Synthetic versus Cash

Derivation and Analysis of the CDS-Bond Basis

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Summary

In this thesis default swap spreads and cash bond spreads of European companies are compared, by analyzing the movement of the difference between the two spreads. We find a significant positive non-zero basis. The basis is not constant over time, with an average positive basis before the credit crisis and an average negative basis during the crisis. The existence of the basis is primarily caused by a lead-lag relationship between synthetic and cash credit markets. Default swap spreads lead in price discovery compared to bond spreads.

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Chapter 1 Introduction

The credit derivatives market has grown rapidly over the past years. The notional amount of outstanding credit default swaps has increased from 20bn USD in 2006 to 57bn USD in 2008[1]. Besides the volume and notional, a large diversity of different types of credit derivatives has been introduced over the years. The Credit Default Swap has been the most influential and traded credit derivative, and has provided investors easy access to corporate credit. Although the growth of the credit derivatives markets and the technicalities of the different derivatives have been documented extensively over the years, a closer look at the market is relevant at the moment. Credit derivatives have played a important role in the financial crisis that erupted in the summer of 2007, and are considered to be one of the main causes. With credit derivatives having received much attention, and above all much scrutiny, the aim of this thesis is to look at the relationship within the credit market between the cash bond market and synthetic credit market during the financial crisis. This crisis, with all its drastic events, such as the collapse of Bear Stearns & Lehman Brothters , poses an opportunity to look at how the relatively new synthetic credit market reacts to severe events compared to the traditional cash market.

The default swap spread is the periodical fee paid/received in a CDS agreement for the protection against default of a certain company's debt, hence a traded compensation for credit risk. The credit risk on cash bonds can also be measured and is called the cash bond or credit spread. Hence, default swap spreads and bond spreads are linked and should be equal. In reality, discrepancies between synthetic and cash exist and cause a persisting spread difference between synthetic and cash markets. The purpose of this thesis is to analyze this relationship between synthetic and cash credit markets. The analysis of the relationship is important for investors and bond insurers, as discrepancies between the two markets may lead to relative value opportunities. Compared to previous studies that focus on the relationship, the added value lies in the possibility that the crisis may bring to light new factors influencing the relationship and/or a different magnitude of influence discovered previously.

[1] BIS Quarterly Review, December 2008

The Research Question

Research question 1:
"Are spreads in the European cash and synthetic credit market equal to each other, both before and during the credit crisis?"

Research question 2:
"What factors can explain the difference between cash and synthetic credit spreads?"

Sub-Hypotheses

1. CDS and cash bond spreads are equal, the basis is zero

Academic studies on the relation between CDS and bond spreads have focused on the long-term pricing equality between CDS and cash bond spreads. These studies find a significant positive difference between the two spreads, called the CDS-Bond basis. These studies also find a stationary basis for some European companies, which implies that CDS and bond spreads price credit risk equally in the long run.

2. The average CDS-Bond basis is constant over time

We are interested if the basis observed prior to the financial crisis differs from the basis during the crisis. A different pattern can indicate discrepancies between the synthetic and cash market caused by the crisis. We are interested what economic variables may cause the latter.

3. The average CDS-Bond basis is the same for different maturities, sectors and ratings

Finally, the findings of the second hypotheses are further refined using these three different subsets:

Chapter 2 Theoretical Background

In this chapter the theoretical background of this study is described. Firstly in 2.1 and 2.2 the basic concepts of the bond spread and CDS are described. Section 2.3 describes the theoretical non-arbitrage relationship between the two spreads and the definition of the CDS-Bond basis. In 2.4 the studies already performed on the subject are described. The main focus of this chapter lies in section 2.5, where a detailed summary is given of the variables that influence the basis according to theory.

2.1 The Cash Bond Spread

The cash bond spread or bond spread is the premium or return that a corporate bond holder earns relative to a benchmark as compensation for credit risk of the issuer. There are two issues with this definition of the bond spread. Firstly, there are different ways of estimating the credit spread on corporate bonds. Each method has its assumptions, advantages and disadvantages. These methods are described later on in this these (section 4.1). Secondly, theoretically the bond spread should only be a measurement of credit risk. However, studies have pointed out that the bond spread reflects more than only compensation for the probability of default[2]. These two issues have an impact on the relationship that we try to analyze in this thesis.

2.2 The Credit Default Swap (CDS)[3]

Basic Description

Credit derivatives are directly linked to the credit worthiness of a firm or sovereign. Credit derivatives allow market participant to directly trade credit risk. The Credit Default Swap (CDS) has been the derivative most popular and dominant in the credit derivatives boom of the last ten years. It has been the building stone for structured credit products. The CDS is comparable to an insurance contract. It is a bilateral contract between the protection buyer and protection seller[4]. The protection buyer insures himself against the losses on a bond after default by a certain company, referred to as the reference entity. The protection seller takes on the risk of default by the reference entity, promising the protection buyer to pay the face value for the company's bond after default. In return, the protection buyer pays an upfront amount or a periodic[5] fee to the protection seller. The latter payment method is the conventional way, and the periodic fee is called the CDS premium or default swap spread. If

[2] For example, Elton et. al (2001) find tax-related components and a component related to risk premiums for common stock. Longstaff et al. (2005) find significantly positive non-default components in US corporate bonds. This component consists of a tax-effects related part and liquidity premium.

[3] A basis explanation of how a CDS contract is priced is given in the Appendix.

[4] Protection buyer = Insurance buyer

[5] In most cases the payment frequency is quarterly, with Act/360 day count

default occurs, the payments are settled and the contract is terminated. If no defaults occur, the contract expires on the swap's maturity date.

The protection seller is 'long risk', as he takes on the default risk while receiving periodical payments. This position is similar to buying the underlying corporate bond and receiving the periodical coupon payments. The added value of the default swap to academics and practitioners lies in the fact that default swap spreads provide researchers with a direct way of measuring credit risk, which is traded in the market (Longstaff, 2005). Contrary to the bond spread, the default swap spread is a directly traded spread, whereas most bond spreads depend on a measurement method.

Default definitions

It is important for CDS contracts to specify which credit events are defined as 'default' and trigger payment by the protection seller. The International Swaps and Derivatives Association specifies five main credit events (ISDA, 2003):

1. Bankruptcy: Insolvency, appointment of administrators/liquidators and creditor agreements
2. Failure to pay: Payment failure of obligations after expiration of a grace period
3. Restructuring: change in the agreement between the reference entity and the bond holders due to deterioration of creditworthiness
4. Repudiation/moratorium: government authority imposes moratorium and failure to pay or restructuring occurs
5. Obligation acceleration

The first three credit events are considered to be main credit events, and standard credit events for CDS contracts.

Settlement

In the event of default there are two types of settlement of the default swap, physical and cash settlement. With physical settlement the protection buyer sells and delivers the entity's bond to the protection seller, in exchange for the par value of the bond. With cash settlement the parties agree that the seller pays the buyer the difference between face value and the bond's recovery value or that the seller pays the buyer a predetermined percentage of the face value. Besides the payment of the bond's face value, the buyer is typically required to pay the seller the accrued fee until default.

2.3 The CDS – Bond Basis

2.3.1 Non-arbitrage relationship with the yield spread

There is a non-arbitrage relationship between default swaps and corporate bonds. Hull (2003) and Blanco et al. (2005) use this approximate relationship in their studies of the pricing relationship between default swaps and cash bonds. In this relationship an investor buys a corporate bond at par with maturity n and yield to maturity y. Simultaneously, the investor buys CDS protection on that bond, paying a spread s annually. The combined position should result in a yearly return close to the n-year par yield of a risk-free bond, r, as the credit risk is hedged out of the corporate bond through the CDS. Thus, the relationship that Hull states is:

$$s_{CDS} = y - r \tag{1}$$

The right hand side of equation 1 is the same as the bond spread measured by the interpolated yield spread. If the default swap spread is larger than the bond spread, an investor would make a profit by selling protection on the CDS (receiving the higher spread), plus selling the corporate bond and buying the risk-free bond (paying the smaller spread). This relationship is straightforward and a quick estimation but has some assumptions.

The assumptions are:

1. Market participants can short bonds
2. No counterparty default risk
3. No liquidity and/or tax effects
4. After default, the protection buyer can sell against the recovery value plus accrued interest
5. Payments on the bond coincide with payments in the default swap
6. Interest rates are constant (a flat curve)

Many of these assumptions do not hold in reality and cause a persisting difference between the CDS and bond spread, which will be described in section 2.3.3. One of the assumptions of the approximate arbitrage relationship by Hull is a flat interest rate curve, which is often not the case in reality.

2.3.2 Non-arbitrage relation with an asset swap

The assumption of a flat curve can be set aside if the relationship uses floating rate bonds (Duffie, 1999). Using floating rate bonds, the default swap cash flows for a protection buyer are replicated by a portfolio of long a risk-free floating rate bond paying LIBOR, and short the corporate floating rate bond paying LIBOR+Spread. If no default occurs, the par amounts at maturity cancel each other out, and the investor has periodically paid the spread above Libor. This is similar to a CDS protection buyer not confronted with default before the swap's maturity.

If default does occur the investor sells the risk free floater against par ($100) and pays the recovery value of the corporate floater (e.g. $40) to cover the short position. The investor thus receives the difference between par and the recovery value ($60), which is the same as a CDS protection buyer receives after default.

In practice there are not many risk-free floating rate bonds. Risk-free borrowing is usually done through repurchase agreements (Duffie, 1999). At the same time, floating rate corporate notes are very rarely issued. One way to replicate a floating rate corporate note is through an asset swap, which will be described in more detail in section 4.1.4. Therefore the relationship between the default swap is often expressed as

$$s_{CDS} = s_{ASW} \tag{2}$$

Duffie (1999) states that this way the default swap spread can be approximated by the ASW spread, but that the accuracy depends on the fact if the bond is trading at par, discount or premium.

2.3.3. The Basis

The CDS-Bond basis is the difference between the default swap spread and the bond spread.

$$Basis = s_{CDS} - s_{Bond} \tag{3}$$

A positive (negative) basis implies that the default swap spread lies above (below) the bond spread. Theoretically the synthetic and cash credit markets should price credit risk equally, leading to a basis of zero. A large positive or negative basis implies arbitrage opportunities.

Table 1

Arbitrage Opportunities:	
Positive Basis:	Sell cash bond (short risk) and sell protection (long risk)
Negative Basis	Buy cash bond (long risk) and buy protection (short risk)

In practice the basis may be positive or negative due to differences between synthetic and cash markets. Some of these differences are structural and have a persisting influence on the basis. Other factors may cause the basis to be non-zero for only a short term, leading to relative value opportunities. Besides the factors behind these differences, the different measurements of the cash bond spreads and their weaknesses influence the sign and size of the basis. All these factors need to be assessed carefully to spot relative value opportunities (Das, 2005).

2.4 Previous Literature

The aim of this thesis is to analyze the relationship between cash and synthetic credit markets. A number of previous studies in this area have focused on this relationship using default swap spreads and bond spreads. Hull et al. (2005) use an approximate non-arbitrage relationship between the default swap spread and the bond spread. They find statistical evidence that default swap spreads and bond spreads are not exactly equal. However, the theoretical relationship holds fairly well in their view. Using two different measurements of the risk-free rate, namely the treasury rate and swap rate, they find that the swap rate is a better measurement of the risk free rate when calculating bond spreads and comparing the latter with default swap spreads.

Houweling & Vorst (2005) find similar results in a direct comparison between bond spreads and default swap spreads. Additional to the treasury and swap rate, Houweling & Vorst (2005) indicate that the repurchase agreement rate (repo rate) is a better proxy for the risk-free rate, due to the absence of credit risk. They find that repo rates and swap spreads yield better results than the treasury rate in the investment grade spectrum. However, the spread discrepancies between default swap spreads and corporate bond spreads are significantly different from zero, with default swap spreads being larger than bond spreads.

In a detailed study to the relationship between investment grade bonds and default swaps, Blanco et al. (2005) compare bond spreads to default swap spreads and conclude that the relationship holds fairly well if swap spreads are used as a proxy for the risk free rate. Similarly to Houweling & Vorst (2005), Blanco et al. (2005) find that for Eurobonds the default swap spread is slightly larger than the bond spread. They call the difference between the spreads, the CDS-bond basis. The basis is the default swap spread minus the bond spread. The average basis in this study is 5.5 basis points, if the bond spread is calculated using swap rates. They attribute this positive basis to non-zero repo costs, and the Cheapest To Deliver (CTD) option[6] in default swaps, after asking credit derivatives traders for an explanation. Further, they find that CDS markets lead in price discovery, contributing about 80% of the price discovery compared to the bond market. This difference is attributed to short-selling restrictions in bond markets, and the fact that counterparty risk in CDS markets may cause the types of investors to differ between these two markets. Additionally CDS markets are the ideal place for market participants to hedge counterparty and loan risk. All these factors lead to the CDS market being the primary place where credit risk is traded and a persisting basis.

Cossin & Lu (2005) further analyze what drives the difference between default swap spreads and bond spreads. They find an average difference of -12 basis points and only -1 basis point after correcting for liquidity. In contrast to the other studies, they do not find an average significant positive

[6] The CTD option will be described more detailed later on in this chapter

basis. However, they do indicate that the basis varies over time, becoming highly positive at times. They attribute these upward movements to the previously mentioned CTD option. Extending their analysis, they use implied put volatility as a proxy for the CTD option. They contend that a large implied put volatility indicates company distress and a CTD option which is deep in the money. Their findings support this relation, with higher volatility leading to relatively higher spread and a higher positive basis.

Zhu (2006) finds that in the short run default swap spreads deviate from bond spreads. Subsequently the basis is analyzed using variables that proxy liquidity, contractual agreements, macro-economic variables and lead-lag relationships. According to Zhu (2006), the main reason of the basis is a different reaction to changes in credit quality. The findings suggest that the synthetic market moves ahead of the cash bond market in price discovery.

Longstaff et al. (2005) find that default swap spreads and bond spreads are not equal. A first comparison of the spreads leads to the conclusion that the two spreads are not equal. The second comparison involves a method of bond-implied CDS spreads. In this approach, bond market data is used to estimate default swap spreads. The computed default swap spreads in Longstaff et al's study are higher than the default spreads in the CDS market. They attribute this difference to the existence of non-default component in the bond spread. This non-default component is correlated to several liquidity measurements, suggesting the existence of a liquidity premium in bond spreads.

Choudhry (2006) describes the various basis drivers more detailed and provides a couple of observations of the basis for a set of 100 investment grade US bonds. His observation is that the overall basis is positive but moves into negative territory sometimes. The main conclusions are that the overall basis is positive and that the basis moves in the direction of the market. The latter conclusion means that as default swap spreads and/or bond spreads widen, the basis will widen to.

All the above-mentioned studies have been performed prior to the financial crisis of 2007, and show relatively small, if any, deviations between the default swap spread and bond spread. The occurrence of a deep credit crisis may bring to light new factors that influence the difference between the synthetic market and cash market.

2.5 Basis Drivers

Summarizing and complementing the findings of the previous studies, a list can be made of what drives the discrepancies between default swap and bond spreads. The drivers of the basis are divided in three categories, technical/structural factors, market factors and lead-lag relationships. Technical/structural factors are based on differences caused by the nature of the contracts, and structural differences between cash and synthetic markets. Market factors are economic factors linked to supply and demand in credit markets, with an often more temporal segmenting effect on the basis. Lead-lag relationships between cash and synthetic markets may cause the basis to move directionally with either default swap spreads or cash bond spreads.

Technical/Structural factors

1. Positive default swap spreads: Cash bond spreads of a reference entity can be negative if the entities are perceived to be more credit worthy than the sovereigns or banks used to reference the risk-free rate to. These entities have low funding costs and their bond and asset swap spreads can lie below the LIBOR curve, resulting in a negative bond spread. However, protection sellers always ask a positive (over Libor) default swap spread to sell protection on those bonds. For these entities, the basis is positive.

2. Funding of market participants: Cash bonds are on-balance sheet investments and require funding. The cost of funding for market participants is generally expressed in terms of basis points above LIBOR. CDS contracts are off-balance sheet unfunded instruments with LIBOR as funding cost, as shown by Duffie (1999). An institution with high funding costs (large spread over LIBOR) will prefer to sell protection instead of buying a cash bond. In general, most institutions fund above LIBOR. For these participants a long risk (sell protection) position in the synthetic market is more attractive. The subsequent protection selling will lead to lower default swap spreads and a negative basis.

3. The Repo Market: Shorting a cash bond is equivalent to buying protection in a CDS contract. Shorting cash bonds through repo agreements in the cash bond market is difficult in practice. Shorting credit risk is therefore done more frequently in the synthetic market, leading to higher spreads and a positive basis.

4. Greater protection by CDS: The default definition in CDS contracts is broad and contains technical defaults that do not influence the cash bond. This causes default swap spreads to trade wider as they cover more credit events and a positive basis.

5. Cheapest to Deliver option: Most CDS contracts are physically settled. Instead of choosing a specific asset of the reference entity, the protection buyer has the choice which assets to use according to certain requirements. Theoretically these assets should be priced equally, but in practice the market prices can differ, leading the protection buyer to deliver the cheapest asset. This pushes default swap spreads up and makes the basis positive, as the protection seller will require a higher periodical fee as compensation for receiving the cheapest assets in the event of default. A proxy for the CTD option is the implied put volatility of the reference entity (Cossin & Lu, 2005). The CTD option is more in the money (and thus more valuable), when the reference entity is more likely to be in distress, measured by the implied volatility of put options on the company's equity.

6. Assets trading above or below par: CDS contracts are always valued as par contracts. The default swap spread is the compensation for default relative to the par value ($100) of the reference entity's debt. However, cash bonds are sometimes priced at a discount or a premium. Let's say an investor buys a bond at $90. If the bond defaults with a recovery value of $40, the bondholder loses $50. An investor that sells CDS protection on the same reference entity will lose the difference between par ($100) and $40, thus $60. To reflect this differences in risk, the default swap spread will trade higher than the par asset swap spread, leading to a positive basis. The bond spread needs to be adjusted upwards, to reflect the correct credit risk of the bond.

7. Counterparty risk: Both the protection buyer and seller are exposed to the credit risk of the other party. The counterparty risk on the protection seller will drive the default swap spread lower. On the other hand the protection seller is exposed to the counterparty risk on the protection buyer, driving the spread higher. Traditional practice indicates that instead of letting counterparty risk be reflected in the spreads, the counterparty risk that CDS dealers (usually investment banks) are exposed to is typically resolved by collateral requirements or upfront payments. The financial crisis, poses a good example of counterparty risk of the CDS dealer. The collapse of Bear Stearns and bankruptcy of Lehman Brothers, both large players in synthetic markets, are events that have an influence on counterparty risk. The default of both banks should result in CDS spreads increasing more than bond spreads.

Market demand factors

8. Liquidity Premium: Relative liquidity due to supply and demand differences between the synthetic and cash markets influences the basis. Relative liquid synthetic markets lead to lower default swap spreads and a negative basis, and vice versa.

9. Structured Credit Products: The increasing amount of structured credit products issued before 2007, led to an increased demand for protection selling and lower spreads by the issuing investment banks. This caused default swap spreads to tighten relative to cash spreads and a negative basis.

10. New Market Issuance: New cash bond issues enlarge the pool of deliverable assets for the CDS contracts and have a positive impact on the basis.

Lead-Lag Relationship

The existence of the basis can also be the result of a lead-lag relationship between the default swap and bond spread. If synthetic credit markets lead in price discovery the basis will move directionally with the default swap spread, until cash markets 'connect' leading to mean reversion of the basis. Blanco et al (2005) and Zhu (2006) observe this lead-lag relationship, with default swap spreads leading cash bond spreads.

The Basis Ratings Smile

It is necessary to look at patterns of the basis overall, as the basis drivers have different signs. The synthetic credit market is considered to be more liquid than the cash bond market. Shorting credit risk in credit markets is not possible for most corporate bonds, while shorting risk in synthetic markets only requires the investor to buy protection on a bond. On average, though liquidity pushes the basis into negative territory, the CDS-Bond basis is positive. If the basis is analyzed for entities in different ratings classes a basis-smile is observed. Entities in the higher region of the ratings spectrum have a slight positive basis. Most of these entities with AA or AAA ratings, fund near or below LIBOR. They trade slightly above or even below the Swap/Libor curve in the cash bond market due to their high credit worthiness (Choudhry, 2006). This leads to low or even negative cash bond spreads. Default swap spreads are always positive (technical factor nr. 1), hence the basis is positive. Entities with lower ratings exhibit a large positive basis due to their relative 'bad' credit worthiness. This results in more protection buying and a more valuable CTD option.

Chapter 3 Data

Corporate Bond Data

For European corporations a dataset is constructed with bonds that meet the following criteria according to Bloomberg[7]:

- Euro denominated
- Senior Unsecured
- Fixed Coupon
- Non-Callable
- Non-Convertible

An overview of the companies with sufficient bonds outstanding between 1 January 2005 and 31 December 2008 is given in table 3. For the bonds that fulfill the requirements, yields, prices and Par ASW Spreads are collected for the period 1 January 2005 until 31 December 2008 from Bloomberg. The quotes provided by Bloomberg are so-called "generic" quotes. These quotes are an average of firm and indicative quotes submitted by at least five market participants[8]. This results in a total dataset of 209 bonds for 32 different European companies.

The ratings history according to S&P and Moody's, issue size (face value), coupon rate, and coupon frequency are also collected from Bloomberg. As the bonds have different maturities and different issue dates we will use interpolation methods to calculate a constant maturity yield. The precise method will be described in 4.1. The average face value of the bonds in our dataset is 947 mln euros. The largest bond issue is an bond issue by Deutsche Bank in 2008 with an issue size of 4.25 bln euro. The smallest issue is from Renault with an issue size of 10 mln euro. \

Credit Default Swaps

For the reference entities reported in table 3, default swap spreads are obtained from Bloomberg.. Though CDS contracts are Over The Counter instruments, the quoted spreads on Bloomberg and Datastream are generic spreads. In both databases, the spreads originate from CMA Datavision. CMA calculates average daily default swap spreads using quotes given by as many as 30 firms active in the London CDS market. The default swap spread data runs from 1 January 2005 till 31 December 2008. The spreads are all for CDS contracts on the underlying entities' senior unsecured debt with physical settlement after default (ISDA standard). Default swap with maturities of 3, 5 and 7 years are chosen, because these are considered to be the most liquidly traded contracts, especially the 5-year maturity (Choudhry, 2006).

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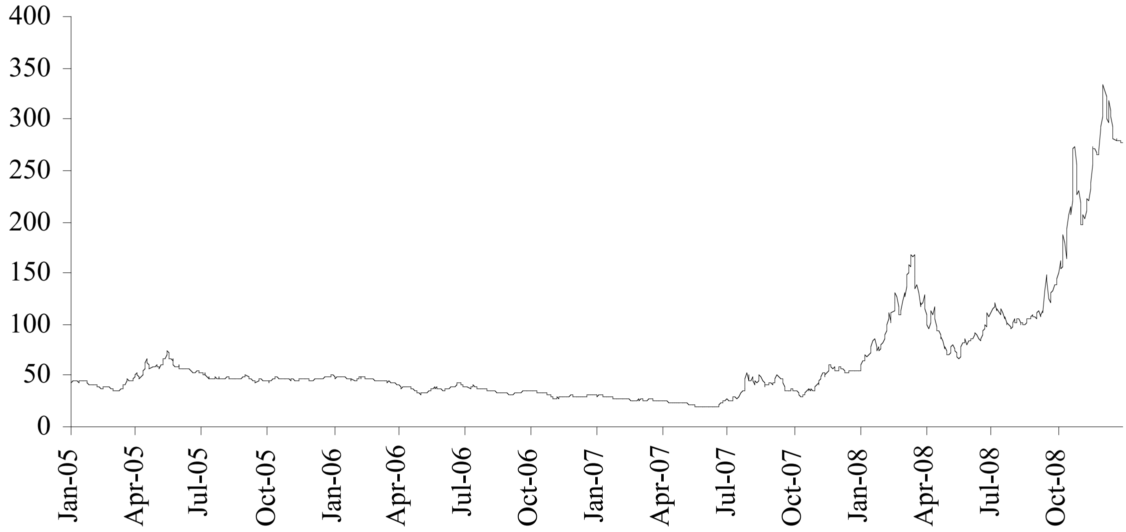
[7] Using the RELS, SRCH and BLP functions

[8] According to the Bloomberg documentation. Blanco et al. (2005) and Zhu (2006) also mention this

Figure 1: Average Credit Default Swap Spread



Benchmark Rate Data

For the calculation of the bond spread a benchmark rate is needed. The traditional benchmark is a yield curve of constant maturity bonds issued by sovereigns, also called the 'risk-free' rate. However, the previously mentioned studies have found that swap rates provide a more accurate benchmark rate, as swaps are more liquid and contain a small premium for counterparty risk, which is also present in the CDS market. For the Euro denominated bonds in the dataset the Euro vs. Euribor swap rates are used as the benchmark rate. As a proxy for the cost of funding in the interbank market we collect the 3-month US T-Bill rate and the 3-month US LIBOR rate and calculate the difference called the US TED spread. The TED-Spread will be used later in our analyses.

Equity Data

For the replication of previous studies and analysis of the basis drivers we collect company specific equity data. The company-specific equity prices are collected from Thomson Datastream from 1 January 2005 until 31 December 2008. Also the daily At-The-Money implied put volatilities are collected with Thomson Datastream. We also collect the prices of the national equity indices, matched to the countries in our dataset. The indices are reported in table **2**

Table 2
National Equity Indices

Country	Index Name	Netherlands	AEX Index
Denmark	OMX Copenhagen	Spain	IBEX 35
France	CAC 40	Sweden	OMX Stockholm
Germany	Xetra DAX 30	United Kingdom	FSTE 100
Italy	Milan MIB 30		

Table 3

Overview of Companies/Reference Entities.

This table lists the reference entities in our dataset, with additional information about country, sector/industry and rating.

Company	Country	Sector	Rating
Air Liquide	France	Energy	A
Allianz	Germany	Banking	AA-
Bayer AG	Germany	Chemical/Pharmaceuticals	A-
Bertelsmann AG	Germany	Media/Telecom	BBB+
BMW	Germany	Automobile	A
BNP	France	Banking	AA
Bouygues	France	Construction	BBB+
British American Tobacco	United Kingdom	Tobacco	BBB+
Casino	France	Consumergoods	BBB-
Carrefour	France	Consumergoods	A
Credit Suisse	Switzerland	Banking	AA-
Daimler	Germany	Automobile	A-
Deutsche Bank	Germany	Banking	AA+
Deutsche Telekom	Germany	Media/Telecom	BBB+
Fiat	Italy	Automobile	BBB-
Fortum	Sweden	Media/Telecom	A
France Tel	France	Media/Telecom	A-
GlaxoSmithKline	United Kingdom	Chemical/Pharmaceuticals	A+
Iberdrola	Spain	Energy	A-
KPN	Netherlands	Media/Telecom	BBB
Lafarge	France	Construction	BBB
PPR	France	Luxurygoods	BBB-
Renault	France	Automobile	BBB
Schneider	France	Energy	A-
Saint Gobain	France	Construction / Materials	BBB+
Siemens	Germany	Conglomerate Industrial	A+
Telecom Italia	Italy	Media/Telecom	BBB
ThyssenKrupp	Germany	Steel	BBB
Telefonica	Spain	Media/Telecom	BBB+
Teliasonera	Denmark	Media/Telecom	A-
Vodafone	United Kingdom	Media/Telecom	BBB+
Volkswagen	Germany	Automobile	A-

Chapter 4 Methodology

In this chapter the different calculations and analysis methods are described. In section 4.1, firstly the interpolation method is explained to calculate a constant-maturity bond spread. Secondly, the different bond spread measurement methods are described. In section 4.2 it is explained hoe we will analyze the CDS-Bond basis to find the factors that drive movements in the basis.

4.1 Bond Spread Calculation

There are several ways to estimate a bond's credit spread and thus several ways to estimate the CDS-Bond basis. In this study, we estimate five different bond spreads:

1. Interpolated Yield Spread (I-Spread)
2. Z-spread
3. Bond Implied CDS Spread
4. Interpolated Par Asset Swap Spread (ASW-Spread)
5. Interpolated Adjusted Asset Swap Spread (Adjusted ASW-Spread)

Constant Maturity Spread Calculation

CDS contracts are usually quoted with a fixed constant maturity. The 5-year CDS contract is considered to be the standard maturity. Hence, to compare the bond spread with the CDS spread we need to calculate a constant maturity spread. In the literature there are several ways of constant-maturity calulation. Hull (2004) uses regression analysis on the total set of bonds to calculate the constant maturity spread. Longstaff et. al (2005) calculate the theoretical 'risk-free' yield with the same coupon and maturity as the matched corporate bond for the whole dataset. However, in this study we follow the straightforward 'model independent' linear interpolation method used by Houweling & Vorst (2005). This means that in our dataset we calculate the constant maturity spread as follows. Out of the set of bonds collected for each company a bond with maturity smaller than the default swap maturity, but not twice as small, and a bond with maturity larger than the maturity, but not twice as long, are chosen. Using linear interpolation, a constant maturity interpolated spread is then calculated on a daily basis for each company in the dataset. Blanco et al. (2005) and Zhu (2006) use linear interpolation too but impose slightly different restrictions on the bonds suitable for linear interpolation. Blanco et. al (2005) calculate the 5-year constant maturity yield spread, and use bonds with 3 to 5 years remaining maturity for the lower data point and a bond with maturity larger than 6.5 years as the upper data point. Zhu (2006) imposes the restriction that one of the two data points should have a maturity between 3.5 and 6.5 years. These latter two methods seem to be more precise than the method used by Houweling & Vorst (2005). However, using the method of Houweling & Vorst (2005) lead to more basis spreads.

4.1.1. Interpolated Yield Spread (I-Spread)

The most rough and simple estimation of the bond spread is called the yield spread. Firstly, the yield to maturity is calculated, meaning the bond's cash flows are discounted against a single discount rate, which makes the sum of discounted cash flows equal to the bond's price. Subsequently, the spread over the benchmark is estimated by taking the yield to maturity and subtracting the yield on a benchmark bond with a maturity closest to the corporate bond's maturity. There are several shortcomings to this estimation. Firstly, the yield to maturity calculation assumes that coupons can be reinvested at the same return (a flat yield curve). This means that the yield spread ignores the fact that realized reinvestment rates can differ for different maturities. Secondly, the spread estimation is biased if the benchmark bond's maturity differs from the corporate bond's maturity and the benchmark term structure is sloped. To resolve the latter issue, another way of measuring the spread is the interpolated yield spread. Instead of taking the benchmark bond with a maturity close to that of the corporate bond, the benchmark bonds yields are interpolated to exactly match the maturity of the corporate bond, shown in equation 4.

$$I - Spread = y_C - \left[y_{b1} + \left(\frac{y_{b2} - y_{b1}}{T_{b2} - T_{b1}} \right) (T_c - T_{b1}) \right] \tag{4}$$

Where:

Y_c Yield to maturity of the corporate bond

Y_{b2} yield to maturity of a benchmark bond with larger maturity than corporate bond

Y_{b1} Yield to maturity of a benchmark bond with shorter maturity than corporate bond

T_c Time to maturity of the corporate bond

T_{b1} Time to maturity of benchmark bond with shorter maturity

Firstly a benchmark bond yield with a maturity larger than the corporate bond Y_{b2} and one with shorter maturity Y_{b1} are used to linearly interpolate a benchmark yield with the same remaining maturity as the corporate bond. Secondly, this interpolated benchmark yield is subtracted from the corporate bond's yield Y_c. Hence, the I-spread takes into account the fact that the benchmark curve is sloped[9]. However, a remaining assumption of the I-Spread method is that the coupons of the bond are reinvested against a constant rate. Theoretically this makes it not directly possible to compare the I-spreads of two bonds with same maturity, but different coupon, if the benchmark curve is sloped.

Neither the yield nor interpolated yields spread are considered to be very precise measurements of the compensation an investor receives for credit risk. These spread measurements are to be considered

[9] However, it does not fully take into account the sloped benchmark curve

a quick estimation of the credit risk of the corporate bond relative to a benchmark. Besides these measurement issues, another issue that has been discussed frequently is the question if the spread fully represents a compensation for the probability of default. Despite obvious shortcomings, the I-Spread is used by all previously described studies to describe the relationship between CDS and cash bonds. These studies also conclude that the swap rate yields better results than the sovereign risk-free rate if bond spreads are compared to default swap spreads.

4.1.2 Zero-Volatility Spread (Z-Spread)[10]

An alternative to the 'crude' way the I-Spread method accounts for a sloped benchmark curve, is the zero-volatility spread (Z-Spread) method. The Z-spread is the parallel shift applied to the benchmark curve in equation 5 that makes the present value of the bond's discounted cash flows equal to the bond's full market price.

$$P_{full} = \sum_{t=i}^{N} \frac{C_i}{(1+s_i+Z)^i} + \frac{100}{(1+s_i+Z)^N} \tag{5}$$

And with continuous compounding:

$$P_{full} = \sum_{t=i}^{N} \left[C_i e^{-(s_i+Z)t} \right] + \left[100 e^{-(s_i+Z)N} \right] \tag{6}$$

Where:

P_{full} Full/Dirty price of the bond

C_i Coupon payments

s_i Zero swap rate

Z Z-Spread

Instead of subtracting the yield of the corporate bond with interpolated benchmark yield, and losing valuable information about the curvature of the benchmark curve, the Z-spread fully takes into account the fact that the benchmark curve can be sloped/inverted instead of being flat (Choudhry 2006). The more the benchmark curve deviates from a flat curve, the more important it is to use the Z-spread instead of the I-Spread. Contrary to the I-Spread, which assumes a constant reinvestment rate and thus a flat yield curve, the reinvestment rate in the Z-Spread calculation can vary per coupon date. Thus, the Z-Spread assumes that coupons can be reinvested at the forward zero rates plus the Z-spread. This makes it possible to directly compare the spreads of two bonds with the same maturity, but different coupons, in a sloped benchmark curve environment. One can use different benchmark curves to calculate the spread. Market practice is that Z-spreads are calculated using the zero-swap curve.

[10] Sometimes referred to as the Option Adjusted Spread (OAS)

Figure 2: Zero-Swap Curve

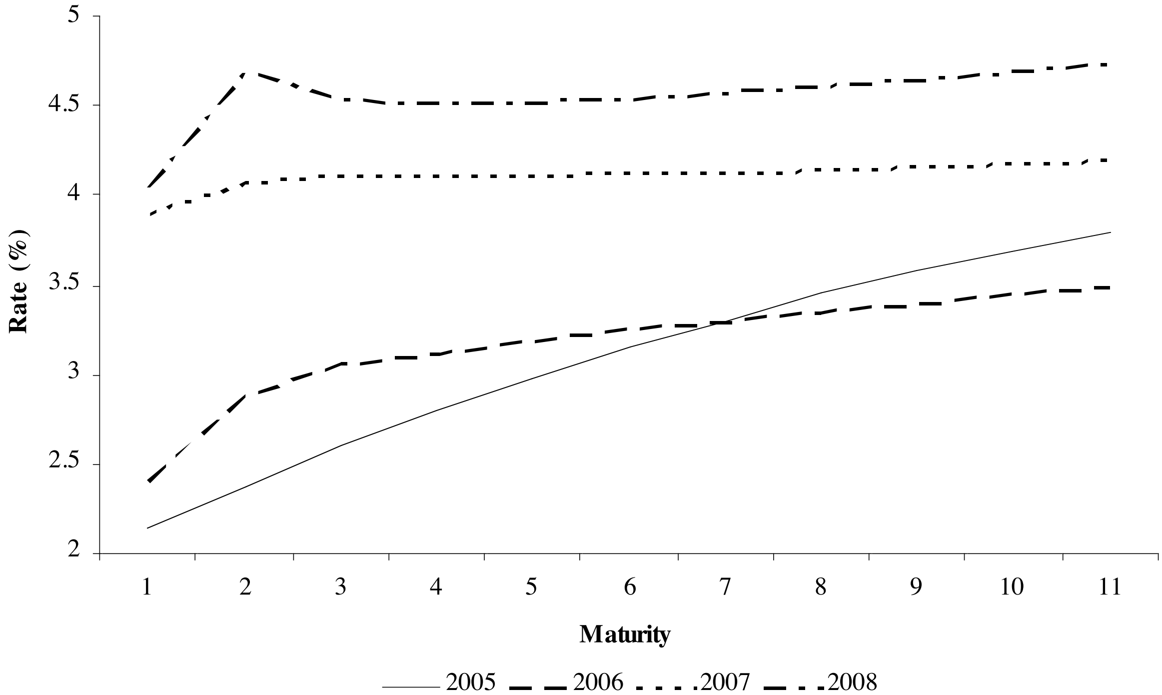


Figure 2 shows that the benchmark curve was non-flat in our data period. Hence, theoretically the Z-spread should be more accurate than the I-Spread for our dataset. We use equation 6 to calculate the daily Z-spread for each bond in our dataset. Each day, the bond's remaining coupon payments and par redemption are discounted with the corresponding zero swap rates. The zero swap rates are linearly interpolated to obtain the appropriate discount rates. Subsequently we solve for the parallel shift to the zero swap curve, Z, which leads to a price corresponding to the full price quoted in the market.

4.1.3 Bond Implied CDS Spread[11]

As explained in the previous section, the Z-spread is an improvement over the I-spread. However, one major disadvantage in comparing the I-spread and Z-spread with the default swap spread is the fact that the two bond spreads are still not directly comparable to a default swap spread if the bond is trading at a discount or premium. An investor that buys a corporate at a discount loses less in case of default compared to an investor that sells protection against par under a CDS contract. This results in a positive basis if the bond is trading at a discount and a negative basis if the bond is trading at a premium. If the bond is trading at a discount, the Z-spread must be adjusted upwards to be comparable to the default swap spread, and vice versa if the bond is trading at a premium. Another theoretical disadvantage of the I- and Z-Spread is that they do not assume that the bond issuer will default.

A way to circumvent these two problems is by calculating a default swap spread, implied by the bond's market price. To calculate this spread, the coupon and par payments are discounted against a benchmark rate and adjusted for the probability of default according to equation 7.

$$P_{full} = \sum_{t=i}^{N}\left[C_i e^{-(s_i)t} * Ps_i\right] + \sum_{t=i}^{N}\left[R*100e^{-(s_i)t} * Pd_i\right] + \left[100e^{-(s_i)t} * Ps_i\right] \quad (7)$$

Where:

N maturity in years

s_i Zero swap rate with maturity i

Ps_i Cumulative Probability of Survival to time i

Pd_i Probability of default in period i

R Expected Recovery Rate after default

Each coupon payment of the bond is discounted using the zero-swap rate s_i and then adjusted for the probability of survival Ps_i at the coupon date. This way we get the default adjusted present value of each coupon payment. In case of default on the coupon date, the investor receives the assumed recovery amount (R*100). This amount is discounted against the zero-swap rate and adjusted for the probability of default Pd_i, This is done for each coupon payment and the par redemption at maturity, resulting in a default adjusted bond price.

The probability of survival, Ps_i, and probability of default, Pd_i, are calculated using the hazard rate. The hazard rate λ_i, is the conditional probability of default in period i. Therefore the bond's price can also be expressed using λ_I in equation 8.

$$P_{full} = \sum_{t=i}^{N}\left[C_i e^{-(s_i)t} * e^{-(\lambda_i)t}\right] + \sum_{t=i}^{N}\left[R*100e^{-(s_i)t} * (e^{-(\lambda_i)t_{-1}} - e^{-(\lambda_i)t})\right] + \left[100e^{-(s_i)t} * e^{-(\lambda_i)t}\right] \quad (8)$$

[11] "Bond Implied CDS Spread" is the name Lehman Brothers used to call this spread measurement. JPMorganChase uses the same methodology but calls it the "Par-Equivalent CDS Spread".

Assuming a constant hazard rate, the hazard rate is adjusted (and thus also the probability of survival/default) until the calculated price matches the full price [12]quoted in the market.

Under the assumption of a constant hazard rate, λ_i can then be converted to the spread of a CDS contract with par value 100 using equation 9. Hence, if the bond is trading at a premium/discount, the bond implied CDS spread is directly comparable to the default swap spread. The latter is not the case with the I-Spread and Z-Spread. [13].

$$\lambda = \frac{S}{(1-R)} \tag{9}$$

There is a direct link between the bond implied CDS spread and the Z-Spread. The bond implied CDS spread gives the same spread as the Z-spread if the issuers recovery rate is 0% [14] If the recovery rate is non-zero the bond implied spread can be seen as a Z-spread adjusted for the discount/premium of a bond. The limitation of this method is that we assume default on the coupon dates and a constant hazard rate (flat hazard curve). More advanced methods model the probability default continuously and allow for a sloped hazard curve.

For each bond in our dataset, we calculate the daily bond implied CDS spread using equations 8 & 9. The difficulty then lies in using the correct recovery rate. The default swap data provided by CMA Datavision does not provide the recovery rates assumed by the traders that have given the quote. Most 'textbook' examples of the bond implied CDS spread, use a 40% recovery rate, which is considered to be the historical recovery rate. However, recent bankruptcies have shown that at the moment recovery rates are likely to be lower. Research by Moody's shows that the average recovery rate for senior unsecured bonds in 2007 was 53.3%, if weighted by issuer, and 56.9% if weighted by value of the bond issues.[15]In 2008, the recovery rate dropped to 33.8% on issuer-weighted basis and 26.2% on value-weighted basis. An extreme example of low recovery rates is the bankruptcy of Lehman Brothers. The recovery rate on senior unsecured bonds of Lehman Brothers was only 8.175%. Unfortunately, no industry or ratings-class specific recovery rates are reported by Moody's, which would improve our calculations of the bond implied CDS spread. Therefore the bond implied CDS spread used in our calculations assumes a recovery rate of 40%.

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12 The 'full' or 'dirty' bond price means that the accrued interest since the last coupon payment is included in the price of the bond

13 For further explanation, see Pedersen (2006)

14 exp(-(s(t)+Z)t) = exp(-s(t)t)*exp(-λ*t) where λt is the survival probability up to time t, which implies that Z = λ.

15 Moody's explains that the issuer weighted Recovery rate is calculated by taking the mean recovery rates of the issuers and then weighted with the number of issuers. The value weighted recovery rate is the average recovery rate averaged by the face value of each bond issue. The issuer-weighted recovery rate should be used for portfolios diversified across issuers. The value-weighted recovery rate should be used for market portfolios.

4.1.4 Asset Swap Spread (ASW-Spread)

The credit risk on a corporate bond is often measured by the bond's asset swap spread. It is a spread against which market participants can trade in the cash bond market. An asset swap is constructed as a portfolio of the corporate bond combined with an interest rate swap, which is expressed in equation 10. In a standard asset swap the investor, called the asset swap buyer, buys a bond from the seller against par value (100). Subsequently the buyer and seller engage in an interest rate swap in which the asset swap buyer pays a fixed rate to the seller, equal to the bond's coupon rate C_i. In exchange the asset swap seller pays the buyer a floating rate of Libor (or Euribor) + the ASW spread (L+A). The asset swap spread A is the spread above LIBOR that makes the value of the floating leg equal to the combined value of the fixed leg and discount/premium of the bond.

$$(100 - P_{full}) + C_i \sum_{i}^{N} z(t_i) - \sum_{i}^{N} \Delta_i (L_i + A) z(t_i) = 0 \qquad (10)$$

Where:

N Maturity in years

P_{full} Full/Dirty price of the corporate bond

C_i Periodic coupon payment

$z_{(ti)}$ discount factor to time i

L_i LIBOR rate

A Par Asset Swap Spread

The purpose of the asset swap is to remove the interest rate risk on the corporate bond with a fixed coupon. Effectively, the investor transforms the fixed rate corporate bond to a floating rate note. Asset swaps are usually constructed in such a way that the buyer pays par for the bond, even if the bond is trading at a discount or premium. As the value of the swap is zero at inception, the difference between the par value and discount/premium (100 - P_{full}) of the bond should be the value of the interest rate swap in the portfolio. This resulting spread in this asset swap is therefore called the par asset swap spread. For each bond available in our dataset we have collected the corresponding par ASW spreads from Bloomberg, which are calculated using equation 10.

4.1.5 Adjusted Asset Swap Spread

The disadvantage of the par asset swap is that the credit risk of the cash bond is not directly comparable to that of a CDS if the bond is trading at a premium or discount. If the bond is trading at a discount the par ASW spread needs to be adjusted upwards in order to be compared to the default swap spread. However, as many bonds have been trading at a discount during the financial crisis, the need to adjust for this is bigger than in the other studies' periods when most bonds were trading very close to par. The asset swap can be calculated in such a way that the bond is purchased at its full price and is adjusted for the possibility that it is trading at a discount or a premium. The resulting asset swap spread M is often referred to as the market asset swap spread[16]. A par asset swap spread is converted to a market spread by dividing the spread with the bond's full price.

$$M = 100 \frac{A}{P_{full}} \tag{11}$$

The main advantage of the ASW spreads over the other bond spread measurements is, that instead of being only a measurement of relative value between the corporate bond and a benchmark bond the ASW spread is a tradable spread. Investors can actually invest in an asset swap package and receive LIBOR+ASW over the maturity of the swap. To actually earn the I-Spread and Z-Spread, the reinvestment rates for coupons need to be as expected on inception. The adjusted ASW spread is directly comparable to a default swap spread, as it is adjusted for the bond's discount/premium. A practical disadvantage of the ASW spread is that when the bond defaults, the interest rate swap does not terminate automatically. In a CDS the protection buyer and protection seller have no payment obligations after default, other than the repayment of the par value. Hence, the ASW investor either needs to keep his position in the swap or terminate it against the current market value of the swap.

4.1.6 Spread Comparison

Table 4

Overview of the different Bond Spread Measurements

	Description	**Comments**
Interpolated Spread (I-Spread)	Difference between the yield of a corporate bond and the interpolated benchmark rate	Assumes constant reinvestment rate and does not fully adjust for a sloped benchmark curve
Z-Spread	Parallel shift to the zero swap curve	Takes into account a sloped benchmark curve, but does not adjust for bonds trading at premium/discount compared to CDS
Bond Implied CDS Spread	Spread calculated using the hazard rate that adjusts the bond's coupons for default	Assumes a constant hazard rate and needs an assumed recovery rate. If recovery rate = 0%, then equal to Z-Spread.
Par Asset Swap Spread	Investor pays par and receives floating spread	Tradable spread, does not correctly reflect the credit risk if a bond is trading at a premium/discount
Adjusted/Market Asset Swap Spread	Investor pays the full price of the bond and receives a floating spread	The same as Par Asset Swap Spread, but adjusted for the bond's discount/premium

[16] O'Kane, D. (2001), Introduction to Asset Swaps, Lehman Brothers.

Table 3 shows a comparison of the different spread measurements used in our analysis. In the reported results of the basis level and analysis of basis drivers we focus on the Adjusted ASW Spread and Bond Implied CDS Spread as measurements of the bond spread. These two spread measurements are the only spread measurements adjusted for a bond's premium/discount, and therefore theoretically more fit to be compared to the default swap spread.

4.2 Basis Analysis Methodology

4.2.1 General information

There are several methods of measuring the bond spread, as discussed in the previous section. However, for the calculation of the basis we only use the I-Spread, Adjusted ASW Spread and Bond Implied Spread (R=40%). Using these different spreads, the constant 3, 5 and 7-year maturity CDS-Bond basis is calculated. In our calculation of the average basis level, we use the daily observations of the basis. Due to the more limited availability of 3-year and 7-year basis levels, and for direct comparison with previous studies we only use the 5-year basis in our analysis of the basis drivers. In our analysis of basis drivers we use weekly and monthly observations to avoid any effects noise may have in time series analysis. Weekly changes in the variables are calculated from Wednesday to Wednesday.

Testing periods

The total testing period in our dataset runs from January 1st 2006 until 31 December 2008. This allows for a pre-crisis period of 18 months (January 2006 – June 2007) and an 18 months crisis period. Though we were able to calculate the basis from January 1st 2005 until the end of 2008 for 13 companies in our dataset, the basis driver analyses are performed from 2006 onwards. The availability of the basis for 25 companies from 2006 onwards allows for a better comparison between the different testing periods. Another reason to choose January 2006 as the starting point is the availability of implied put volatility data. Implied put volatility for many companies was only available after 2006.

Pooled Regression

Using the weekly basis changes pooled OLS regression is used to look which variables/drivers have an influence on the basis. We use pooled regression to capture both the time-series and cross-section (company specific variables) properties of our dataset.

4.2.2. Replication of previous studies

As part of our basis driver analysis we replicate two previous studies. Firstly we estimate the relationship between the basis level and implied put volatility level, similar Cossin & Lu (2005). The intuitive relationship between implied put volatility and credit spreads should be positive. The existence of a CTD option implies that default swap spreads are more sensitive to implied put volatility than the bond spread. A higher implied put volatility level should reflect a higher financial distress level and thus a more valuable CTD option. Cossin & Lu (2005) find a positive relationship between the implied put volatility level and the basis calculated with the I-Spread method according to the relationship in equation 12

$$basis = a + \beta * \sigma \tag{12}$$

Cossin & Lu (2005) only estimate individual company regression analyses of the basis on the implied put volatility level. In our study we present the results using pooled regression analysis, to analyze the effect on the whole dataset. The main disadvantage of the Cossin & Lu (2005) study is that they try to explain the basis only with one variable, whereas theoretically many factors can have an influence. Therefore, we replicate the study of Zhu (2006), as that study contains an analysis of the basis using more basis drivers. Zhu (2006) includes a number of variables in his analysis of the basis. Our replication will include some of these variables. Contrary to the dataset of Zhu, there were no ratings changes in the pre-crisis testing period of our dataset, and the Bloomberg CDS data does not specify the precise contractual terms of the CDS quotes. Zhu (2006) does not find significant relationships with these variables, which makes omission of the variables less of an issue.

The relationships we estimate following Zhu (2006) are shown in equation 13. The first variable to be included in our replication is the lagged basis level. A significant positive coefficient between 0 and 1 would indicate a mean-reverting basis. The second variable is a dummy variable with value 1 if the lagged basis level is positive and 0 if the lagged level is negative e. A significant positive coefficient would indicate that due to short selling restrictions in the bond market, the mean reverting process would be slower if the basis is positive in the previous period. The third variable is the rating of the companies. The rating classes AAA, AA+, AA, AA- etc. are assigned the values 1, 2, 3, 4 etc. The fourth and fifth variables are the interest rate and equity index return. These two macro-economic indicators should be priced equally by synthetic and credit markets, hence they should have no significant effect on the basis. The sixth variable is the difference between the bid-ask spread of the default swap and the bid-ask spread of the bond. This is a measurement of relative liquidity between the two markets. To avoid that the bid-ask spreads are highly endogenous with the respective spreads, the bid-ask differential is calculated as an average of the previous 20 trading days.

$$\begin{aligned} basis = \alpha + \beta_1 * basis_{t-1} + \beta_2 * dummy(basis_{i,t-1} > 0) + \beta_3 * SPRating + \beta_4 * R_f + \\ \beta_5 * R_m + \beta_6 * BAdifferential \end{aligned} \tag{13}$$

Table 5

Augmented Dickey Fuller Tests of the Basis Levels

Theis table shows the outcomes of the Augmented Dickey Fuller tests of the basis level. The null-hypothesis of the ADF-test is that the basis level has a unit root, and therefore is non-stationary. Rejection of the null-hypotheseis leads to the conclusion that the basis level is stationary. The tests are performed for the basis calculated as the CDS spread minus the interpolated 5-year bond spread. The bond spread is calculated using three different methods: Adjusted ASW Spread, Bond Implied CDS Spread (R=40%) and the I-Spread. T-statistics and the conclusions about stationarity are reported. Rejection of the null-hypothesis at the 5% is indicated by an *.

		Adj. ASW		Bond Implied		I-Spread	
Company	**No. Obs (days)**	**Statistic**	**Stationary?**	**Statistic**	**Stationary?**	**Statistic**	**Stationary?**
Air Liquide	783	-4,66*	Yes	-3.32*	Yes	-4.19*	Yes
Allianz	262	-2.76	No	-2.01	No	-3.07*	Yes
Bayer AG	668	-5,16*	Yes	-4.43*	Yes	-4.38*	Yes
Bertelsmann AG	599	-2,92*	Yes	-2.64	No	-2.71	No
BMW	783	-3,66*	Yes	-4.30*	Yes	-3.50*	Yes
BNP	523			-5.44*	Yes	-1.88	No
Bouygues	1038	-3,14*	Yes	-3.33*	Yes	-3.26*	Yes
British American Tobacco	463	-0,29	No	-0.69	No	-0.53	No
Casino	1043	0,50	No	0.417	No	0.01	No
Carrefour	1043	-2,95*	Yes	-3.03*	Yes	-2.75	No
Credit Suisse	328	-2,78	No	-2.25	No	-2.76	No
Daimler	691	-3,39*	Yes	-2.83	No	-3.46*	Yes
Deutsche Bank	262	-3,79*	Yes	-2.95*	Yes	-3.14*	Yes
Deutsche Telekom	1022	-3,92*	Yes	-3.29*	Yes	-3.26*	Yes
Fiat	1043	0,14	No	0.084	No	-0.83	No
Fortum	1043	-3,58*	Yes	-2.72	No	-4.73*	Yes
France Tel	1043	-3,16*	Yes	-3.31*	Yes	-3.19*	Yes
Glaxo	783	-2,73	No	-2.99*	Yes	-2.98*	Yes
Iberdrola	1042	-4,10*	Yes	-4.02*	Yes	-3.27*	Yes
KPN	1043	0,012	No	0.046	No	-0.40	No
Lafarge	1043	-0,81	No	0.323	No	0.04	No
PPR	804	-4,90*	Yes	-4.87*	Yes	-4.78*	Yes
Renault	1043	-0,39	No	-0.49	No	-3.29*	Yes
Schneider	891	-2,66	No	-2.77	No	-2.80*	No
Saint Gobain	968	-3,44*	Yes	-1.61	No	-1.69	No
Siemens	149	-2.05	No	-1.59	No	-1.59	No
Telecom Italia	783	-3,54*	Yes	-5.45*	Yes	-5.43*	Yes
ThyssenKrupp	1043	-0.69	No				
Telefonica	767	-2,29	No	-2.7	No	-3.22*	Yes
Teliasonera	783	-1.99	No	-1.01	No	-1.01	No
Vodafone	1043	-3,87*	Yes	-3.96*	Yes	-3.52*	Yes
Volkswagen	1043	-4,49*	Yes	-4.00*	Yes	-5.57*	Yes
Overall	1043	-2.82	No	-3.04*	Yes	-3.89*	Yes
No. Stationary			17		16		19

4.2.3 Stationarity tests

Cossin & Lu (2005) and Zhu (2006) try to explain the dynamics of the basis using the basis level and level variables. However, one criticism of both studies is that they use ordinary least squares (OLS) regression on the basis level. Blanco et al (2005) and Zhu (2006) show that the basis level is non-stationary for most European companies. As both Cossin & Lu (2005) and Zhu (2006) use European companies in their basis analysis, their regression analyses are likely to be spurious. Table 5 reports the results of the Augmented Dickey Fuller tests on the basis levels in our dataset. Out of the 32 companies in our dataset we can reject the null hypothesis of a unit root for at most 19 companies, meaning that at most 19 companies in our dataset have a stationary basis. This is consistent with the findings by Blanco et. al (2005) and Zhu (2006), who find a stationary basis for almost all US companies, but only for about half the European companies in their dataset. The non-stationary basis of the other companies lead to the conclusion that for our own analysis of the basis drivers we need to use the basis changes as dependent variable instead of the basis level.

4.2.4 Basis Driver Analysis

In our own analysis of basis drivers we use pooled regression of the basis changes using some of the variables of the replicated analyses and some additional variables. We estimate the relationships according to equation 14.

$$\begin{aligned}\Delta Basis = \alpha + \beta_1 * Basis_{t-1} + \beta_2 * \Delta Basis_{t-1} + \beta_3 * \Delta vol + \beta_4 * R_E + \beta_5 * \Delta BAdiff + \beta_6 * \Delta USTED + \\ \beta_7 * dummyratehike + \beta_8 dummyratecut + \beta_9 dummycollapse + \beta_{10} * R_m + \beta_{11} * \Delta r_f\end{aligned} \tag{14}$$

Directionality

To assess the existence of a lead-lag relationship between synthetic and cash credit markets and the resulting directional behavior of the basis, we include the lagged basis change and lagged basis levels as variables in our regression. The presence of a lead-lag relationship should result in a mean-reverting basis, hence a negative relationship with the lagged basis change. However, the lagged basis level is also included. Blanco et. al (2005) use VECM regressions to assess the lead-lag relationship. If we rewrite the VECM equations used by Blanco et al (2005), the basis change is dependent on the lagged basis level. The presence of a lead-lag relationship should result in negative coefficients.

CTD Option

Similar to Cossin & Lu (2005), we use changes in company-specific implied put volatility as a proxy for the CTD option. Increased financial distress on the company level, measured by an increased implied put volatility, leads to a more valuable CTD option. This coefficient should be positive, as the default swap should react more than the bond spread. Blanco et al. (2005) also mention that the existence of a CTD option should in general result in higher sensitivities of the default spread to company-specific variables compared to the bond spread. This means that besides the implied put volatility, the basis should also be influenced by the company-specific equity return. Equity returns are negatively correlated with credit spread changes, and therefore the coefficient on the basis should be negative.

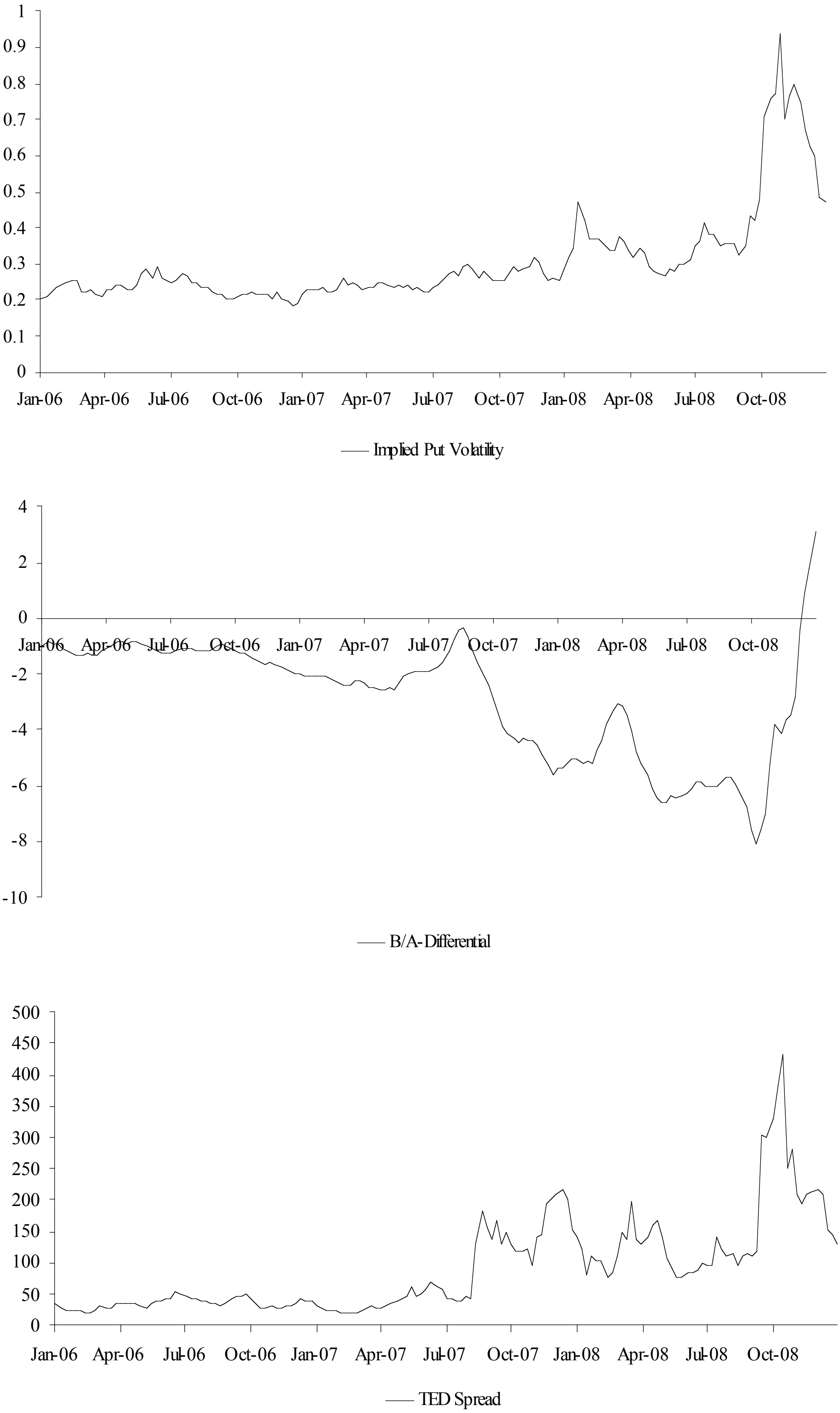
Liquidity

To assess the relative liquidity between cash and synthetic markets, the bid-ask spreads of the default swaps and bonds are used. For each company, the constant maturity interpolated yield is calculated using the bid and ask yields in our dataset. Using these interpolated bid & ask yields, the daily bid/ask spread is calculated for each company. Following the methodology of Zhu (2004) the average of the past 20 trading days is calculated. The reason behind using the average according to Zhu (2004) is the fact that bid-ask spreads are likely to be an endogenous variable and strongly interact with credit spreads. Using the lagged average should solve this problem. For the default swaps, the same procedure is followed. To assess the relative liquidity, the bid-ask spread of the bond is subtracted from the corresponding default swap's bid-ask spread. The coefficient of this variable should be positive, because if the CDS gets relatively more illiquid this results in a higher default swap spread and therefore higher basis.

Funding

The effect of funding costs on the basis is measured by difference between the 3m LIBOR and 3m US Treasury Bill rates, called the US TED Spread. A higher TED-Spread means that funding in the interbank market has increased relatively to the sovereign benchmark rate. Higher funding costs should make a position is cash bonds relatively less attractive, resulting in a higher bond spread and lower basis. Though our study concentrates on European bonds and CDS, the US TED spread is an important indicator. It must also be noted that many market participants in European credit markets are US based institutions or institutions that partially fund in the US money market.

Figure 3: Regressors



Event Dummies

We include the FED and ECB key interest rate changes as events in our analysis. Theoretically a rate increase should have a negative influence on the basis, as a rate increase should translate into higher funding cots. Vice versa, we expect a positive influence on the basis of a rate cut. The two bank collapses in the US, Bear Stearns & Lehman Brothers, are put into an event dummy. As both banks were major counterparties in the CDS market, we examine the effect of their collapse on the basis. Theoretically, the collapse should have a positive effect on the basis, as protection sellers want to be paid a higher spread as compensation for the risk that their counterparty (a bank) will default. These increased counterparty risks are reflected in the default swap spread, but not the bond spread.

Control Variables

To check if the above mentioned basis drivers explain all or most of the movements of the basis we include two control variables similar to Zhu (2006). We include the national equity market return and changes in the 10-year spot interest rate as measurements of macro-economic information. Both variables should have a negative effect on both default swap spreads and bond spreads. Synthetic and cash markets should price this information equally. Hence, the effect of these variables on the basis should be zero.

Table 6

Expected Signs of the Basis Drivers

Coefficient	Expected Sign	Coefficient	Expected Sign
Lagged Basis Level	-	US TED Spread	-
Lagged Basis Change	-	FED/ECB Rate Hike	-
Implied Put Volatility	+	FED/ECB Rate Cut	+
Company-Specific Equity Return	-	Equity Market Return	0
Bid-Ask Differential	+	10-year Interest Rate	0

Chapter 5 Results

Section 5.1 reports the bond spreads, calculated using the different methods and compares them to each other. Sectgion 5.2 reports the average basis levels, calculated with the Adjusted ASW Spread and Bond Implied CDS Spread, and includes a comparison of basis levels per ratings class, sector and maturity. Section 5.3 contains the analysis of basis drivers.

5.1 Bond Spread Measurements

5.1.1 Comparing the spreads: I-Spread, Z-Spread, Bond Implied Spread

Figure 4: Comparison of the I-Spread, Z-Spread and Bond Implied CDS Spread

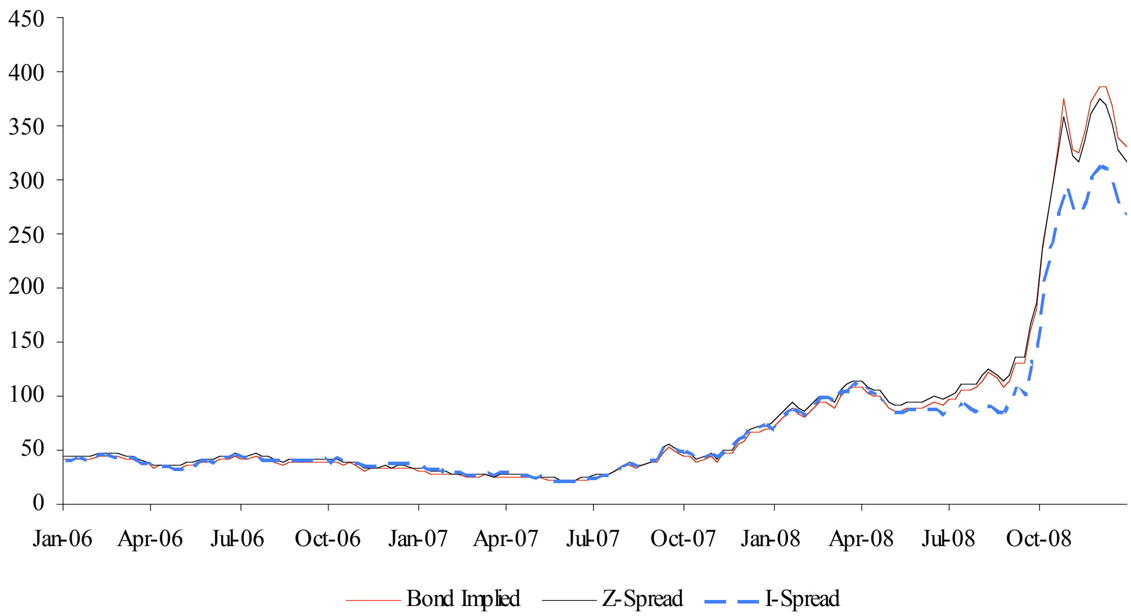


Figure **4** shows a comparison of the average bond implied CDS spread, Z-Spread and I-Spread from January 2006 until 31 December 2008. The figure shows that from July 2007 on, cash bond spreads have widened by a great amount. Prior to July 2007, bond spread levels were relatively constant with an average of 33 bps from January 2006 until July 2007 for all three spread measurements. From the figure we can also conclude that the bond implied CDS spread with a recovery rate of 40% and Z-Spread follow each other closely, with the bond spread being slightly higher in the last quarter of 2008. The average difference between the two measurements is a mere 8 basis points between a spread average of 333 bps for the bond implied spread and 325 bps for the Z-Spread. This small difference is due to more bonds trading at a discount, resulting in a relative upward adjustment. The correlation of the weekly spread changes between the two measurements is very high, 0.99, meaning that both spreads can be considered to move equally.

Figure 5 Bond Implied CDS Spread, Casino 4.875% 10/04/2014

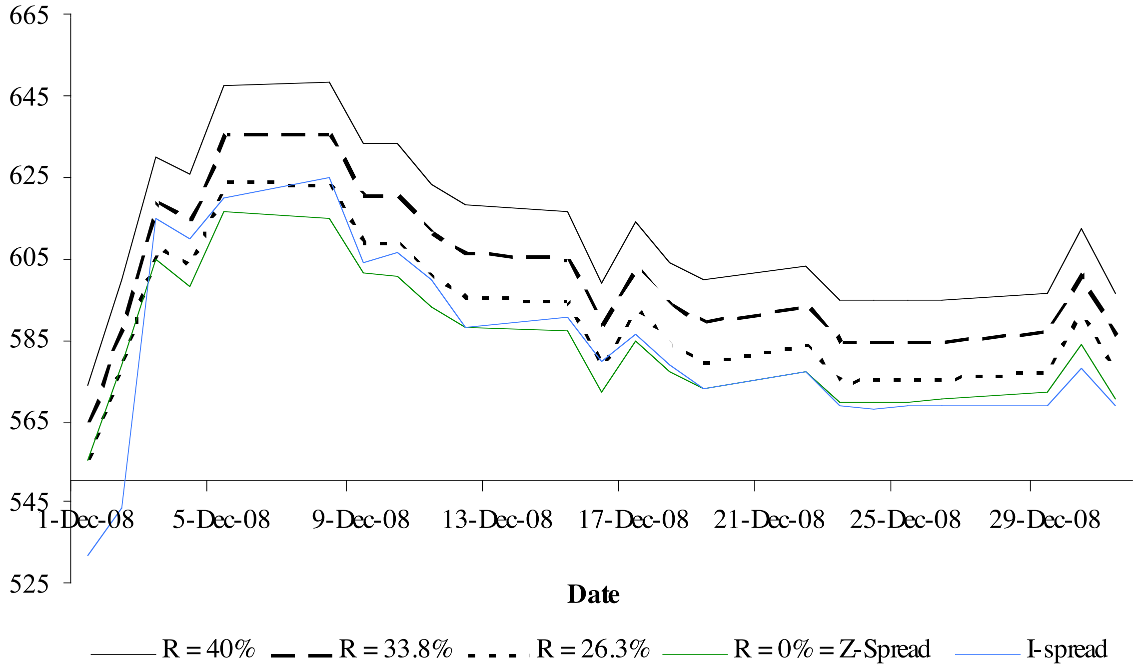


Figure 5 shows the bond implied CDS spread, calculated with different recovery rates, of a senior unsecured bond from the company Casino, during December 2008. The bond traded at a discount during that month with a price between 84 and 85 cents on the dollar. This means that the bond implied CDS spread with non-zero recovery should be higher than the 0% recovery (Z-Spread). The calculated spreads in the graph show this, with the bond implied CDS spread assuming a recovery of 40% about 40bps higher than the Z-Spread. This observation indicates that if an investor wants to assess the relative value opportunities of the bond versus CDS, e.g. the basis level, he/she should take into account the discount/premium of the bond. We observe that as the recovery rate is reduced, the bond implied CDS spread approaches the Z-Spread. We also observe that the recovery rate has an impact on the absolute level of the spread but not so much on the changes in the spread[17]. This observation is similar to the previous conclusion that the movements of the bond-implied CDS spread are highly correlated with the movements in the Z-Spread. Hence, it is highly questionable if different results are obtained if we use basis changes.

[17] However, the changes in the spread aren't exactly equal for the different recovery rates.

5.1.2 Comparing the spreads: I-Spread, ASW-Spread and Adjusted ASW Spread

Figure 6: I-Spread and ASW Spreads

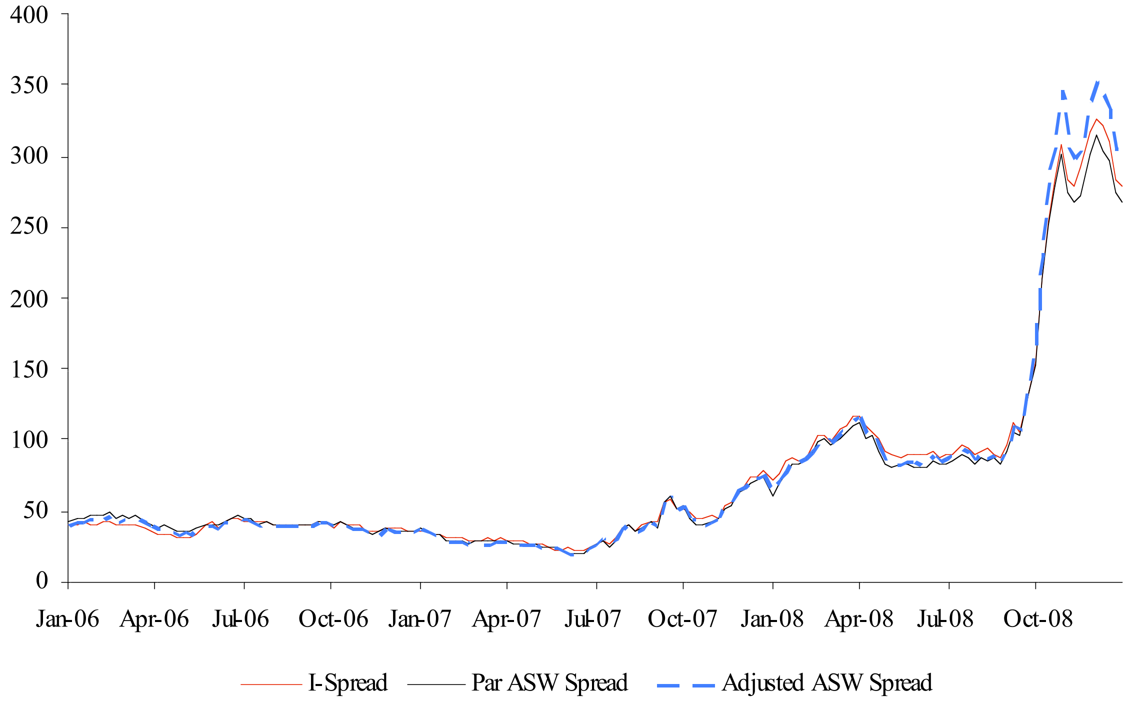
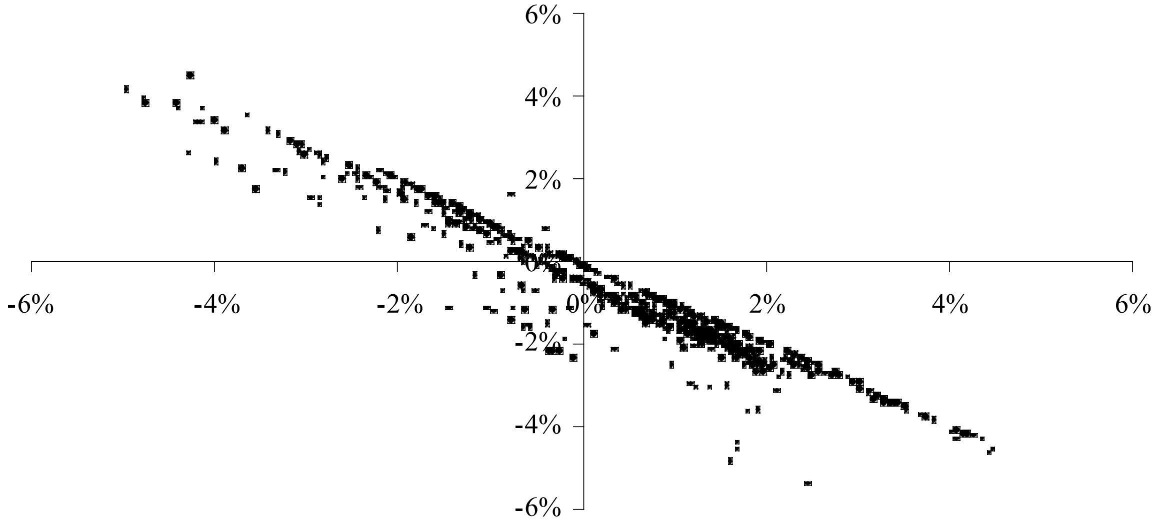


Figure 6 shows the average interpolated yield spread, par ASW spread and adjusted ASW spread from 2006 until the end of 2008. Similarly to the previous paragraph, the impact of the financial crisis on the credit spread is clearly visible from July 2007 onwards. The average par ASW spread increased from approximately 25 bps at the beginning of July 2007 to approximately 325 bps in November 2008. This observation shows that the financial crisis has had a severe impact on corporate credit, especially in the last quarter of 2008.

If we compare the average par ASW spread and the interpolated yield spread, figure 1 shows that both credit spread measurements move the same direction and are equal in some periods. The correlation between the weekly spread changes of the two measurement methods is 0.96, indicating that both credit spread measurements move together. A statistical test of equality of the weekly spread changes, also results in non-rejection of the null hypothesis that both spread measurements are equal. These findings indicate that there are no significant differences between the interpolated yield spread and asset swap spread. The adjusted ASW spread lies above the par ASW spread and I-Spread in the last quarter of 2008, similarly as the bond implied CDS spread in the previous section.

5.1.3 The Adjusted Asset Swap Spread

Figure 7 Par Adjustment of ASW Spreads

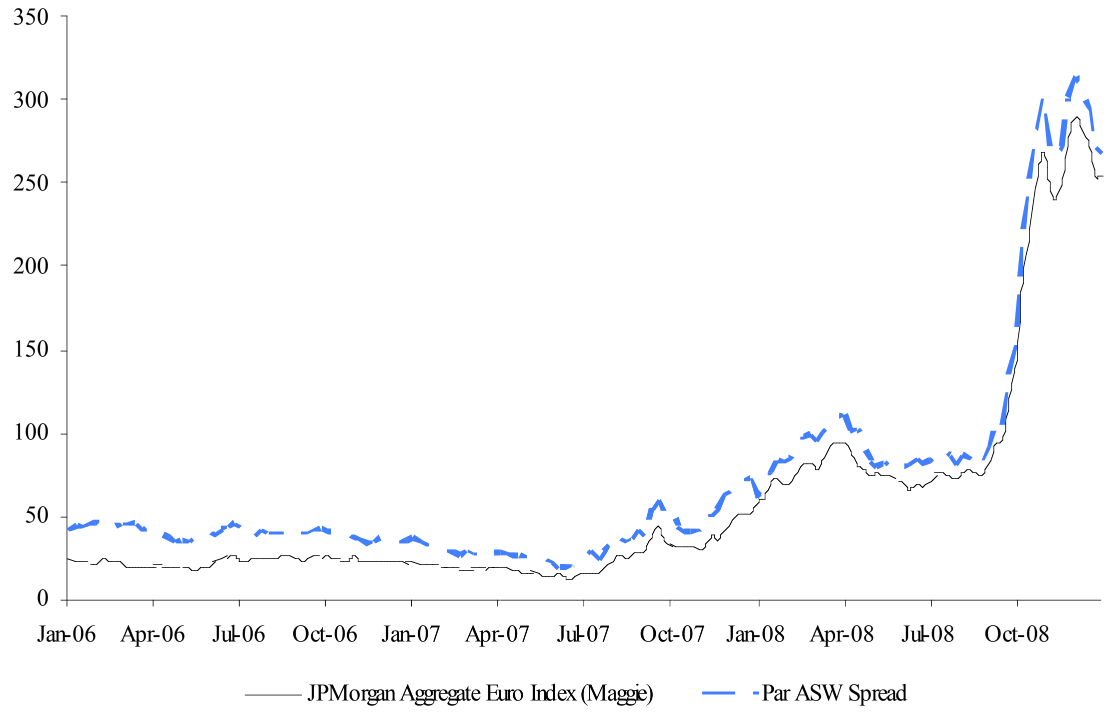


The interpolated yield spread and par ASW spread do not account for the fact that, theoretically, bond spreads should not be compared directly to default swap spreads in case the bond is trading at a large discount or premium. During the crisis, more bonds have been trading at a discount, and also a larger discount. On the last trading day in 2008, 112 of the 197 (57%) quoted bonds in our dataset were trading at a discount. At the end of 2006 59 out of 139 bonds (44%) were trading at a discount. The average discount (price – 100) of the bonds trading at a discount at the end of 2008 was -6.94 compared to -2.73 at the end of 2006. The average premium (price – 100) of the bonds trading at a premium was 2.38 at the end of 2008, compared to 4.15 in 2006.

Figure 7 shows a scatter plot of the percentage adjustment to the par ASW spread (vertical axis), relatively to the average discount/premium (horizontal axis) for all observations of one of the companies in our dataset, Air Liquide S.A. The figure shows that as bonds trade at a discount (premium) the ASW spread is adjusted up (down).

5.1.4 Comparison of the ASW spread to the JPMorgan Aggregate Euro Credit Index

Figure 8: ASW Spread and MAGGIE Index



In Figure 8 the average par ASW spread of our dataset is compared to the Adjusted ASW spread and the JPMorgan MAGGIE Index. The Morgan Aggregate Index Euro (MAGGIE) is a series of indices constructed for different sectors by JPMorgan to measure credit risk in the Eurozone. The MAGGIE index in figure 3 is the average ASW spread of a set of MAGGIE indices matched by sector to our dataset. The results show that the MAGGIE index, is not equal to the average ASW spread of our dataset. The average ASW spread of the Maggie index is consistently lower than the equally weighted average of our dataset, with an average difference of 14 bps.. After inquiries about the calculation of the MAGGIE ASW spread, it turns out that the MAGGIE ASW spread is the result of a weighting process in which the ASW spreads of the underlying names are weighted using the constituting bonds' market capitalizations[18]. This makes direct comparison to the average par ASW spread of our dataset troublesome, because the average ASW spread in our dataset is calculated using hypothetical 5-year constant maturity bonds. Another troubling factor is the fact that the MAGGIE index is composed of bonds with maturities ranging from 3 to 5 years, in contrary to our 5-year constant maturity. However, the direction and shape of the MAGGIE index and the average ASW spread of our dataset are consistent. The correlation between the indices' weekly differences is 0.92, underlining the view that our dataset captures the dynamics of European corporate credit.

[18] Volume of outstanding price * full price of a bond

5.2 The Basis Level

5.2.1The Average Basis Level

Figure 9 The CDS-Bond Basis

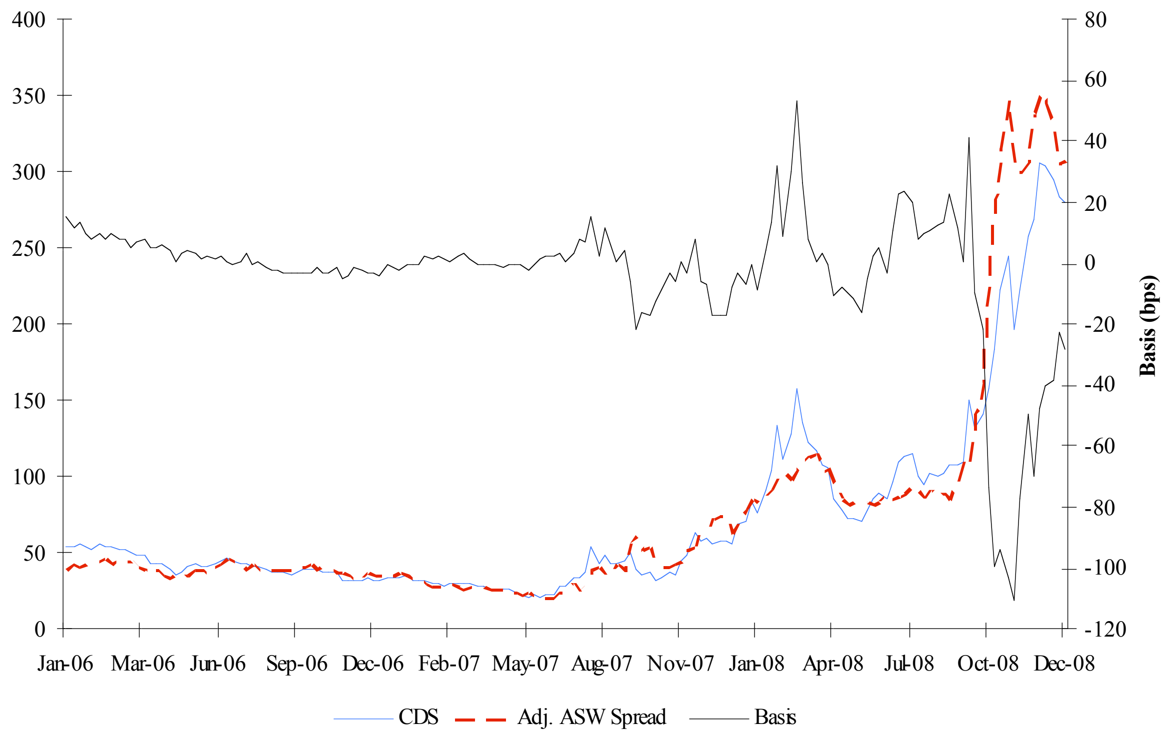


Figure 9 shows the weekly levels of the CDS spread, Adjusted ASW spread and the Basis from 2006 until 2008. Before July 2007 the average credit spread was relatively flat, with default swap spreads and bond spreads not far from each other. The basis was close to zero in that period and on average does not exhibit much volatility. July 2007 marks the beginning of the financial crisis. From that moment on the basis is more volatile and reaches much higher and lower levels. The average basis reaches a maximum value of 69 bps in March 2008 and minimum value of -123 bps in October 2008. The movements of the basis seem to indicate that until October 2008 the basis moves directionally with the default swap spread. This is clearly visible in March/April 2008. The figure does not make clear whether this movement of the basis is caused by technical factors impacting the default swap spread or if it is caused by a lead-lag relationship. The directional pattern of the basis ends abruptly at the end of September 2008[19], as the average basis moves quickly into negative territory for the last quarter of 2008. A first hand explanations for the fact that the average basis is highly negative in the last quarter of 2008, is the lack of liquidity in the bond markets and high funding costs. Both factors theoretically have a negative impact on the basis. The average basis from July 2007 until the end of September 2008 was 3 bps, whereas the average basis in the last quarter was -66 bps. This pattern of

[19] After the collapse of Lehman Brothers

the basis makes it possible to divide our dataset in three subperiods: the period before the crisis (January 2006 – June 2007), the first 5 quarters of the crisis (July 2007 – September 2008) and the last quarter of 2008 (October 2008 – December 2008).

Table 7
The 5-year CDS-Bond Basis – Adjusted ASW Spread

This table shows descriptive statistics of the CDS-Bond Basis in basis points for each separate reference entity in the dataset. The basis is calculated as the 5-year CDS spread minus the interpolated 5-year adjusted ASW spread. Rejection of the null hypothesis at 5% that the average basis is zero is indicated by an *. Overall the average basis is close to zero, with a value of 0.91 basis points. The average basis has decreased from 13 bps in 2005 to -10 bps in 2008. Stationarity of the basis level is tested using the Augmented Dickey Fuller test. T-statistics of the ADF test and conclusions about stationarity are reported in the last two colums. The results show that the basis of 14 out of 31 companies has a unit root according to the ADF test and therefore is non-stationary.

		Basis Levels					ADF test	
Company	**No. Obs (days)**	**Average**	**2005**	**2006**	**2007**	**2008**	**Statistic**	**Stationary?**
Air Liquide	783	1.55*		6.61*	3.65*	-5.57*	-4.66*	Yes
Allianz	262	18.62*				18.62*	-2.77	No
Bayer AG	668	-2.58*	4.34*	-3.71*	-4.58*	2.37*	-5.16*	Yes
Bertelsmann AG	599	-16.01*		-5.23*	-5.18*	-29.92*	-2.92*	Yes
BMW	783	13.53*		4.98*	9.72*	25.80*	-3.66*	Yes
BNP								
Bouygues	1038	-11.82*	1.26*	-2.56*	-6.19*	-39.36*	-3.14*	Yes
British American Tobacco	463	-46.06*			-10.99*	-72.96*	-0.29	No
Casino	1043	-23.32*	0.18	-2.31*	-6.11*	-84.67*	0.501	No
Carrefour	1043	-1.94*	7.06*	-1.04*	1.90*	-15.61*	-2.95*	Yes
Credit Suisse	328	19.73*			17.04*	20.41*	-2.78	No
Daimler	691	-5.52*		5.91*	-1.23*	-17.14*	-3.39*	Yes
Deutsche Bank	262	18.99*				18.99*	-3.79*	Yes
Deutsche Telekom	1022	6.43*	16.68*	4.66*	-1.14*	6.416*	-3.92*	Yes
Fiat	1043	-9.55*	82.35*	27.71*	-5.72*	-141.5*	0.139	No
Fortum	1043	0.15	5.25*	-1.61*	-1.30*	-1.696*	-3.58*	Yes
France Tel	1043	4.76*	16.23*	8.59*	-4.81*	-0.884	-3.16*	Yes
Glaxo	783	-3.57*		8.36*	4.15*	-23.13*	-2.73	No
Iberdrola	1042	0.71	5.66*	-0.26	0.37	-2.85	-4.10*	Yes
KPN	1043	-17.83*	4.41*	-0.46*	-3.59*	-71.32*	0.012	No
Lafarge	1043	28.00*	9.67*	4.25*	4.82*	92.85*	-0.81	No
PPR	804	-0.91*	5.45*	-3.62*	-4.40*	-2.51*	-4.90*	Yes
Renault	1043	-6.56*	5.79*	-4.87*	-3.47*	-23.60*	-0.39	No
Schneider	891	-5.95*	6.34*	1.44*	-1.76*	-22.53*	-2.66	No
Saint Gobain	968	9.08*	2.01*	-3.49*	-1.88*	37.50*	-3.44*	Yes
Siemens	149	38.60*				38.60*	-2.06	No
Telecom Italia	783	-12.19*		-1.47*	-9.65*	-25.37*	-3.54*	Yes
ThyssenKrupp	1043	19.95*	6.37*	-5.83*	3.84*	75.06*	-0.69	No
Telefonica	767	-5.21*		-3.78*	-3.90*	-7.852*	-2.29	No
Teliasonera	783	-16.59*		3.24*	-7.79*	-45.05*	-2.00	No
Vodafone	1043	2.511*	8.15*	1.11*	-2.31*	3.11	-3.87*	Yes
Volkswagen	1043	26.08*	17.16*	16.76*	14.06*	56.15*	-4.49*	Yes
Overall	25342	0.91	12.61	2.46	-1.25	-9.86	-2.82	No

Table 8

The 5-year CDS-Bond Basis – Bond Implied CDS Spread (R = 40%)

This table shows descriptive statistics of the CDS-Bond Basis in basis points for each separate reference entity in the dataset. The basis is calculated as the 5-year CDS spread minus the interpolated 5-year adjusted ASW spread. Rejection of the null hypothesis at 5% that the average basis is zero is indicated by an *. Overall the average basis is close to zero, with a value of 0.91 basis points. The average basis has decreased from 13 bps in 2005 to -10 bps in 2008. Stationarity of the basis level is tested using the Augmented Dickey Fuller test. T-statistics of the ADF test and conclusions about stationarity are reported. The results show that the basis of 16 out of 31 companies has a unit root according to the ADF test and therefore is non-stationary. The last column contains the correlation between the weekly basis changes calculated with the Adjusted ASW Spread and the Bond Implied Spread.

		Basis Levels					ADF test		Correlation
Company	**No. Obs (days)**	**Average**	**2005**	**2006**	**2007**	**2008**	**Statistic**	**Stationary?**	
Air Liquide	783	1.598*		6.911*	5.063*	-7.124*	-3.32*	Yes	0.94
Allianz	262	23.29*				23.29*	-2.01	No	0.65
Bayer AG	668	4.349*	7.395*	4.933*	2.543*	6.155*	-4.43*	Yes	0.74
Bertelsmann AG	599	-14.43*		-3.667*	-3.467*	-28.52*	-2.64	No	0.98
BMW	783	15.21*		4.904*	9.539*	31.10*	-4.30*	Yes	0.95
BNP	523	7.061*			10.16*	3.967*	-5.44*	Yes	
Bouygues	1038	-8.664*	1.676*	-1.206*	-1.631*	-33.13*	-3.33*	Yes	0.87
British American Tobacco	463	-42.79*			-7.872*	-69.57*	-0.69	No	0.91
Casino	1043	-18.56*	1.880*	0.344	-2.208*	-73.92*	0.417	No	0.93
Carrefour	1043	-1.658*	6.924*	-0.515*	3.306*	-16.25*	-3.03*	Yes	0.97
Credit Suisse	328	18.64*			18.51*	18.67*	-2.25	No	0.99
Daimler	691	-3.322*		7.738*	0.642	-14.36*	-2.83	No	0.87
Deutsche Bank	262	13.19*				13.19*	-2.95*	Yes	0.94
Deutsche Telekom	1022	9.836*	21.36*	12.05*	0.759	6.161*	-3.29*	Yes	0.91
Fiat	1043	-8.913	87.76*	34.97*	5.173*	-162.4*	0.084	No	0.98
Fortum	1043	15.29*	6.770*	4.979*	15.61*	33.65*	-2.72	No	0.83
France Tel	1043	5.729*	16.25*	9.333*	-2.856*	0.260	-3.31*	Yes	0.93
Glaxo	783	-2.137*		8.474*	4.760*	-19.53*	-2.99*	Yes	0.77
Iberdrola	1042	1.275	6.350*	0.673*	3.699*	-5.577	-4.02*	Yes	0.90
KPN	1043	-15.00*	4.907*	1.749*	-0.114	-66.21*	0.046	No	0.90
Lafarge	1043	34.13*	9.690*	4.807*	6.508*	115.0*	0.323	No	0.95
PPR	804	1.154*	6.524*	-1.969*	-1.200	2.489	-4.87*	Yes	0.94
Renault	1043	-3.730*	6.274*	-3.287*	14.20*	-31.96*	-0.49	No	0.82
Schneider	891	-7.725*	6.586*	1.440*	-1.337*	-29.03*	-2.77	No	0.97
Saint Gobain	968	15.54*	2.158*	-2.429*	1.052	57.28*	-1.61	No	0.90
Siemens	149	41.81*				41.81*	-1.59	No	0.84
Telecom Italia	783	-5.072*		0.524*	-6.093*	-9.607*	-5.45*	Yes	0.81
ThyssenKrupp	1043	2.666*				2.666*			
Telefonica	767	-2.452*		-2.087*	-1.841*	-3.400	-2.7	No	0.89
Teliasonera	783	-14.02*		6.083*	-5.871*	-42.11*	-1.01	No	0.92
Vodafone	1043	4.544*	8.551*	2.085*	-0.126	7.660*	-3.96*	Yes	0.88
Volkswagen	1043	22.63*	18.15*	15.55*	13.66*	43.03*	-4.00*	Yes	0.75
Overall	24823	3.19	13.43	4.87	2.58	-8.01	-3.04*	Yes	0.95

A detailed overview of the basis per company per year is shown in Tables 7 and 8. Table 7 reports the basis calculated using the adjusted ASW Spread. Table 8 reports the basis calculated using the bond implied CDS spread with an assumed recovery rate of 40%. Overall the average basis for the whole dataset is significantly positive, approximately 1-3 bps. Prior to the financial crisis, the average basis was positive. In 2005 the basis for all companies was positive, approximately 12-14 bps, regardless of the way the bond spread is measured. In 2006 the average basis was positive, between 2 and 5 bps, with a negative basis for some companies. These findings are consistent with studies performed prior to the financial crisis, which also find a significantly positive basis. For example, Blanco et. al find an average positive basis for European reference entities of 7.5 basis points. They attribute the average positive basis to the CTD option in European CDS contracts, which leads to a positive basis. The CTD option is more valuable if a company is in distress or is considered to be in financial difficulties, leading to a large positive basis. In these two years Fiat SPA shows the largest positive basis of all reference entities in 2005 (82.35) and 2006 (27.71). The CTD option seems an intuitive explanation for this high basis level. Fiat had severe financial difficulties in 2005 and 2006, making the CTD option in the CDS more valuable, resulting in a higher CDS spread compared to bond spread.

If we compare the results of 2005 and 2006 to those of 2007 and 2008 we see a different picture in the last two years. The average basis for 2007 and 2008 was negative. For the basis calculated with the adjusted ASW spread, 12 out of 32 companies have a positive basis in 2008. The remaining 20 companies have a negative basis, and Fiat has the most negative basis. The latter observation is quite remarkable, given the fact that in 2005 and 2006 Fiat had the most positive basis. These findings together with the general pattern of the basis as shown in figure 9 show that the financial crisis had an impact on credit markets, influencing the basis. However, we are not able to provide concise conclusions about the possibility if these basis levels are an indicator of arbitrage possibilities, due to the absence of transaction cost data. A non-zero basis level might persist through time if the transaction costs, as a running spread, are higher than the basis level.

The stationary tests reported in both tables show that not all basis levels are stationary. This supports previous conclusions by Blanco et al (2005) and Zhu (2006). Blanco et al. (2005) contend that a stationary basis indicates that synthetic and cash markets price credit risks equally in the long-run. Zhu (2006) contends that a stationary basis implies that in the long-run there are no arbitrage possibilities between default swaps and cash bonds. The non-stationarity of the basis for European companies is an indication that default swap spreads and/or bond spreads may contain factors other than credit risk, e.g. liquidity premium, CTD option and other basis drivers.

These findings lead to rejection of the first sub-hypothesis in chapter 1, namely: “CDS and cash bond spreads are equal, the basis is zero”. Consistent with previous studies, we find a basis which is significantly different from zero. Consistent with previous studies we find a significant positive basis, if we look at the pre-crisis years of 2005 and 2006. Half of the companies in our dataset have a stationary basis level. A stationary basis means that though in the short run the two spreads may differ, in the long run CDS spreads and bond spreads price credit risk equally. The absence of a stationary basis for the other companies is a strong indication of the existence of factors which persistently cause CDS and bond spreads to differ.

We can also reject sub hypothesis 2: “The average CDS-Bond basis is constant over time”. The basis level prior to the financial crisis is positive, while during the financial crisis the average basis was negative. The pattern of the average basis in figure 9 shows that the basis is much more volatile during the crisis than before.

The answers to these sub hypotheses lead to an answer of the first research question: “Are spreads in European cash and synthetic credit market equal, before and during the credit crisis?” Our findings seem to indicate that default swap spreads and bond spreads are not equal, both before and during the credit crisis. Our findings also indicate that there is a difference between the period prior to the crisis and during the crisis. Before the crisis default swap spreads were larger than cash bond spreads on average, while during the crisis the opposite is the case.

However, the answers to these sub-hypotheses and research question do not lead to an understanding what actually causes the default swap and bond spreads to differ. Additionally we cannot conclude what caused the basis to be different if we compare the pre-crisis and crisis period. These are questions we will answer in section 5.3.

5.2.2 The basis per ratings class, sector and maturity

Table 9
Basis per Ratings class and Sector (Adjusted ASW Spread)

This table shows the average basis for the rating classes in our dataset in Panel A. AA rated companies (only financials in our dataset) have a significant positive basis, due to their high credit worthiness, which results in low funding costs and low bond spreads. The basis for the two other ratings classes in our dataset has decreased over time from positive to negative. BBB rated companies exhibit the lowest basis, which is possibly due to the relatively high illiquidity of lower-rated bonds compared to higher rated bonds. The average basis for each sector in the dataset is reported in Panel B. There does not seem to be a specific pattern in the basis over the different sectors, except that the financial companies coincide are the AA rated companies in our dataset and have a positive basis, which is explained above.

Panel A	**Ratings**						
	AA	A	BBB				
2008	19.35	-0.89	-20.12				
2007	17.04	1.03	-3.68				
2006		4.11	0.59				
Panel B	**Sectors**						
	Automobile	Financial	Consumergoods	Chemicals	Construction	Energy	Media/Telecom
2008	-20.07	19.35	-50.14	-10.38	30.33	-10.32	-17.83
2007	2.67		-2.11	-0.22	-1.09	0.76	-4.32
2006	10.10		-1.68	2.33	-0.60	2.60	1.29

Basis per Ratings Class

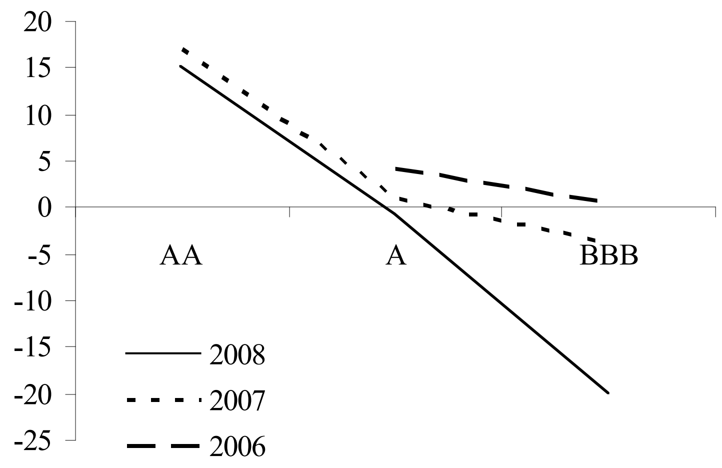
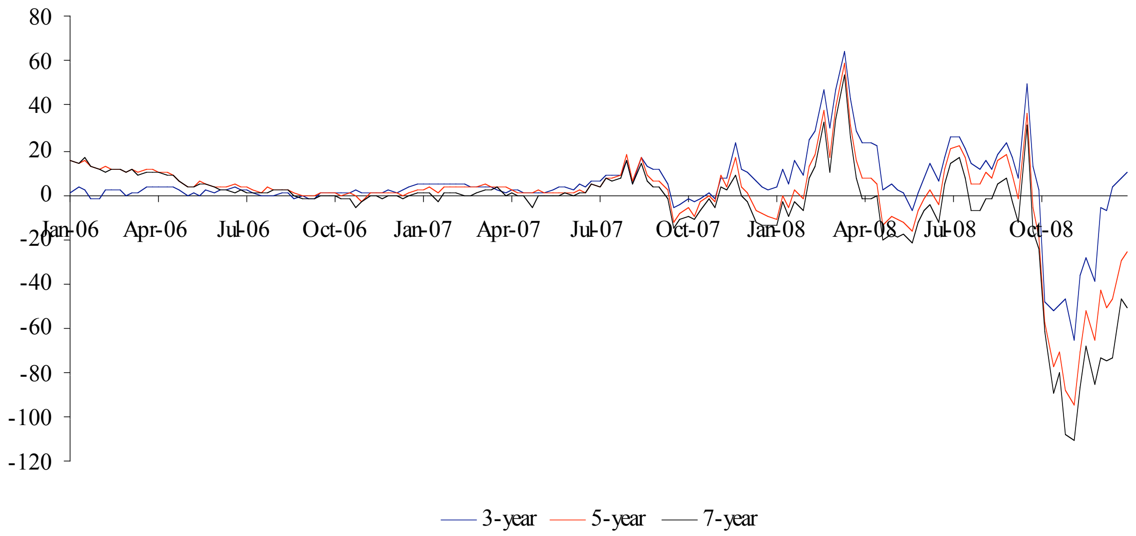


Table 9 shows the basis sorted per ratings class in panel A and per sector in Panel B. In 2008 the average basis was highest and positive for the AA rated companies in our dataset. This is consistent with the findings by Blanco et al. (2005), Cossin & Lu (2005) and Choudhry (2006). Choudhry (2006) suggests that companies with relatively high ratings (AA and above) have a positive basis. As mentioned in 2.6 the positive basis for higher rated names is explained by the high credit worthiness and low funding costs of these companies. The cash bonds of these companies trade at high levels compared to other companies, resulting in lower spreads. Choudhry (2006) also mentions that the bond markets for these high rated names are more liquid than lower rated names. Consistent with the above mentioned studies is the observation that the average basis for A rated companies is lower than for AA rated companies and close to zero. However, the BBB rated companies have a negative average basis of -20. According to Choudhry (2006) the basis for BBB and lower rated names should positive. The first reason behind a positive basis for these ratings classes should be that there is relatively more protection buying than bond-short selling. Because bond short selling is more difficult than protection buying for lower rated names, and market participants desire a short risk position due to the lower credit worthiness, a positive basis is the result. The second reason is the CTD option. Because BBB rated names are relatively less credit worthy and more likely to be in distress, the CTD option is more valuable, resulting in a higher CDS spread. One of the explanations for the negative basis in the BBB spectrum in our dataset is that the relatively high illiquidity and high funding costs in the cash bond market have influenced the cash bond markets severely, resulting in higher bond spreads and a negative basis. The results in panel B of table 4 show that for 2008 all sectors have a negative basis except financials and the construction sector. As mentioned before, the financials coincide with the companies with rating AA.

The main focus of this study is the 5-year basis. However, the dataset allows us to calculate the basis for the 3-year and 7-year maturities for some companies. The company specific basis levels are reported in appendix B. Figure 10 shows the basis calculated with the bond implied CDS spread for the three different maturities. The figure shows that until the start of the crisis in July 2007, the basis for the three maturities do not deviate much. During the crisis we observe that the 3-year basis is higher than the 5-year and 7-year, especially in the last quarter. The latter may be explained by higher illiquidity for longer maturity bonds, resulting in a lower basis.

Figure 10: The basis per maturity



The reported findings lead to rejection of the third sub-hypothesis: "The average CDS-Bond basis is the same for different maturities, sectors and ratings". We find different basis levels for the three ratings classes in our dataset. The higher rated companies have a positive basis, which is consistent with previous studies. However, contrary to these studies we find a lower basis for the lower rated companies, whereas the studies find a positive basis for BBB rated companies. We attribute this result to possible liquidity effects on the basis level. Similar to the previous studies we do not find a clear pattern of the basis per sector. Calculation of the basis for three different maturities indicates that during the financial crisis the basis level and maturity are inversely related.

5.2.3 Conclusions on the basis level

The findings described in 5.2 indicate a slightly positive basis, regardless of the bond spread measurement. Prior to the financial crisis, the average basis level was positive. During the crisis, the average basis level was negative, which may be caused by relative illiquid cash bond markets. Looking at the company specific basis, we see that the basis varies widely. Fiat SPA has a large positive basis pre-crisis and the large negative basis during the crisis. The positive basis level is likely to be caused by the financial distress at the company and the relatively high default swap spread, due to a valuable CTD option. Stationarity tests show that about half of the companies in our dataset have a non-stationary basis. Lastly, we find different basis levels for different maturities, sectors and ratings.

5.3 Basis Drivers - Replication of Previous Studies

Table 10

Pooled Regression of the CDS-Bond Basis Level on Implied Put Volatility Level

This table shows the results of the replication of the study performed by Cossin & Lu (2005). Panel A contains the pooled regression estimates of the relationship between the weekly basis level and the implied put volatility. We find significant positive relationships both before and during the financial crisis. Panel B contains the analysis performed individually for Fiat SPA. Panel C contains the same analysis but includes two macro-economic control variables. We still find significant relationships with the implied put volatility, but also with the two control variables.

Panel A

	Pre-Crisis (Jan 2006 - Jun 2007)			Crisis (July 2007 - Sep 2008)		
Dependent: Basis level (in bps)	**I-Spr**	**Adj ASW**	**Bond Impl**	**I-Spr**	**Adj ASW**	**Bond Impl**
Intercept (in bps)	**-8.16**	**-7.18**	**-7.73**	**-22.39**	**-19.41**	**-20.02**
	(-6.24)	**(-5.48)**	**(-5.67)**	**(-8.23)**	**(-6.92)**	**(-7.42)**
Implied Put Volatility (%)	**41.09**	**38.67**	**47.71**	**75.64**	**70.61**	**80.19**
	(7.51)	**(7.05)**	**(8.36)**	**(9.14)**	**(8.27)**	**(9.77)**
R^2	0.03	0.03	0.04	0.05	0.04	0.06

Panel B

Dependent: Fiat SPA Basis	**I-Spr**	**Adj ASW**	**Bond Impl**
Intercept (in bps)	**-46.75**	**-46.86**	**-33.81**
	(-5.39)	**(-5.11)**	**(-3.78)**
Implied Put Volatility (%)	**296.00**	**298.29**	**280.42**
	(10.78)	**(10.29)**	**(9.91)**
R^2	0.15	0.14	0.13

Panel C

Dependent: Basis level (in bps)	**I-Spr**	**Adj ASW**	**Bond Impl**	**I-Spr**	**Adj ASW**	**Bond Impl**
Intercept (in bps)	2.66	2.52	2.88	**48.29**	**74.08**	**68.52**
	(0.89)	(0.84)	(0.92)	**(5.06)**	**(7.61)**	**(7.31)**
Implied Put Volatility (%)	**42.14**	**39.34**	**48.94**	**53.43**	**43.53**	**54.32**
	(7.70)	**(7.16)**	**(8.56)**	**(6.21)**	**(4.97)**	**(6.43)**
Equity Market Return (%)	-20.24	**-26.17**	-14.12	**-84.69**	**-89.29**	**-76.51**
	(-1.60)	**(-2.06)**	(-1.07)	**(-3.68)**	**(-3.80)**	**(-3.38)**
Treasury Rate (%)	**-2.73**	**-2.42**	**-2.69**	**-14.58**	**-19.50**	**-18.42**
	(-3.96)	**(-3.51)**	**(-3.74)**	**(-7.50)**	**(-9.84)**	**(-9.64)**
R^2	0.04	0.04	0.05	0.09	0.10	0.11

5.3.1 Replication of Cossin& Lu (2005)

The first study to be replicated in this section is the study performed by Cossin & Lu (2005). Panel A of table 10 shows the pooled regression estimates of the relationship between the basis level and the implied put volatility level. The results show that similar to Cossin & Lu we find a significant positive relationship between the implied put volatility and the basis level, prior to the financial crisis and regardless of how the bond spread is measured. However, the explanatory power of the relationship is very low, only 3 to 4% of the variation is explained. Cossin & Lu (2005) only report company specific regression results, with the adjusted R^2 varying from 0% to 60%. Therefore our results lead to the conclusion that though we find a significant relationship, the influence of the CTD option on the basis level prior to the crisis seems to be minimal.

In 5.2.1 we reported that Fiat had the highest basis prior to the crisis, with an average basis of about 85 bps in 2005. We attributed this high basis to the high level of financial distress at the company, resulting in a valuable CTD option. Panel B shows an individual regression of Fiat's basis level on the company's implied put volatility level, from 2005 until the start of the crisis. Compared to the overall pooled regression, the relationship of Fiat's basis with the volatility is much stronger. The coefficient is larger and the variance explained is higher. This seems to support the existence of a CTD option, but only in cases of a high level of financial distress.

If we perform the regressions on the first 5 quarters of the crisis (July 2007 – September 2008) similar results are found compared with the pre-crisis period, namely a significant positive effect of implied put volatility on the basis level. Panel C shows the estimates if we add two control variables to the regression. In all cases implied put volatility still has a significantly positive effect on the basis level. Additionally there seems to be a significant negative relationship between the basis level and national treasury rate.

5.3.2 Replication of Zhu (2006)

Table 11

Pooled Regression Analysis of the CDS-Bond Basis Level similar to Zhu (2006)

This table contains the pooled regressions results of the equation similar to the one estimated by Zhu (2006). For each time-period a pooled regression of the weekly basis levels is performed. This is done for each of thee different basis estimates: Adjusted ASW Spread, Bond Implied CDS Spread with R = 40% and I-Spread, all with a constant maturity of 5-years. Firstly we report the estimates for the pre-financial crisis period (January 2006 – June 2007) and secondly for the financial-crisis excluding the last quarter of 2008 (July 2007 – September 2008. T-statistics are given in parentheses. Estimates and t-statistics significant at the 5% level are in bold.

	Pre-Crisis (Jan 2006 - Jun 2007)			**Crisis (Jul 2007 - Sep 2008)**		
Dependent: Basis level (in bps)	**Adj. ASW**	**Bond Impl.**	**I-Spr**	**Adj. ASW**	**Bond Impl.**	**I-Spr**
Intercept (in bps)	-1.14	-0.78	-0.59	0.53	0.77	-1.33
	(-1.18)	(-0.74)	(-0.58)	(0.18)	(0.26)	(-0.44)
Lagged Basis Level	**0.94**	**0.94**	**0.94**	**0.92**	**0.91**	**0.90**
	(92.64)	**(92.59)**	**(86.49)**	**(71.51)**	**(72.86)**	**(70.31)**
Dummy ($Basis_{i,t-1}$>0)	0.05	-0.04	-0.07	0.17	0.45	0.45
	(0.27)	(-0.19)	(-0.31)	(0.25)	(0.66)	(0.65)
ΔCDS	**0.37**	**0.38**	**0.38**	**0.81**	**0.85**	**0.82**
	(17.20)	**(15.96)**	**(16.61)**	**(40.30)**	**(42.45)**	**(40.65)**
SP Rating	0.00	0.04	-0.01	**-0.77**	**-0.51**	**-0.65**
	(0.01)	(0.74)	(-0.19)	**(-4.96)**	**(-3.40)**	**(-4.19)**
Treasury Rate	0.32	0.20	0.22	0.59	0.14	0.75
	(1.57)	(0.89)	(1.04)	(0.84)	(0.21)	(1.08)
Equity Index (%)	**-7.64**	-1.02	-0.31	-16.61	-16.09	**-28.05**
	(-2.00)	(-0.25)	(-0.08)	(-1.91)	(-1.87)	**(-3.20)**
B/A Spread Differential	0.04	0.07	0.06	**-0.15**	**-0.15**	**-0.18**
	(1.05)	(1.49)	(1.32)	**(-2.63)**	**(-2.81)**	**(-3.25)**
Adjusted R^2	0.90	0.90	0.90	0.90	0.90	0.89
Number of Observations	1686	1686	1686	1525	1525	1525

Table 11 shows the results of the replicated study, originally performed by Zhu (2006). We find in the pre-crisis period, for all three different basis calculation methods, a significant relationship with the lagged basis level and a significant relationship with the movement in the default swap spread. These findings are similar to Zhu's (2006). The former relationship indicates a mean-reverting basis as the coefficient lies between 0 and 1. The coefficient size is the same as Zhu's. The difference with Zhu (2006) is that we find a much stronger relationship measured by the coefficients t-statistic. The latter significant relationship indicates a basis level which is directional with the default swap spread. Zhu (2006) finds a similar positive relationship with the default swap spread, but his coefficient estimate is larger than ours (approximately 0.70 versus 0.40). Contrary to the findings of Zhu (2006) we do not find a significant relationship between the bid/ask-differential and the basis level. The coefficients are positive but not significant. Another difference is that we find a significant relationship between the basis level and equity market returns if we calculate the basis with the adjusted ASW spread. The other two basis calculation methods do not exhibit a positive relationship, thus we do not find support for a possible relationship between the basis level and equity market return. Table 11 also extends the analysis of Zhu to the crisis period. We find the same mean-reverting relationship between the basis level and the lagged basis level. The directional behavior of the basis is also present. The coefficient is larger compared to the pre-crisis period indicating an increased level of directionality. Additional to these two similar findings, we find a significant effect of the ratings class on the basis level. The significantly negative coefficient for all three basis calculation methods indicates that the basis level was more negative for the lower rated names. This is supported by our previous findings that the basis level of lower rated names is lower than for higher rated names. We also find a significant negative effect of the bid-ask differential on the basis level, while we expected a positive effect.

5.3.3 Conclusions

From the replication of previous studies we can draw some preliminary conclusions on what drives the difference between default swap spreads and bond spreads. We find a significant positive effect of implied put volatility as a proxy for the CTD option on the basis level. This is similar to the findings performed by Cossin & Lu (2005). This relationship persists even if we add market equity returns and national interest rate as control variables. However, the explanatory power of the estimated regressions is very low, leading us to conclude that factors other than the CTD option influence the difference between default swap and bond spreads. The replication of the study performed by Zhu (2006) leads to additional insights. Similarly to Zhu (2006), we find that the basis moves directional with the default swap spread. At the same time, the basis does exhibit mean-reversion, indicating a lead-lag relationship between synthetic and cash markets. Additionally to the analysis of Zhu (2006), we find a negative relationship between the rating of a company and its basis level during the credit crisis.

5.4 Basis Drivers- Analysis of Basis Changes

5.4.1 Directionality test

Table 12

Pooled Regression of the Basis Changes on CDS & Bond Spread Changes

This table contains the results of a pooled regression of the weekly basis changes on the weekly changes in the CDS and Bond Spread. The Basis and Bond Spread are calculated using the Adjusted ASW Spread and the Bond Implied CDS Spread with R = 40%. In the regressions of the basis on the change in the CDS spread, a positive significant coefficient indicates directionality of the basis with the CDS Spread. Vice versa for the bond spread. Estimates and t-statistics significant at the 5% level are in bold.

	CDS		**Bond**	
Dependent: Basis Change	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**
Intercept	**-1.97**	**-1.95**	**1.18**	**1.36**
	(-8.12)	**(-8.11)**	**(3.51)**	**(3.99)**
Change in CDS Spread	**0.84**	**0.88**		
	(46.63)	**(49.19)**		
Change in Bond Spread			**-0.71**	**-0.76**
			(-21.17)	**(-22.25)**
Adjusted R^2	0.58	0.61	0.22	0.24
Number of Observations	1578	1578	1578	1578

As shown in sections 5.2.1 and 5.3.2 there is strong evidence of a basis that moves directional with the default swap spread. This directionality is specifically observed during the financial crisis from July 2007 until the end of September 2008. To further investigate this, we have performed pooled regressions of the basis changes on the changes in default swap spread and bond spread. Including both default swap and bond spread changes in the same equation results in a perfectly explanatory equation. Therefore, they are separately regressed to look at the directional movements. The results in table 12 indicate that the movements of the basis show significant directional movements with both default swap spreads and bond spreads. However, the absolute size of the coefficients and the variation explained, confirm our assumption that the basis moved substantially more in line with the default swap spread. A possible first explanation for this directional behavior can be the fact that synthetic markets lead cash markets in price discovery. This is found by Blanco et al (2005) and Zhu (2006) in their studies. To support this lead-lag relationship, we need to find a mean reverting basis, because if synthetic markets lead, cash markets should reconnect at a certain point in time. The latter should result in a negative relationship with the lagged basis change and level. An additional explanation for this directional behaviour would be that there are technical and market factors which influence the default swap spread and not the bond spread. For example, increasing concerns about counterparty default risk should be reflected in the default swap spread and not in the bond spread, leading to increasing default swap spreads and basis.

Table 13

Pooled Regressions Analysis of the CDS-Bond Basis Changes, before and during the financial crisis

The results of the pooled regressions estimates of the coefficients are given below. For each time-period a pooled regression of the weekly changes in the basis is performed on 8 different variables. This is done for each of two different basis estimates: Adjusted ASW Spread, Bond Implied CDS Spread with R = 40% with a constant maturity of 5-years. Firstly we report the estimates for the whole testing period (January 2006 – December 2008), secondly for the pre-financial crisis period (January 2006 – June 2007), thirdly for the financial-crisis excluding the last quarter of 2008 (July 2007 – September 2008) and lastly for the last quarter of 2008 (October – December 2008). T-statistics are given in parentheses. Estimates and t-statistics significant at the 5% level are in bold.

	All		Pre-Crisis (Jan 06 - Jun 07)		Crisis (Jul 07 - Sep 08)		Crisis (Oct 08 - Dec 08)	
Dependent: Change in Basis (in bps)	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**
Intercept (in bps)	-0.46	-0.28	0.02	0.14	**-1.28**	**-0.79**	-4.61	-3.98
	(-1.49)	(-0.82)	(0.25)	(1.47)	**(-3.64)**	**(-2.15)**	(-1.35)	(-1.02)
Lagged Basis Level (in bps)	**-0.03**	**-0.01**	**-0.09**	**-0.09**	**-0.08**	**-0.10**	-0.02	-0.01
	(-4.22)	**(-1.94)**	**(-5.11)**	**(-10.99)**	**(-7.29)**	**(-7.91)**	(-1.13)	(-0.43)
Lagged Change in Basis (in bps)	**-0.05**	**-0.12**	**-0.19**	**-0.22**	**-0.16**	**-0.16**	0.02	-0.08
	(-2.72)	**(-6.75)**	**(-6.73)**	**(-9.06)**	**(-7.00)**	**(-6.88)**	(0.36)	(-1.35)
Change in Implied Put Volatility (%)	**-12.98**	-3.46	-4.55	-2.77	-7.38	-10.11	-10.54	0.20
	(-3.23)	(-0.77)	(-1.05)	(-0.98)	(-0.94)	(-1.26)	(-0.78)	(0.01)
Company equity returns (%)	-0.00	0.00	0.00	0.00	**-0.00**	-0.00	-0.00	0.00
	(-0.75)	(1.02)	(1.59)	(0.51)	**(-1.97)**	(-1.21)	(-0.28)	(0.54)
Change in Bid/Ask spread differential (in bps)	0.40	0.22	-0.04	-0.38	**0.91**	**1.08**	0.36	0.24
	(1.54)	(0.75)	(-0.33)	(-1.37)	**(2.57)**	**(2.99)**	(0.41)	(0.23)
Change in TED spread (in bps)	-0.02	-0.01	0.01	-0.02	-0.00	0.01	-0.06	-0.04
	(-1.34)	(-0.47)	(1.36)	(-0.91)	(-0.25)	(0.82)	(-1.33)	(-0.77)
Change in long-term interest rate (in bps)	**-0.21**	**-0.26**	0.03	0.05	**-0.15**	**-0.18**	**-0.46**	**-0.64**
	(-6.89)	**(-7.65)**	(0.84)	(3.85)	**(-4.54)**	**(-5.36)**	**(-2.74)**	**(-3.26)**
Market equity returns (%)	**-40.34**	**-45.82**	**-33.44**	**-24.81**	**-102.24**	**-105.13**	71.54	47.26
	(-3.02)	**(-3.05)**	**(-5.62)**	**(-4.18)**	**(-6.85)**	**(-6.86)**	(1.10)	(0.62)
Dummy FED & ECB rate hikes	2.50	2.24	0.56	0.41				
	(1.28)	(1.02)	(1.34)	(0.98)				
Dummy FED & ECB rate cuts	**-8.31**	**-8.51**			**-4.78**	**-4.30**	-6.43	-11.22
	(-7.49)	**(-6.85)**			**(-4.64)**	**(-4.07)**	(-0.97)	(-1.44)
Dummy US Bank collapses	**31.81**	**29.52**			**30.16**	**28.22**		
	(12.16)	**(10.02)**			**(14.78)**	**(13.47)**		
Adjusted R^2	0.10	0.09	0.13	0.14	0.33	0.33	0.03	0.03
Number of observations	3332	3332	1541	1541	1512	1514	322	322

Table 14

Pooled Regressions Analysis of the CDS-Bond Basis Changes – Choosing the final set of variables

The results of the pooled regressions estimates of the coefficients are given below. We estimate the relationships between the weekly basis changes and a set of variables for the financial-crisis excluding the last quarter of 2008 (July 2007 – September 2008. T-statistics are given in parentheses. Estimates and t-statistics significant at the 5% level are in bold.

	Implied Put Volatility		Company Equity Returns		Market Equity Returns	
Dependent: Change in Basis (in bps)	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**
Intercept (in bps)	**-0.76**	-0.41	**-0.83**	-0.46	**-1.27**	**-0.76**
	(-2.20)	(-1.15)	**(-2.43)**	(-1.32)	**(-3.63)**	**(-2.09)**
Lagged Basis Level (in bps)	**-0.10**	**-0.11**	**-0.09**	**-0.11**	**-0.08**	**-0.10**
	(-8.37)	**(-8.87)**	**(-8.14)**	**(-8.74)**	**(-7.36)**	**(-7.92)**
Lagged Change in Basis (in bps)	**-0.16**	**-0.17**	**-0.16**	**-0.17**	**-0.16**	**-0.16**
	(-7.18)	**(-7.12)**	**(-7.28)**	**(-7.18)**	**(-6.99)**	**(-6.94)**
Change in Implied Put Volatility (%)	**22.59**	**16.32**				
	(3.19)	**(2.25)**				
Company equity returns (%)			**0.00**	**0.00**		
			(-6.44)	**(-5.31)**		
Change in Bid/Ask spread differential (in bps)	**0.98**	**1.13**	**0.95**	**1.10**	**0.92**	**1.08**
	(2.78)	**(3.13)**	**(2.73)**	**(3.07)**	**(2.61)**	**(3.00)**
Change in TED spread (in bps)	**0.03**	**0.04**	0.02	**0.04**	0.00	0.01
	(2.64)	**(3.84)**	(1.94)	**(3.20)**	(-0.19)	(0.82)
Change in long-term interest rate (in bps)	**-0.23**	**-0.27**	**-0.21**	**-0.25**	**-0.15**	**-0.18**
	(-7.50)	**(-8.48)**	**(-6.88)**	**(-7.93)**	**(-4.51)**	**(-5.36)**
Market equity returns (%)					**-111.89**	**-107.82**
					(-9.04)	**(-8.49)**
Dummy FED & ECB rate hikes						
Dummy FED & ECB rate cuts	**-5.10**	**-4.39**	**-4.84**	**-4.19**	**-4.92**	**-4.44**
	(-4.91)	**(-4.12)**	**(-4.72)**	**(-3.99)**	**(-4.79)**	**(-4.23)**
Dummy US Bank collapses	**30.07**	**28.26**	**30.19**	**28.30**	**29.98**	**28.02**
	(14.61)	**(13.38)**	**(14.88)**	**(13.57)**	**(14.76)**	**(13.43)**
Adjusted R^2	0.29	0.29	0.31	0.30	0.33	0.33
Number of observations	1565	1567	1576	1578	1523	1525

Table 15

Pooled Regressions Analysis of the CDS-Bond Basis Changes by ratings class

The results of the pooled regressions estimates of the coefficients are given below. The final set of variables is used, which means the exclusion of company specific equity returns and implied put volatilities. For each rating class a pooled regression of the weekly changes in the basis is performed on 8 different variables for the time period July 2007 – September 2008. This is done for each of three different basis estimates: Adjusted ASW Spread, Bond Implied CDS Spread with R = 40% with a constant maturity of 5-years. T-statistics are given in parentheses. Estimates and t-statistics significant at the 5% level are in bold.

	AA		A		BBB	
Dependent: Change in Basis (in bps)	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**
Intercept (in bps)	**10.33**	**5.36**	-0.02	0.03	**-1.81**	**-1.10**
	(3.50)	**(1.97)**	(-0.06)	(0.06)	**(-3.46)**	**(-2.05)**
Lagged Basis Level (in bps)	**-0.45**	**-0.33**	**-0.18**	**-0.16**	**-0.06**	**-0.07**
	(-5.57)	**(-4.42)**	**(-3.50)**	**(-7.25)**	**(-3.86)**	**(-4.41)**
Lagged Change in Basis (in bps)	-0.15	-0.17	**-0.07**	**-0.07**	**-0.16**	**-0.18**
	(-1.89)	(-2.17)	**(-1.99)**	**(-1.98)**	**(-4.98)**	**(-5.42)**
Change in Bid/Ask spread differential (in bps)	-0.06	-3.19	**2.14**	**2.21**	0.28	0.52
	(-0.02)	(-1.05)	**(2.91)**	**(4.79)**	(0.56)	(1.01)
Change in TED spread (in bps)	0.06	0.04	0.01	0.02	-0.02	0.00
	(1.25)	(0.73)	(1.12)	(1.36)	(-0.90)	(0.13)
Change in long-term interest rate (in bps)	-0.13	-0.16	**-0.16**	**-0.17**	**-0.14**	**-0.19**
	(-0.80)	(-1.03)	**(-7.71)**	**(-4.11)**	**(-2.79)**	**(-3.59)**
Market equity returns (%)	**-152.48**	**-172.39**	**-84.18**	**-81.52**	**-120.46**	**-115.46**
	(-3.01)	**(-3.14)**	**(-10.59)**	**(-5.16)**	**(-6.42)**	**(-6.00)**
Dummy FED & ECB rate cuts	-3.38	-1.24	**-4.71**	**-3.94**	**-4.99**	**-4.83**
	(-0.75)	(-0.25)	**(-7.80)**	**(-3.05)**	**(-3.21)**	**(-3.04)**
Dummy US Bank collapses	**54.51**	**55.18**	**24.45**	**22.72**	**30.83**	**28.50**
	(6.77)	**(6.27)**	**(8.53)**	**(8.87)**	**(9.88)**	**(8.89)**
Adjusted R^2	0.69	0.62	0.39	0.36	0.28	0.29
Number of observations	86	88	631	631	806	806

5.4.2 Basis Drivers

Pre-Crisis: January 2006 – July 2007

Table 13 contains pooled regression of our own basis driver analysis, using basis changes. The pre-crisis period estimates are similar to the regressions we performed with the basis levels in section 5.3.2 We find significantly negative coefficients for the lagged basis level and lagged basis change. This supports our expectation of a lead-lag relationship between synthetic and cash credit markets.

In constrast to the findings in 5.3.1. we do not find a significant positive effect of implied put volatility. The coefficient of the variable is negative, though a positive sign is expected. An explanation for the absence of a significant relationship can be that the level of implied volatility is a better proxy for the CTD option than changes in the volatility. The CTD option becomes valuable once a company reaches a certain level of financial distress. Using the changes in implied put volatility discards this notion of a threshold. We find significantly negative coefficients for the equity market returns and do not find a significant effect of the bid-ask spread differential and US TED spread on the basis changes. The key interest rate increases do not seem to affect the basis. The variation explained is low, approximately 13-14%, which indicates that there are important basis drivers not measured in this period.

Crisis Period 1: July 2007 – September 2008

The first crisis period yields additional results. Again, we find significant negative coefficients for the lagged basis level and lagged basis changes, indicating a lead-lag relationship between synthetic and cash credit markets in this period. We do not find a significant relationship with the changes in implied put volatility and the company-specific equity returns. Similar to the pre-crisis period it is remarkable that the sign of the implied put volatility coefficient is negative.

We find significant negative relationships between the basis and both macro-economic control variables, the equity market return and changes in the spot interest rate. Theoretically the coefficient should be zero, as both synthetic markets and cash markets should price this information equally. However the existence of a lead-lag relationship between synthetic and cash markets, could also result in finding these significant relationships, as the negative sign points at directional movement with the default swap spread. Additionally we find a significantly positive relationship between the weekly basis changes and the liquidity-factor measured by the bid-ask differential. A less liquid CDS, proxied by a positive change in the bid-ask differential leads to a positive change in the basis. We do not find a significant negative relationship with changes in the US TED spread.

The two event-dummies have a significant effect on the basis. The dummy containing the FED & ECB rate cuts has a significant negative effect on the basis. We expected this coefficient to be positive, as rate cuts should translate into lower funding costs in the cash market and therefore have a positive effect on the basis. Apparently the rate cuts by the two central banks did not have this effect, but rather an adverse effect on the cash bond market. The collapse of the two US banks (Bear Stearns, Lehman Brothers) seems to have had a large positive effect on the basis. This is as expected, because both banks[20] were large counterparties in the CDS market. As default swaps are subject to counterparty risk, the collapse of both banks caused a market-wide increase of the perceived counterparty risk in the whole CDS market. This translates into higher default swap spreads and therefore a higher basis. Many, if not the majority, of the market participants in synthetic credit markets, are financial institutions themselves. The variation explained is higher than the pre-crisis period, indicating that the variables explain more of the basis movements in this period.

Crisis Period 2: October 2008 – December 2008

Analysis of the last quarter in our dataset returns only a significant negative relationship with the long-term interest rate. Apparently, the other variables do not explain the dynamics of the basis in this period. As shown in figure 9 the last quarter of 2008 was characterized by a steep decrease of the basis. A plausible explanation is the increased illiquidity of the cash bond market after collapse of Lehman Brothers and AIG. However, this change in illiquidity is not captured by the bid-ask differential, which we use as a proxy for relative liquidity. A better measurement of liquidity and real transaction data are likely to explain the dynamics in this period.

Total Period: January 2006 – December 2008

The pooled regression of the whole period results in a significant negative relationship with the lagged basis, significant negative relationships with the two control variables and significant effect of the rate cuts and bank bankruptcies.

5.4.3 Final set of variables

Table 16

Correlation Between Variables

This table contains the correlations of the average equity returns, average market equity returns and average changes in implied put volatility.

	Company Equity Return	Market Equity Returns	Implied Put Volatility
Company Equity Return	1.00	0.95	-0.55
Market Equity Returns	0.95	1.00	-0.60
Implied Put Volatility	-0.55	-0.60	1.00

Before continuing with the analysis of the basis for the different ratings classes, we determine the final set of variables. Table 16 shows the correlations of three of the independent variables in our analysis, namely the company equity returns, market equity returns and changes in implied put

[20] Especially Lehman Brothers

volatility. The results show that the variables are highly correlated. The average company equity returns are highly positively correlated with the average market equity returns. This is logical, because the average of all the company-specific equity returns can be seen as market return itself. The changes in implied put volatility are highly negatively correlated with both types of equity returns. This high correlation between the variables, also called multicollinearity, can result in wrong coefficient estimates and/or insignificant coefficients. Therefore we perform the regressions again, but include only one of the three variables next to the other presumed basis drivers.

The results in table 16 show that if we include the implied put volatility changes and not the equity returns in the equation, we find a significantly positive relationship between the put volatility and basis changes, compared to an insignificant negative relationship if the equity returns are also included. If we only include the company equity returns, we find a significant negative relationship with the basis. These two separate significant relationships with the basis and the sign of the coefficients indicate that there is a factor present which influences only the default swap spread or that influences the default swap spread more than the bond spread. The relationships found between the basis and the company-specific equity returns and the changes implied put volatility support the notion of a CTD option in CDS contracts. According to Blanco et al. (2005) the CTD option should lead to a higher sensitivity of default swap spreads to company specific information. The CTD option becomes more valuable as financial distress at the company level increases, measured by the decrease in equity returns or increase in implied put volatility.

However, if the equity market returns are included instead of the two company-specific variables, we get higher R^2 values. The coefficient of the equity market returns is also larger than the coefficient for the company specific returns. Both the market equity returns and spot interest rate changes are significantly related to the basis and the negative signs point at directionality with the default swap spread. This is more proof for the existence a lead-lag relationship. The final set of variables includes the equity market returns, and excludes the company equity returns and changes in implied put volatility.

5.4.4 Basis Drivers per rating class

With the final set of variables, we look if there are substantial differences in the basis drivers between the ratings classes for the time period July 2007 – September 2008. The results are reported in table 15. We find a significant negative relationship with the lagged basis level for all ratings classes, regardless of how the basis is calculated. We do not find a significant negative relationship with the lagged basis change for the AA subset. We find significant negative relationships for the A-rated subset and BBB rated subset. We do not find a significant relationship with the changes in implied put volatility for all ratings classes. The coefficients for the equity market returns and spot interest rate changes are significantly negative for the A rated and BBB rated names. The bid-ask spread differential is only significantly positive for the A rated names. The FED & ECB rate cuts are only significant for the A and BBB rated names. The bank collapse dummy is significant for all ratings classes and the effect on the AA rated names is larger. The latter is due to the fact that the AA rated names consist of the financial companies in our dataset, whose default swap spreads are more affected by a default by one of their peers.

The first remarkable outcome after comparing the different ratings classes is the fact that the AA subset shows less significant relationships with the variable compared to the A and BBB rated subsets. The AA subset only returns negative relationships with the lagged basis level and event dummy. One of the likely reasons for this difference is the fact that there we do not have much data for the AA rated names. We only have 86 observations for the AA subset compared to more than 600 for each of the other ratings subsets. The second remarkable outcome is the fact that the changes in the bid-ask differential are only significantly positive for the A rated subset. Together with the findings in section 5.3.2 in which we found a significant negative relationship between the basis level and bid-ask spread differential, we suspect that the bid-ask differential is not a very reliable measurement of relative liquidity.

Table 17

Pooled Regression of the Monthly Basis Changes on CDS & Bond Spread Changes

This table contains the results of a pooled regression of the weekly basis changes on the weekly changes in the CDS and Bond Spread. The Basis and Bond Spread are calculated using the Adjusted ASW Spread and the Bond Implied CDS Spread with R = 40%. In the regressions of the basis on the change in the CDS spread, a positive significant coefficient indicates directionality of the basis with the CDS Spread. Vice versa for the bond spread. Estimates and t-statistics significant at the 5% level are in bold.

	CDS		**Bond**	
Dependent: Basis Change	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**
Intercept	**-3.57**	**-4.53**	**2.10**	**2.71**
	(-3.58)	**(-4.69)**	**(2.24)**	**(2.57)**
Change in CDS Spread	**0.31**	**0.50**		
	(7.04)	**(11.87)**		
Change in Bond Spread			**-0.40**	**-0.43**
			(-10.60)	**(-8.87)**
Adjusted R^2	0.12	0.28	0.24	0.18
Number of Observations	351	351	352	352

Table 18

Pooled Regressions Analysis of the Monthly Basis Changes, before and during the financial crisis

The results of the pooled regressions estimates of the coefficients are given below. For each time-period a pooled regression of the monthly changes in the basis is performed on 8 different variables. This is done for each of two different basis estimates: Adjusted ASW Spread, Bond Implied CDS Spread with R = 40% with a constant maturity of 5-years. Firstly we report the estimates for the whole testing period (January 2006 – December 2008), secondly for the pre-financial crisis period (January 2006 – June 2007), thirdly for the financial-crisis excluding the last quarter of 2008 (July 2007 – September 2008) and lastly for the last quarter of 2008 (October – December 2008). T-statistics are given in parentheses. Estimates and t-statistics significant at the 5% level are in bold.

	All		Pre-Crisis (Jan 06 - Jun 07)		Crisis (Jul 07 - Sep 08)		Crisis (Oct 08 - Dec 08)	
Dependent: Change in Basis (in bps)	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**	**Adj. ASW**	**Bond Impl.**
Intercept (in bps)	-0.71	-0.71	0.09	**0.75**	0.07	-0.41	-45.70	-5.63
	(-0.61)	(-0.52)	(0.31)	**(2.38)**	(0.07)	(-0.38)	(-0.49)	(-0.05)
Lagged Basis Level (in bps)	**-0.07**	-0.04	**-0.27**	**-0.28**	**-0.09**	**-0.13**	0.06	0.05
	(-2.32)	(-1.20)	**(-10.65)**	**(-10.70)**	**(-2.25)**	**(-2.65)**	(0.50)	(0.40)
Lagged Change in Basis (in bps)	-0.07	**-0.13**	**-0.16**	**-0.16**	-0.07	-0.13	-0.26	-0.24
	(-1.59)	**(-3.06)**	**(-3.50)**	**(-3.51)**	(-0.91)	(-1.85)	(-1.73)	(-1.56)
Change in Bid/Ask spread differential (in bps)	-0.14	-0.60	-0.30	-0.49	**1.21**	**1.38**	-1.29	-2.07
	(-0.42)	(-1.53)	(-1.15)	(-1.72)	**(3.70)**	**(3.76)**	(-1.08)	(-1.39)
Change in TED spred (in bps)	**-0.06**	-0.01	**-0.10**	-0.03	**-0.11**	**-0.06**	-0.81	-0.13
	(-2.23)	(-0.37)	**(-4.43)**	(-1.37)	**(-7.24)**	**(-3.47)**	(-0.63)	(-0.09)
Change in long-term interest rate (in bps)	**-0.29**	**-0.31**	**0.05**	**0.04**	**-0.15**	**-0.12**	-0.69	-0.88
	(-4.70)	**(-4.30)**	**(3.43)**	**(2.39)**	**(-2.82)**	**(-1.97)**	(-0.92)	(-0.97)
Market equity returns (%)	**216.56**	**191.06**	-6.71	**-19.90**	-26.92	**-63.74**	459.08	576.23
	(9.50)	**(7.20)**	(-0.87)	**(-2.37)**	(-1.38)	**(-2.92)**	(1.32)	(1.34)
Adjusted R^2	0.15	0.09	0.27	0.25	0.24	0.18	0.35	0.24
Number of observations	790	790	394	396	350	351	69	69

5.4.5 Monthly changes in the Basis

The findings of a directional and mean-reverting basis suggest a lead-lag relationship between the synthetic and cash credit market. This is consistent with the studies performed by Blanco et al. (2005) and Zhu (2006), who find that synthetic markets lead in price discovery on a weekly basis. On a weekly basis this lead-lag relationship might dominate the dynamics of the basis in our analysis. Theoretically, this lead-lag relationship should be weaker or absent if we increase the measurement interval, allowing for us to observe the 'real' basis drivers. Therefore, we repeat the analyses of sections 5.4.1 and 5.4.2 using monthly basis changes. Monthly basis changes are measured using the first Wednesday of each month. Table 17 reports the estimates of the monthly basis changes regressed on the monthly default swap and bond spread changes for the period July 2007 until end of September 2008. Compared to the weekly intervals, we still find directional movements of the basis with both the default swap and bond spread. However the directional movements seem to be weaker, shown by the lower variation explained and the smaller coefficients. The evidence for a leading synthetic market is weaker, because the difference between the variation explained by default swap changes and the bond spread changes is not as large as the difference using weekly intervals.

Table 18 shows the analysis of the basis drivers with monthly changes. The relationship with the lagged basis level is still significantly negative, before and during the crisis. However, the statistics are lower, which that the relationship on a monthly interval is weaker than on a weekly interval. We do not find a significant negative relationship with the lagged basis changes during the ciris, which supports the assumption of a much weaker lead-lag relationship.

The bid-ask differential still shows a significant positive relationship with the basis changes during the crisis. Additional to the results of the weekly analysis we find a significant negative relationship between the monthly basis changes and monthly changes in the US TED Spread. The sign is as expected. An increase in the US TED Spread means that funding in the interbanking market has increased relative to the sovereign "risk-free" market. Higher funding costs should result in a less attractive cash bond market vis-à-vis higher bond spreads and thus a decrease in the basis. A possible explanation for finding this relationship with monthly intervals but not with weekly intervals is that the absence of a strong lead-lag relationship makes it possible to discover this relationship.

The monthly changes in the spot interest rate still show a negative relationship with the basis changes before and during the crisis. The statistics of the coefficients are lower than with the weekly intervals.. A significant negative relationship with the equity market returns is only discovered with the basis calculated with the bond implied spread. These findings support our observation that the lead-lag relationship between synthetic and cash markets is weaker on a monthly interval.

5.4.6. Conclusions on the Basis Drivers

The analysis of basis drivers in 5.4 yields the following conclusions, which are an answer to the second research question in chapter 1.

Firstly, a significant lead-lag relationship between synthetic and cash credit markets is found. Analysis of the weekly basis changes shows that the basis moves more directionally with the default swap spread than with the cash bond spread. Significant negative relationships with the two control variables in our analysis also point at a basis that moves directionally with the default swap spread. The lead-lag relationship is underlined by the significant negative relationships of the weekly basis changes with the lagged basis levels and changes, which indicate mean-reversion. Analysis of the monthly basis changes shows that the lead-lag relationship is much weaker compared to weekly intervals.

Secondly, we find some evidence that liquidity affects the basis. However, measuring relative liquidity as the bid/ask spread differential is likely to be a relative week proxy, because we do not find significant relationships across all data subsets.

Thirdly we find significant effects of two events. FED & ECB rate cuts seem to have a negative influence on the basis. The bankruptcy of Bear Stearns and Lehman Brothters seem to have had a large positive influence on the basis. This is likely due to the perception of increased counterparty risk by market participants.

Lastly, in the monthly analysis we find evidence of a negative relationship between the basis and funding costs. Using the US TED Spread as a measurement of the funding costs, we find that increased funding costs make cash bond positions less attractive. The latter results in higher bond spreads and thus a lower basis.

Chapter 6 Conclusion

The purpose of this thesis was to investigate the relationship between synthetic and cash credit markets, by deriving and analyzing the difference between default swap spreads and bond spreads, the CDS-Bond Basis. By using different measurement methods of the bond spread, we have been able to analyze the basis in a robust way. Our first main conclusion is that discrepancies between default swap and bond spreads do exist. This existence of the basis, is in line with studies previously performed by researchers on this subject. The basis is non-zero for many companies. However, there appears to be a long-run equilibrium, measured by the stationarity of the basis, for about half of the companies in our dataset. This means that the existence of the basis in the short run, there are no arbitrage relationships on the long run. The basis is not constant over time. Analysis of the basis per company over time, and analysis of the average basis shows an increased volatility of the basis during the credit crisis.

To understand the existence of the basis, we have analyzed the influence of variables that should theoretically cause the discrepancies between synthetic and cash markets to exist. This analysis of the basis drivers generates our second main conclusion. The strongest relationship we find is that the basis exists due to a lead-lag relationship between synthetic and cash markets. Synthetic credit markets lead in price discovery, causing the basis to move directionally with default swap spreads. Besides this lead-lag relationship we find evidence of liquidity and funding cost effects on the basis. However, because we do not find statistical evidence for these relationships in all of our analyses, the objective of a follow-up study would be the inclusion of better variables to measure these effects.

Appendix A

CDS Valuation

At inception of the default swap the value of the swap should be zero. The CDS has two cash flow streams: a fee leg and a contingent leg. The left hand term in equation 4 represents the fee leg, the right hand term the contingent leg. The fee leg consists of the periodic payments from the buyer to the seller and accrued payment till default. The contingent leg is the payment made by the protection seller to the buyer in case of default. The default swap spread should be such that the present value of the fee leg is equal to the present value of the contingent leg.

$$Sn \cdot \sum_{i=1}^{n} (\Delta_i \cdot Ps_i \cdot DF_i) + Accrual \ = (1-R) \cdot \sum_{i=1}^{n} ((Ps_{(i-1)} - Ps_i) \cdot DF_i)$$

$$Accrual = S_n \cdot \sum_{i=1}^{n} (\frac{\Delta_i}{2} \cdot (Ps_{(i-1)} - Ps_i) \cdot DF_i)$$

Where,

n	maturity in years
S_n	Spread for a n-year contract
Δ_i	Length of time period i in years
Ps_i	Cumulative Probability of Survival to time i
DF_i	Discount Factor to time i
R	Expected Recovery Rate after default

In the framework for calculating the default swap spread, one needs an estimation of the probability of default from which the probability of survival can be derived. Many CDS valuation frameworks try to model the probability of default using the periodical/conditional probability of default, called the hazard rate (λ_i). The probability of survival after two periods is then calculated by:

$$Ps_2 = (1-\lambda_1) \cdot (1-\lambda_2)$$

and the probability of default by:

$$Pd_2 = (1-\lambda_1) \cdot \lambda_2$$

Assuming a flat default curve the constant hazard rate can be directly estimated from the spread and recovery rate, according to the relation:

$$\lambda = \frac{S}{(1-R)}$$

Appendix B

Table B1
The 3-year CDS-Bond Basis – Bond Implied CDS Spread (R = 40%)

This table shows descriptive statistics of the CDS-Bond Basis in basis points for each separate reference entity in the dataset. The basis is calculated as the 3-year CDS spread minus the interpolated 3-year bond implied spread (R=40%). Rejection of the null hypothesis at 5% that the average basis is zero is indicated by an *.

		Basis Levels				
Company	**No. Obs (days)**	**Average**	**2005**	**2006**	**2007**	**2008**
Air Liquide	395	0.578			-0.818	1.287
Allianz		2.666*				2.666*
Bayer AG		2.666*				2.666*
Bertelsmann AG	411	-9.871*			-2.212*	-14.22*
BMW	533	32.62*		15.36*	12.08*	53.75*
BNP		2.666*				2.666*
Bouygues	688	-0.081		-2.515*	0.031	1.339
British American Tobacco	143	-67.69*				-67.69*
Casino	1043	-8.004*	-1.683*	-3.812*	1.948*	-28.35*
Carrefour	727	5.104*		5.270*	6.966*	3.120
Credit Suisse	328	6.301*			16.60*	3.706
Daimler	603	14.14*		2.401*	2.717*	29.10*
Deutsche Bank	185	4.264*				4.264*
Deutsche Telekom	759	13.96*		9.461*	8.606*	23.36*
Fiat		2.666*				2.666*
Fortum		2.666*				2.666*
France Tel	298	38.10*			40.38*	37.79*
Glaxo	673	11.71*		19.84*	11.87*	6.910*
Iberdrola	679	16.80*		0.270	12.32*	31.11*
KPN	822	-12.32*	9.499*	0.469	0.978*	-41.53*
Lafarge		2.666*				2.666*
PPR	526	-4.721*		-4.995*	-4.851*	-0.349
Renault	657	8.893*		-4.471*	4.107*	20.49*
Schneider	827	-7.459*	-2.482*	-3.401*	-3.134*	-16.63*
Saint Gobain	447	27.05*			6.106*	41.84*
Siemens		2.666*				2.666*
Telecom Italia	242	-2.736				-2.736
ThyssenKrupp		2.666*				2.666*
Telefonica	238	-2.308				-2.308
Teliasonera	342	-21.17*			-7.166*	-25.45*
Vodafone	548	11.36*		4.057*	7.347*	16.07*
Volkswagen	421	38.46*			16.48*	51.80*
Overall	12535	3.294*	-0.639	1.350*	4.891*	7.538*

Table B2

The 7-year CDS-Bond Basis – Bond Implied CDS Spread (R = 40%)

This table shows descriptive statistics of the CDS-Bond Basis in basis points for each separate reference entity in the dataset. The basis is calculated as the 7-year CDS spread minus the interpolated 7-year bond implied spread (R=40%). Rejection of the null hypothesis at 5% that the average basis is zero is indicated by an *.

		Basis Levels				
Company	**No. Obs (days)**	**Average**	**2005**	**2006**	**2007**	**2008**
Air Liquide	783	1.776*		10.75*	6.966*	-12.30*
Allianz	262	51.13*				51.13*
Bayer AG		2.666*				2.666*
Bertelsmann AG	599	-26.83*		-2.906*	-5.765*	-54.77*
BMW	783	7.379*		6.117*	8.077*	7.937*
BNP	523	-2.751			6.535*	-12.00*
Bouygues	1038	-10.75*	4.694*	0.646	-5.296*	-42.53*
British American Tobacco	463	-55.98*			-9.766*	-91.43*
Casino		2.666*				2.666*
Carrefour	809	-9.167*	6.708*	-2.051*	4.633*	-31.55*
Credit Suisse	328	6.301*			16.60*	3.706
Daimler		2.666*				2.666*
Deutsche Bank	262	9.973*				9.973*
Deutsche Telekom	1022	1.161	20.66*	4.398*	-6.420*	-12.28*
Fiat	410	-129.9*			-8.171*	-198.7*
Fortum		2.666*				2.666*
France Tel	785	2.393*	30.37*	10.40*	-2.825*	-0.570
Glaxo		2.666*				2.666*
Iberdrola	1043	-0.264	7.801*	0.197	-2.017*	-6.981*
KPN	420	-50.38*			-1.437	-79.90*
Lafarge	1043	12.87*	9.756*	3.772*	2.061*	35.79*
PPR		2.666*				2.666*
Renault	411	4.728			19.40*	-3.619
Schneider	891	-10.18*	1.751*	0.593	-1.414*	-34.54*
Saint Gobain	968	5.205*	5.091*	0.985*	-3.582*	18.22*
Siemens	149	30.31*				30.31*
Telecom Italia	783	-7.747*		1.772*	-5.681*	-19.25*
ThyssenKrupp		2.666*				2.666*
Telefonica	767	-10.69*		-1.073*	-3.427*	-26.88*
Teliasonera	622	-7.428*		-0.288	-8.208*	-23.35*
Vodafone	1043	6.884*	14.21*	1.782*	0.364	11.16*
Volkswagen	1043	23.08*	17.18*	17.30*	14.07*	43.66*
Overall	17250	-0.924	10.64*	3.586*	0.111	-17.91*

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