78	11,28	23,13	18,20	-4,93	16,24	15,56	-0,69	83,05	144,26	61,21
Amro	27,00	120,47	93,47	9,66	20,17	10,51	7,51	-42,56	-50,07	74,56	458,42	383,86
AvalonBay	76,44	88,25	11,80	30,54	33,00	2,46	28,57	27,48	-1,09	202,50	236,09	33,59
Banca Paschi	29,54	94,26	64,72	17,46	130,55	113,09	10,51	120,18	109,67	67,37	65,86	-1,51
Banco Santander	27,54	21,15	-6,39	10,64	-25,14	-35,78	10,74	-6,39	-17,13	71,07	-10,43	-81,50
Bank of America	35,44	-10,29	-45,74	16,36	6,29	-10,07	12,04	-196,86	-208,90	88,36	128,12	39,76
Barclays	30,61	52,14	21,53	9,77	32,68	22,90	8,31	-1,82	-10,13	89,20	74,67	-14,53
Bear Stearns	63,49	133,12	69,63	28,38	66,42	38,03	31,49	90,04	58,55	152,62	278,28	125,66
BNP Paribas	20,18	45,13	24,95	9,18	28,21	19,03	7,06	15,55	8,49	51,21	99,23	48,02
Citigroup	45,23	60,83	15,60	16,14	13,11	-3,03	11,57	13,50	1,93	126,43	192,50	66,07
Commerzbank	32,34	19,81	-12,52	17,93	8,03	-9,90	11,86	-10,70	-22,57	73,50	-6,84	-80,34
Credit Agricole	25,20	43,29	18,09	9,31	13,16	3,86	7,47	14,77	7,31	69,68	116,25	46,57
Deutsche Bank	31,10	26,05	-5,05	15,65	6,43	-9,22	12,68	16,41	3,73	75,98	66,87	-9,11
Developers	137,14	127,41	-9,74	52,60	58,61	6,01	43,41	40,86	-2,55	374,38	326,48	-47,90
Fannie Mae	22,69	222,91	200,22	14,92	270,47	255,55	9,18	137,67	128,49	44,25	151,14	106,90
Fortis NL	42,96	48,19	5,23	20,12	57,44	37,32	8,58	1,49	-7,09	112,40	90,92	-21,48
Freddie Mac	21,79	532,11	510,33	11,93	464,31	452,38	8,04	485,37	477,33	45,26	714,98	669,72
Goldman Sachs	58,72	-92,36	-151,08	26,07	-115,72	-141,79	27,62	-258,23	-285,86	142,31	66,80	-75,52
Investor	39,69	44,61	4,92	21,78	20,45	-1,33	12,20	15,03	2,84	89,48	100,61	11,13
Kimco	86,87	82,95	-3,92	29,58	31,91	2,33	27,21	28,58	1,37	246,99	230,58	-16,42
Lincoln	66,54	58,17	-8,36	24,47	13,38	-11,08	17,43	24,89	7,46	187,83	151,97	-35,86
Marsh&McLennan	58,84	91,51	32,67	57,24	68,06	10,82	52,35	64,72	12,37	69,64	174,28	104,64
Merril Lynch	71,24	92,24	21,00	25,68	24,04	-1,64	25,94	53,08	27,14	192,39	251,79	59,40
Morgan Stanley	78,01	98,03	20,01	26,50	31,73	5,23	28,04	31,73	3,69	215,11	274,75	59,63
Simon Property	70,44	88,27	17,83	39,22	42,36	3,14	22,72	27,96	5,24	167,75	218,73	50,98
SLM Corp.	169,95	172,00	2,05	25,92	20,96	-4,96	70,58	66,95	-3,63	517,84	541,74	23,90
Societe Generale	25,27	117,50	92,23	10,31	208,34	198,03	7,54	34,40	26,86	68,33	172,21	103,88
Wachovia	56,59	75,62	19,04	15,22	12,49	-2,73	13,48	14,23	0,75	168,59	235,52	66,93
Wells Fargo	33,44	35,87	2,43	14,29	6,90	-7,38	10,49	8,05	-2,44	84,81	110,24	25,43
	52,48	**87,52**	**35,04**	**21,72**	**54,03**	**32,30**	**19,34**	**28,69**	**9,35**	**136,31**	**195,03**	**58,73**

Standard deviations for the data for each entity, for each period

	TOTAL period 2004-01-01 to 2008-11-24			Period 1 2005-01-05 to 2006-04-21			Period 2 2006-04-22 to 2007-08-08			Period 3 2007-08-08 to 2008-11-24		
	Average CDS spread	**Average Bond spread***	**Δ, Bond spread – CDS spread**	**Average CDS spread**	**Average Bond spread***	**Δ, Bond spread – CDS spread**	**Average CDS spread**	**Average Bond spread***	**Δ, Bond spread – CDS spread**	**Average CDS spread**	**Average Bond spread***	**Δ, Bond spread – CDS spread**
Allstate	45,28	71,72	36,29	3,81	4,66	6,34	6,61	4,83	8,10	69,64	83,66	36,19
Amro	33,36	255,28	230,99	1,84	14,16	14,86	4,48	215,02	215,16	33,33	207,30	197,20
AvalonBay	99,25	125,92	45,54	3,89	7,46	7,38	7,97	4,76	9,29	125,29	173,69	83,10
Banca Paschi	26,26	44,78	60,29	2,64	32,79	33,52	5,38	40,79	40,90	24,10	23,88	34,42
Banco Santander	30,16	110,51	116,51	1,69	138,65	138,15	4,45	13,83	16,22	29,07	37,80	28,73
Bank of America	38,21	140,13	116,03	2,87	42,68	41,17	6,09	89,72	85,74	40,52	95,49	67,50
Barclays	42,37	64,15	63,80	1,79	64,49	63,80	4,65	18,68	20,70	46,14	61,35	53,38
Bear Stearns	71,62	105,36	76,21	4,79	24,85	22,49	19,36	40,34	33,03	90,82	103,65	124,36
BNP Paribas	21,37	44,40	30,46	1,78	7,19	6,51	3,39	9,84	9,05	20,07	55,70	49,65
Citigroup	62,08	103,08	46,61	2,87	4,12	4,06	6,51	5,97	4,90	74,69	129,33	68,30
Commerzbank	28,80	78,63	85,76	3,59	91,73	91,73	7,77	29,32	29,24	26,18	34,91	37,12
Credit Agricole	31,19	54,51	34,32	1,70	10,27	9,42	3,32	7,69	7,11	31,21	61,46	56,31
Deutsche Bank	31,91	26,42	16,73	2,55	9,39	9,91	5,57	4,15	5,44	32,94	14,04	28,03
Developers	238,88	169,99	100,95	8,14	8,06	8,46	6,25	5,52	8,07	372,93	234,75	189,05
Fannie Mae	16,26	113,76	115,38	4,61	103,54	99,27	4,60	25,92	25,47	15,62	67,56	66,27
Fortis NL	62,88	52,30	39,43	4,13	37,71	34,36	3,45	15,84	16,26	90,74	65,89	47,11
Freddie Mac	17,27	124,48	112,06	3,34	12,79	14,44	4,65	32,14	31,00	15,76	94,07	87,69
Goldman Sachs	72,75	183,91	139,70	4,71	61,29	62,35	11,54	161,63	159,74	101,96	207,86	130,29
Investor	48,38	58,49	20,26	2,32	3,07	2,55	2,55	3,69	4,52	72,29	90,93	37,82
Kimco	140,21	129,35	37,39	4,05	4,49	6,79	7,49	5,13	9,11	199,10	183,82	69,60
Lincoln	140,18	76,19	77,39	2,53	5,12	5,54	6,28	9,20	13,40	233,05	98,21	145,11
Marsh&McLennan	26,99	70,60	59,89	16,72	19,13	10,16	13,44	11,57	10,66	22,19	81,69	77,64
Merril Lynch	86,77	116,87	51,00	4,66	5,43	4,58	12,81	41,37	32,82	91,98	122,81	77,86
Morgan Stanley	134,59	183,73	75,48	4,34	4,70	7,42	11,72	10,47	12,76	207,22	291,97	138,26
Simon Property	88,95	112,77	36,49	1,84	14,16	14,86	8,64	6,76	9,25	129,14	156,81	57,48
SLM Corp.	274,91	271,87	65,53	3,28	7,60	8,81	86,90	73,34	17,49	337,50	297,47	122,85
Societe Generale	30,50	131,75	126,48	1,97	168,95	170,07	3,23	39,39	39,33	31,45	111,65	104,32
Wachovia	97,42	150,77	78,17	2,60	3,67	4,52	6,00	6,51	6,25	137,38	226,19	140,70
Wells Fargo	36,81	59,31	33,58	2,22	6,72	6,80	5,27	4,65	6,90	38,28	75,65	58,31
AVERAGE	**71,57**	**111,42**	**73,41**	**3,70**	**31,69**	**31,39**	**9,67**	**32,35**	**30,62**	**94,50**	**120,33**	**83,26**

Number of days where bond spread >CDS spread

Name	Total period 2004-01-01 to 2008-11-24		Period 1 2005-01-05 to 2006-04-21		Period 2 2006-04-22 to 2007-08-08		Period 3 2007-08-08 to 2008-11-24	
Allstate	626	48,98%	91	26,92%	190	56,21%	331	97,93%
Amro	1053	82,39%	297	87,87%	184	54,44%	334	98,82%
AvalonBay	866	67,76%	200	59,17%	207	61,24%	212	62,72%
Banca Paschi	1090	85,29%	338	100,00%	338	100,00%	160	47,34%
Banco Santander	626	48,98%	121	35,80%	190	56,21%	331	97,93%
Bank of America	699	54,69%	213	63,02%	0	0,00%	274	81,07%
Barclays	773	60,49%	226	66,86%	191	56,51%	92	27,22%
Bear Stearns	1195	93,51%	317	93,79%	329	97,34%	293	86,69%
BNP Paribas	1168	91,39%	334	98,82%	274	81,07%	296	87,57%
Citigroup	630	49,30%	71	21,01%	234	69,23%	300	88,76%
Commerzbank	529	41,39%	221	65,38%	37	10,95%	18	5,33%
Credit Agricole	1088	85,13%	263	77,81%	278	82,25%	283	83,73%
Deutsche Bank	498	38,97%	61	18,05%	280	82,84%	155	45,86%
Developers	717	56,10%	262	77,51%	124	36,69%	136	40,24%
Fannie Mae	1268	99,22%	338	100,00%	338	100,00%	328	97,04%
Fortis NL	707	55,32%	287	84,91%	116	34,32%	104	30,77%
Freddie Mac	1278	100,00%	338	100,00%	338	100,00%	338	100,00%
Goldman Sachs	100	7,82%	5	1,48%	14	4,14%	81	23,96%
Investor	812	63,54%	101	29,88%	240	71,01%	207	61,24%
Kimco	673	52,66%	203	60,06%	223	65,98%	138	40,83%
Lincoln	723	56,57%	14	4,14%	265	78,40%	212	62,72%
Marsh&McLennan	1021	79,89%	315	93,20%	305	90,24%	336	99,41%
Merril Lynch	713	55,79%	107	31,66%	263	77,81%	291	86,09%
Morgan Stanley	942	73,71%	239	70,71%	210	62,13%	257	76,04%
Simon Property	993	77,70%	236	69,82%	273	80,77%	275	81,36%
SLM Corp.	555	43,43%	74	21,89%	179	52,96%	246	72,78%
Societe Generale	1237	96,79%	338	100,00%	326	96,45%	309	91,42%
Wachovia	762	59,62%	96	28,40%	185	54,73%	252	74,56%
Wells Fargo	431	33,72%	26	7,69%	147	43,49%	236	69,82%
AVERAGE	820	64%	198	59%	216	64%	235	70%

Test statistics for the complete period, 2004-01-01 to 2008-11-24

Company	**Unit root and stationarity tests** ADF Test H0:I(1) KPSS Test H0:I(0)				**Cointegration tests** H0:No cointegrating equation	H0: r=1 cointegrating vector exists
	CDS Spreads		Bond Yields		Engle/Granger	Johansen
	ADF	KPSS	ADF	KPSS	ADF	Trace Stat
Allstate Corp	2.51445	6.10749	4.28346	10.794	-4.31842	14.04399
Amro Bank	-1.94224	10.5424	-0.923968	6.58323	-3.2276	0.211969
Avalon Bay	3.177	9.59306	5.22265	8.27788	-4.61771	19.97770
Banca Paschi	-1.70826	4.21431	-1.379	4.21431	-1.69258	2.395344
Banco Santander	-1.63918	11.2447	-1.75402	5.19767	-1.64464	3.219033
Bank of America	0.220864	10.4593	1.42142	3.9552	-1.88636	1.036899
Barclays	-1.77916	11.0218	-0.179674	4.79985	-2.68331	0.003448
Bear Sterns	-4.13998	7.99017	-0.42855	11.7001	-5.90281	1.700480
BNP Paribas	-1.57048	10.8128	-2.13919	6.87829	-5.22049	1.687035
Citigroup	-0.826945	10.0288	1.10932	10.2412	-6.48285	0.017730
Commerzbank	-2.42439	9.29331	-3.40967	5.73341	-2.44509	5.632254
Credit Agricole	-1.52199	11.0355	1.36672	9.885	-2.87568	0.012850
Deutsche Bank	-1.83305	10.8328	-1.00727	14.6428	-5.12411	0.539458
Developers Dvrsf	9.52973	6.41258	6.57964	8.22024	-5.92106	38.17143
Fannie Mae	-2.31096	6.85323	-0.340243	13.8627	-2.3212	0.157056
Fortis NL	0.574748	4.17919	-1.32534	1.81819	-0.306916	0.887945
Freddie Mac	-2.09341	7.57056	-1.62851	14.2033	-3.93849	1.285915
Goldman Sachs	-0.95606	8.37809	-1.12781	3.38871	-3.40314	0.686447
Investor	0.265039	5.84519	0.305075	5.10185	-6.28677	1.654881
Kimco	5.92526	8.20323	4.55621	8.44415	-4.78493	20.82038
Lincoln	2.71664	5.24984	5.3365	9.40954	-2.93625	8.444370
Marsh McLennan	-4.27927	1.26791	1.32278	9.3127	-3.94917	1.868867
Merril Lynch	-1.44054	11.3785	2.49093	13.353	-4.69704	0.799274
Morgan Stanley	-2.42109	6.97977	0.190096	6.31514	-6.57728	5.031263
Simon Property	4.33887	6.67073	9.75935	7.44565	-7.07322	55.62257
SLM Corp	-1.17943	10.7398	-0.53155	12.0488	-6.76732	1.784499
Societe General	-0.901148	10.846	-1.55127	1.81932	-0.953205	2.037201
Wachovia Corp	-3.04223	8.541	-1.46251	7.6725	-3.467345	13.39102
Wells Fargo	-0.976411	10.3345	4.80425	9.47562	-4.02921	4.917691

Test statistics for period 1, 2005-01-05 to 2006-04-21

Company	**Unit root and stationarity tests** ADF Test H0:I(1) KPSS Test H0:I(0)				**Cointegration tests** H0:No cointegrating equation	H0: r=1 cointegrating vector exists
	CDS Spreads		Bond Yields		Engle/Granger	Johansen
	ADF	KPSS	ADF	KPSS	ADF	Trace Stat
Allstate Corp	-1,82705	1,60101	-2,8896	1,04409	-1,97218	14.04399
Amro Bank	-1,74388	3,05068	2,96055	2,17766	-1,98338	0.211969
Avalon Bay	-2,12849	7,29374	-2,10413	3,21155	-2,56981	19.97770
Banca Paschi	-0,62518	2,48307	1,18677	5,0031	-1,54881	2.395344
Banco Santander	-1,99009	1,79459	-1,91127	3,13143	-2,14252	3.219033
Bank of America	-1,90597	3,05423	1,3287	10,6857	-2,682	1.036899
Barclays	-2,01985	2,18483	-1,48466	11,0787	-2,30349	0.003448
Bear Sterns	-2,17073	6,41488	-1,69047	3,92173	-3,20477	1.700480
BNP Paribas	-1,69234	5,31708	-3,45025	3,96578	-2,89456	1.687035
Citigroup	-1,89827	2,98683	-3,5682	0,713935	-2,17659	0.017730
Commerzbank	-1,37102	2,41775	-2,57325	1,36904	-1,35725	5.632254
Credit Agricole	-1,33462	3,82476	-1,48303	4,07654	-2,07062	0.012850
Deutsche Bank	-2,55403	3,23325	-1,52868	12,4931	-2,28395	0.539458
Developers Dvrsf	-3,01385	2,05458	-2,11408	0,75968	-3,45917	38.17143
Fannie Mae	-0,878306	5,27068	-0,747297	5,63097	-2,61934	0.157056
Fortis NL	-0,972992	4,16331	-1,26839	4,02708	-3,25709	0.887945
Freddie Mac	-1,21475	10,1639	-1,68586	3,42049	-1,62672	1.285915
Goldman Sachs	-0,95606	2,44722	-1,12781	1,30863	-3,40314	0.686447
Investor	-2,73075	1,22542	-2,64171	1,73022	-3,58627	1.654881
Kimco	-2,20008	2,27688	-2,38321	0,899545	-2,46273	20.82038
Lincoln	-2,88806	3,39232	-3,50518	2,37817	-2,92199	8.444370
Marsh McLennan	-2,53289	4,18313	-2,27059	9,12999	-3,51759	1.868867
Merril Lynch	-2,07143	7,64054	-2,78426	2,52714	-3,26102	0.799274
Morgan Stanley	-1,6599	6,82093	-2,76604	1,81854	-2,44422	5.031263
Simon Property	-1,17805	2,53382	-3,16307	2,31579	-1,98448	55.62257
SLM Corp	-1,36097	2,54267	-2,08245	3,81942	-1,69264	1.784499
Societe General	-1,07827	3,25856	-1,27374	4,38638	-1,32502	2.037201
Wachovia Corp	-2,14615	7,60826	-5,90254	0,829033	-2,16162	13.39102
Wells Fargo	-1,73374	4,0404	-2,84882	1,25171	-1,81761	4.917691

Test statistics for period 2, 2006-04-22 to 2007-08-08

Company	Unit root and stationarity tests ADF Test H0:I(1) KPSS Test H0:I(0)				Cointegration tests H0:No cointegrating equation	H0: r=1 cointegrating vector exists
	CDS Spreads		Bond Yields		Engle/Granger	Johansen
	ADF	KPSS	ADF	KPSS	ADF	Trace Stat
Allstate Corp	-0.515458	1.16526	-2.15193	0.743451	-0.518171	14.04399
Amro Bank	1.94019	0.600828	-1.58922	2.18466	-0.853821	0.211969
Avalon Bay	1.65744	2.00376	-3.4316	2.25825	1.22839	19.97770
Banca Paschi	-0.602403	0.49332	0.438894	3.1318	-0.642815	2.395344
Banco Santander	-0.771154	0.323882	1.54581	3.02551	-2.40354	3.219033
Bank of America	-0.0664353	5.80532	0.962621	5.34302	-2.72626	1.036899
Barclays	0.34168	0.537362	-0.863898	2.33358	-1.94404	0.003448
Bear Sterns	3.44817	1.32788	-0.726992	0.898034	-0.157675	1.700480
BNP Paribas	1.82025	0.456133	-1.69831	0.571646	-1.32996	1.687035
Citigroup	2.36959	0.890758	0.460782	3.92254	-0.592118	0.017730
Commerzbank	-0.0975663	0.293659	-0.0160766	2.11174	1.18237	5.632254
Credit Agricole	0.170294	0.625407	-1.03798	0.607918	0.0935481	0.012850
Deutsche Bank	0.838298	0.608595	-1.93315	0.618847	0.453925	0.539458
Developers Dvrsf	3.07608	1.41742	-2.85827	2.74382	2.57996	38.17143
Fannie Mae	-0.979329	0.95293	-1.55105	1.53814	-0.810178	0.157056
Fortis NL	0.0375433	0.699823	-2.72792	0.898406	0.344102	0.887945
Freddie Mac	-2.40084	0.948977	-1.79875	2.83692	-2.65855	1.285915
Goldman Sachs	1.74038	1.10635	-2.22413	0.451012	0.34843	0.686447
Investor	-1.91647	1.38877	-1.94013	3.82275	-1.11225	1.654881
Kimco	0.523705	1.30581	-2.18317	1.2314	0.130403	20.82038
Lincoln	-0.947865	1.62247	-2.16388	1.47508	-1.1239	8.444370
Marsh McLennan	-1.65657	4.19899	-0.6156	0.922454	-2.4892	1.868867
Merril Lynch	1.4665	1.25564	1.61989	2.53058	-0.985102	0.799274
Morgan Stanley	2.22542	1.45481	-0.912535	1.24269	1.02333	5.031263
Simon Property	-0.271136	0.409879	-1.61473	2.36232	-1.00773	55.62257
SLM Corp	1.4575	2.48316	0.298234	3.15986	-4.17625	1.784499
Societe General	-1.16002	0.636405	-5.68107	1.71956	-1.45139	2.037201
Wachovia Corp	3.41652	0.800883	-0.966904	0.956572	-0.687258	13.39102
Wells Fargo	1.6972	0.704594	-2.30772	1.19994	1.1535	4.917691

Test statistics for period 3, 2007-08-09 to 2008-11-24

Company	**Unit root and stationarity tests** ADF Test H0:I(1) KPSS Test H0:I(0)				**Cointegration tests** H0:No cointegrating equation	H0: r=1 cointegrating vector exists
	CDS Spreads		Bond Yields		Engle/Granger	Johansen
	ADF	KPSS	ADF	KPSS	ADF	Trace Stat
Allstate Corp	0.352002	1.85906	1.30828	3.06119	-4.54313	14.04399
Amro Bank	-2.27503	1.74794	-2.10582	0.715558	-2.20435	0.211969
Avalon Bay	0.893398	1.56375	2.29899	2.17475	-2.52625	19.97770
Banca Paschi	-2.24471	1.61997	0.784582	0.544214	-2.14272	2.395344
Banco Santander	-2.09746	2.49046	0.0424825	3.564367	-2.66109	3.219033
Bank of America	-1.00445	2.74676	0.413926	2.35007	-2.91623	1.036899
Barclays	-1.89733	2.10742	0.728115	2.42154	-2.76744	0.003448
Bear Sterns	-2.90892	0.5313	-1.44624	1.92211	-2.42439	1.700480
BNP Paribas	-2.63534	1.26922	-2.21447	1.27402	-2.8749	1.687035
Citigroup	-1.62343	3.89385	-0.298397	3.65063	-3.42896	0.017730
Commerzbank	-2.56647	0.90536	0.482354	4.09612	-2.56679	5.632254
Credit Agricole	-2.28998	1.57881	0.210632	2.79601	-2.31062	0.012850
Deutsche Bank	-1.70061	1.85542	-2.67252	2.33838	-2.47316	0.539458
Developers Dvrsf	5.44471	1.41573	3.12964	3.23437	-2.16726	38.17143
Fannie Mae	-2.4847	0.478321	-0.473892	2.45434	-2.60998	0.157056
Fortis NL	-0.470645	1.90588	-1.86307	4.4837	-0.728951	0.887945
Freddie Mac	-2.40084	0.649529	-1.79875	2.30846	-2.65855	1.285915
Goldman Sachs	-1.5588	1.89893	-1.03995	2.86882	-3.61515	0.686447
Investor	-0.632636	1.9579	-0.958466	2.07005	-2.29221	1.654881
Kimco	1.23289	1.6438	1.23289	2.11118	-2.7225	20.82038
Lincoln	1.1737	2.19481	2.52567	2.5746	-3.29831	8.444370
Marsh McLennan	-2.15506	0.522078	2.33302	2.38176	-2.27396	1.868867
Merril Lynch	-1.72974	3.46647	0.264151	4.95318	-2.23068	0.799274
Morgan Stanley	-2.39827	1.64925	-0.677263	1.89805	-4.41921	5.031263
Simon Property	2.61172	1.79393	4.37058	2.27972	-3.59179	55.62257
SLM Corp	-2.41526	1.57967	-1.7561	1.66601	-3.37602	1.784499
Societe General	-2.14534	1.87844	-2.15896	0.378466	-1.98955	2.037201
Wachovia Corp	-2.7129	1.62582	-1.74663	3.10123	-2.71347	13.39102
Wells Fargo	-1.71965	2.45342	0.96073	2.80408	-2.43683	4.917691

Acknowledgements

First, we would like to thank our supervisor Göran Anderson pointing us in the right direction. We would also like to thank a number of persons at Nordea, Copenhagen (mainly within Group Credit and Markets), for generously contributing with their knowledge, and having the kindness and patience to answer our questions: Johannes Andersen, Marisa Dohrup, Tomas Grill, and all other persons having shared their knowledge.

Nina: I also want to thank Per Vagn Jensen (Head of Credit of Financial and Institutional Banking, and Senior Credit Manager of Corporate Merchant Banking, Nordea) and Hans Henrik Nielsen (Senior Credit Officer and Team Leader, Group Credit, Nordea), as well as my patient colleagues, for providing the flexibility needed to “making it possible” for me to combine my position in Nordea with the participation and completion of this master course.