Credit Default Swaps - A Survey

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Abstract

Credit default swaps (CDS) have been growing in importance in the global financial markets. However, their role has been hotly debated, in industry and academia, particularly after the credit crisis of 2008-2009 and the European sovereign crisis of 2010-2012. We review the extant literature on CDS that has accumulated over the past two decades. We divide our survey into seven topics after providing a broad overview in the introduction. The second section traces the historical development of CDS markets and provides an introduction to CDS contract definitions and conventions. The third section discusses the pricing of CDS, from the perspective of no-arbitrage principles as well as from that of structural and reduced-form credit risk models. It also summarizes the literature on the determinants of CDS spreads, with a focus on the role of fundamental credit risk factors, liquidity and counterparty risk. The fourth section discusses how the development of the CDS market has affected the characteristics of the related bond and equity markets, with an emphasis on the closely related concepts of market efficiency, price discovery, information flow and liquidity. Attention is also paid to the CDS-bond basis, the wedge between the pricing of the CDS and its reference bond, and the mispricing between the CDS and the equity market, which leads to a discussion on capital structure arbitrage. The fifth section examines the effect of CDS trading on firms' credit and bankruptcy risk, and how it affects corporate financial policy, including bond issuance, capital structure, liquidity management, and both external and internal corporate governance. The sixth section summarizes the literature that takes into account how CDS may impact the incentives of the various agents in the economy and the associated impact on the pricing of the contracts. In particular, we examine how CDS may alter the debtor-creditor relationship. Section seven reviews the growing literature on sovereign CDS and highlights the major conceptual and contractual differences between the sovereign and corporate CDS markets. In section eight, we discuss CDS indices, especially the role of synthetic CDS index products backed by residential mortgage-backed securities during the financial crisis. We close with our suggestions for promising future research directions on CDS contracts and markets.

Keywords: Credit Default Swap Spreads, Default Risk, Corporate Bonds, Sovereign Debt, Term structure, Empty Creditors, Basis

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1 Introduction

Two decades have passed since the first credit default swap (CDS) contract was traded in 1994 (Tett (2009)). The market has grown spectacularly, especially after 2000. It went through a boom in 2001-2007, followed by a bust after the 2008 Lehman bankruptcy. Most importantly though, the market has proved resilient in light of several major shocks and corrections. The Russian default in 1998, the Conseco Finance restructuring in 2000, the 2008 AIG bailout, and the 2012 Greece default all contributed in shaping the formalization of CDS contracts and their trading procedures as we know them today. The seminal study by Longstaff et al. (2005), which used CDS as a tool to disentangle credit from liquidity risk in corporate yield spreads, is by far the most cited paper on CDS, and it provides an excellent introduction to the CDS contract and its market. Since the publication of their paper, the CDS literature has blossomed. Accordingly, most of our survey covers studies in the recent decade.

Our attention is first dedicated to the structure of the CDS market. In particular, we explain the many colorful subtleties of CDS contracts and we document the development of the contract templates. We also picture the over-the-counter (OTC) nature of CDS market, and the controversies surrounding contract settlements via CDS auctions, which is one of the many emerging research debates that the CDS literature has stimulated. The CDS market has likely faced its toughest test with the 2007-2008 credit crisis, as it was heavily criticized for facilitating the creation of synthetic mortgage backed securities. But their role was also controversial during the sovereign default episodes of Greece and Argentina, as in particular “naked” CDS buyers were blamed for speculating on government defaults and artificially driving up their borrowing costs. Another scandalous landmark in the CDS history is the 2012 J.P.Morgan “London Whale” CDS trading loss. In the post-crisis period, a regulatory overhaul has been implemented both in the United States (U.S.) and in the European Union (E.U.). First came the CDS “Big Bang” and “Small Bang” in 2009, which pushed for further standardization of the CDS contract, then came the temporary ban on naked CDS in Germany, made permanent by the European Union in 2011. CDS have become the subject of many financial regulations, including the Basel III bank regulations and the Dodd-Frank Act.
Participants in the U.S. CDS market have arguably seen the biggest structural change in CDS history in 2013, with new rules forcing the use of central counterparties (CCPs) and new trading platforms. Central clearing for index CDS was introduced in 2013 with mandatory use of a swap execution facility (SEF) for some contracts. Also 2014 marks a new era for CDS trading, as contracts designated as “made available to trade” (MAT) must be traded on SEFs or Designated Contract Markets (DCMs) after February 26, 2014. The new ISDA 2014 Credit Derivatives Definitions were announced to go live in September 2014. However, the default of Argentina in July 2014 complicated the matter and forced existing sovereign contracts to comply with the older 2003 Definitions.

The pricing of CDS is by far the best understood issue in the literature, which is partly due to the tight relationship between CDS and corporate bonds and a vast literature on the determinants of bond spreads. Early works used to view CDS spread as a pure measure of credit risk, although it is today understood that many other factors are important in capturing both time-series and cross-sectional variation in CDS spreads and their changes. A separate literature has emerged on the role of liquidity in CDS spreads, and how liquidity can affect price discovery. We will discuss both the structural and reduced-form credit risk models that are used for CDS pricing and we discuss their predictions for the determinants of spreads that have been tested in the empirical literature. Other frictions such as counterparty risk are also discussed.

The relationship between the CDS and related markets, in particular the bond and equity markets, is intriguing and important. Even though theory predicts an accounting identity between CDS and bond spreads and a relationship between CDS and equity markets, investors saw significant price discrepancies during the financial crisis that appeared like great arbitrage opportunities. Price discrepancies were particularly strong between the CDS and the bond market, giving rise to the so-called negative CDS-bond basis. Understanding the basis requires a thorough analysis of the market differences. While the literature has made progress in understanding why the basis became negative, we are still far from understanding why it remained persistently negative for an extended period of time. In addition to pricing discrepancies, we also discuss the literature on information flow between CDS and related markets, and the related concept of price discovery. Finally, we examine how the inception of CDS has affected the pricing, efficiency and liquidity of closely related markets.
With the inception of CDS trading, market participants, both creditors and the firms themselves, have received access to credit risk transfer mechanisms. The ability to purchase CDS protection can change creditors' incentives and permits the creation of tough “empty creditors”, enabled through the separation of cash flow from voting rights. The “empty creditor” debate is yet another important research issue that has gathered a lot of steam over the last years. We discuss it in detail, along with other implications of CDS trading for corporate finance and corporate governance. The CDS-induced changes in the debtor-creditor landscape affect their credit supply, credit risk, and corporate policy.

We further focus our attention on the role of CDS for financial intermediaries, both for banks and for other financial institutions. In particular, we look at how the existence of CDS may change the risk-taking behavior of lenders or how it affects their credit supply. Alternatively, we show how banks may potentially exploit their informational advantage from customer relationships and how this can be reflected in CDS spreads. In general, it is interesting to observe that although CDS were originally used by banks to hedge their loan risk, the use by banks nowadays is rather limited, primarily used for trading purposes, and concentrated among a few dominant dealers.

We also dedicate an entire section to sovereign CDS. The interest in sovereign credit risk has been revived with the series of sovereign defaults in both emerging and developed economies over the last two decades. In particular the European sovereign debt crisis was a major catalyst in generating many contributions to the literature. Sovereign CDS were no less controversial than corporate CDS during the 2008 meltdown. The fact that they technically allow to speculate on a government default has led to important political debates with an effective ban on “naked” CDS in the European Union. Various dimensions of this default episode have opened up research questions that start being addressed in the finance, economics and legal literature. We attempt to patch the various angles of analysis together with the goal of providing a coherent and comprehensive picture of the existing results.

Many of existing studies are on single-name CDS, we also review the literature on CDS index products. It is probably not surprising that the bulk of this literature has focused on the role of index products or collateralized debt obligations tied to the performance of mortgage backed securities. CDS were particularly controversial as they facilitated the creation of synthetic mortgage backed
securities during the financial crisis. On the other hand, we will also discuss how CDS index products allowed aggregating the information about toxic assets in the system and how this may have created a panic in financial markets. The number of different products tied to CDS is growing and it is an exciting market to follow. J.P. Morgan even designed an ETF based on CDS contract in August 2014.

There are several prior articles giving survey discussions about CDS. Das and Hanouna (2006) provide the first synthesis of the CDS literature with a focus on pricing. Stulz (2010) gives a great account of the role of CDS during the financial crisis. The focus of Bolton and Oehmke (2013) is on how CDS may affect the incentives of individual market participants, including end-users, debtors and creditors. Jarrow (2011) draws parallels between the CDS and actuarial insurance market, and Augustin (2014) concentrates on the sovereign CDS literature. However, previous reviews typically focus on one specific angle of the CDS market and provide more in-depth analysis of the chosen sub-topic. This manuscript is more comprehensive in scope and covers all major research domains involving CDS.

2 CDS Contract and Market Structure

2.1 CDS Contract

CDS contracts were engineered in the early nineties by J.P. Morgan to meet the growing demand for transferring credit risk. The first such instance was in 1994, when J.P. Morgan off-loaded its credit risk exposure to Exxon by paying a fee to the European Bank for Reconstruction and Development, which was willing to sell protection.\footnote{There is some ambiguity about the precise date of introduction, although the year of introduction of CDS contracts is generally taken as 1994, as noted by Tett (2009).} CDSs represent the simplest (“plain vanilla”) instrument among the broad class of credit derivatives. Nevertheless, they remain, till date, the most widely used, and yet most controversial, among these products. While its proponents defend them as efficient vehicles to transfer and manage credit risk as well as means to widen the investment opportunity set, opponents denounce them as “weapons of mass destruction”, “time bombs”, “financial hydrogen bombs”, or speculative bets that influence government default.\footnote{See Warren Buffett, Berkshire Hathaway Annual Report for 2002, p.13, on-line at http://www.berkshirehathaway.com/2002ar/2002ar.pdf, and also Felix Rohatyn, a Wall Street banker employed at
of this review, we eschew such characterizations and stick to the factual definition of what they really are: insurance contracts offering protection against the default of a referenced sovereign government, corporation, or structured entity, and skirt around the polemics of the popular discussion of these products.

CDS are part of the *over-the-counter* (OTC) market. Thus they are not trading on an organized exchange and remain to a large extent unregulated. The reason for this is a provision inserted in 2000 in the Commodity Futures Modernization Act by Senator Phil Gramm, who from 1995 to 2000 presided over the Senate Banking Committee, exempting CDS from regulation by the Commodity Futures Trading Commission (CFTC)\(^3\). Nevertheless, guidance on the legal and institutional details of CDS contracts is given by the *International Swaps and Derivatives Association* (ISDA)\(^4\). They also act as a non-voting secretary for the various regional *Credit Derivatives Determination Committees* (“The Determination Committees”), which deliberate over issues involving *Credit Events, CDS Auctions, Succession Events* and other related matters. ISDA has played a significant role in the growth of the CDS market by providing a standardized contract in 1992, the *ISDA Master Agreement*, which was updated in 2002, in order to provide OTC counterparties with a fully documented, yet flexible, contract as a basis to negotiate their derivatives transactions. Credit derivatives agreements are further guided by the 2003 *ISDA Credit Derivatives Definitions* (“The 2003 Definitions”) and the July 2009 Supplement, and, going forward, the 2014 *ISDA Credit Derivatives Definitions* (“The 2014 Definitions”).

Technically speaking, a CDS is a fixed income derivative instrument, which allows a protection buyer to purchase insurance against a contingent *credit event* on an underlying *reference entity*, by paying an annuity premium to the protection seller, generally referred to as the *CDS spread*, over the life of the contract. This premium is usually defined as a percentage on the *notional amount* insured (or in basis points), and can be paid in quarterly or semi-annual installments. The concept of a CDS is very much analogous to a widely used financial product, insurance on a car or a home. In the case of car insurance, the true analogy would be that the contingent event could be based on theft, accident or malfunction. In other words, different types of incidents would lead

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\(^3\) Lazard Frères, quoted in Tett (2009).
to an insurance payout. Further, the insurance contract could be based on several cars belonging
to the same brand, rather than on an individual basis, where a contingency for any of the vehicles
would trigger an insurance payment. In the event that no such event occurs over the life of the
contract, the insurance premium would still have to be paid periodically, as specified in the contract.
Similarly, in the language of credit derivatives, you would purchase CDS protection on a company,
the reference entity, for example, and if that company fails to meet its obligations for any of a
predetermined set of its debt claims, default would be triggered and the payout would occur. More
specifically, the CDS contract usually comprises of a specific class of the firm’s capital structure,
such as the senior, unsecured, or the junior debt obligations of the company, and references a
particular amount of the insured debt, defined as the notional amount.

In general, the failure of an entity to meet its debt obligations is labeled a credit event. Con-
sequently, a credit event triggers a payment by the protection seller to the buyer equal to the
difference between the notional principal and the value of the underlying reference obligation, also
called the loss given default (LGD). In practice, the occurrence of a credit event must be docu-
mented by public notice and notified to the investor by the protection buyer. Amid the class of
qualifying credit events are bankruptcy, failure to pay, obligation default or acceleration, repudia-
tion or moratorium (for sovereign entities), and restructuring, and thus, they represent a broader
definition of distress than the more general form of Chapter 7 or Chapter 11 bankruptcy in the
United States.5

The settlement of CDS contracts may occur in two ways: cash settlement or physical delivery of
one among a set of deliverable reference obligations. In the case of a cash settlement, the monetary
exchange involves only the actual incurred losses and the claimant continues to hold on to the debt
claim on the underlying reference entity’s balance sheet. On the other hand, if the settlement is
by physical delivery, the claimant transfers the obligation referenced in the contractual agreement
to the insurer, and receives the full notional amount of the underlying contract in return. The
protection seller can then try to maximize its resale value in the debt claim received or continue to
hold on to it. Conceptually, this is no different than with any put option seller, who is delivered the
underlying asset upon exercise. This right implies that the claimant literally holds a cheapest-to-

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5The Credit Derivatives Determinations Committees of the International Swaps and Derivatives Association (ISDA) are the final arbiters of whether a credit event occurred or not.
deliver (CTD) option, as he may deliver the least valuable bond among the defined set of eligible reference obligations. This option is particularly relevant in the case of corporate restructuring, which is why the restructuring credit event is most critical in the pricing of CDS contracts. As a consequence, the contractual clauses attached to the restructuring credit event have been modified numerous times by ISDA, and there exist nowadays different types of restructuring clauses that can be defined in a CDS contract.

The CTD option is most severe in the so-called Full Restructuring (CR) credit event clause, which stipulates that any obligation with a maturity of up to 30 years could be delivered to settle a triggered CDS commitment. The reason is that long-dated bonds tend to be less liquid than comparable short-dated bonds and often contain a liquidity discount. An illustration of this CTD option was provided by the restructuring of Conseco Finance on September 22, 2000. At the time, CR was the only type of restructuring credit event available in the initial 1999 ISDA Credit Derivatives Definitions (“The Definitions”). The bank debt of Conseco Finance was restructured to the benefit of the debt holders. Yet, the restructuring event still triggered payments from outstanding CDS contracts. Protection buyers exploited this situation and made use of the CTD option created by the broad definition of deliverable obligations in order to obtain additional benefits by delivering the least valuable bond in the settlement. To address this issue, ISDA modified the CDS contract structure to include the Modified Restructuring (MR) credit event clause, which was introduced in the 2001 Restructuring Supplement to the 1999 ISDA Credit Derivatives Definitions (“The Restructuring Supplement”). Under MR, any restructuring is still defined as a credit event. However, the deliverable obligations are limited to those with maturities within 30 months of the CDS contract’s remaining maturity. In March 2003, ISDA made another change and introduced the Modified-Modified Restructuring (MMR) clause into CDS contracts to relax the limitation on deliverable obligations to some extent. Under MMR, the deliverable obligations are restricted to bonds with maturities of up to 60 months within the CDS contract’s remaining maturity for restructured debt, and 30 months for other obligations. Contracts may also agree to eliminate the restructuring credit event altogether from a CDS contract, in which case it is labeled No Restructuring (XR).

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See Jankowitsch et al. (2008) for empirical evidence on the CTD option implicit in corporate CDS, and Ammer and Cai (2011) for similar evidence on sovereign CDS.
Irrespectively of the type of settlement, the prices of the defaulted bonds usually suffer from wide market fluctuations, especially after default, and this makes it challenging to determine the precise value of the insurance settlement. Over time, markets have converged to a practice where the mid-market value is obtained through a dealer poll conducted by ISDA, soon after the credit event. Whether this pricing mechanism is efficient, remains unclear, and is discussed in detail in Section 2.3.

The contractual details of the 2003 Definitions are crucial, and as usual, the devil lies in the details, as was recently proved in the restructuring case of Greek government debt. European officials have heavily pushed towards a voluntary restructuring, which would not be binding on all bondholders. In such a case, it would not be likely that the agreed deal would trigger payments under existing CDS contracts. The landscape for CDS has further altered with the implementation of the CDS Big Bang and CDS Small Bang protocols on April 8, and June 20, 2009 for the American and European CDS markets respectively. The primary goal of these market changes, which brought about significant alterations in the contract and trading conventions, was to improve the efficiency and transparency of the CDS market. One of the major changes of the new conventions is a standardization of the coupon payments. Thus, henceforth, the fixed coupon payments for US single name CDS were defined to be either 100 or 500 basis points, whereby any difference relative to the running par spread would be settled through an upfront payment. An important change in US CDS market is the exclusion of restructuring as a standard credit event in the contractual CDS clauses. Another aspect of the Big and Small Bang Protocols is the hardwiring of the auction settlement mechanism into the standard CDS documentation. In addition, the responsibility of deciding upon the formal trigger of a credit event has been fully attributed to the Credit Derivatives Determination Committees (DCs). All market participants were heavily encouraged to sign up to the Big Bang protocol in order to allow for these changes to be applied to existing CDS contracts.

In 2014, ISDA proposed the most important changes to the CDS contract design in a decade (see Mahadevan et al. [2014]), and published the 2014 ISDA Credit Derivatives Definitions ("The

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7 This is similar to futures contracts, such as the Treasury bond futures contract, where the investor with the short position in the futures contract has the right to deliver the bond that is cheapest, after considering its conversion factor. See Jankowitsch et al. [2014], for an analysis of the recovery rates, or equivalently, the LGD values for different credit events.

8 See Greek Sovereign Debt Q&A, October 31 2011, www.isda.org
2014 Definitions”) in February 2014. The changes mainly related to European financial and global sovereign CDS. One of the key changes is a new credit event applicable for financial entities, i.e. governmental intervention to bail out the financial entity. Another important change relates to asset package delivery, under which any proceeds (deliverable or non-deliverable) received after a restructuring can be delivered to settle a financial/sovereign CDS contract, if the original bond was deliverable. Moreover, under the new definition, senior CDS will be triggered based solely on whether the senior bonds of the entity are restructured. There are many other amendments to the existing trading terms, including bond exchanges, succession and substitution events, among others. For instance, bond exchanges may be considered a credit event. At times, anecdotal evidence suggested that CDS contracts have become worthless following a corporate reorganization, a corporate takeover, or after an initial public offering. Such CDS contracts have become known as orphaned CDS. To reduce the risk of orphaned CDS following a merger, initial public offering or other corporate reorganizations, ISDA has also introduced a set of changes to the succession events. The concept of universal successor is introduced to recognize the succession events when debt is transferred, but identified outside the 90-day succession backstop window. To capture successions that occur gradually in stages, the 2014 Definitions have introduced a “Steps Plan” to determine successors based on a series of successions to reference entities or their obligations that may occur over a period of time.\(^9\)

An interesting feature to highlight is that CDS contracts enjoy special treatment in bankruptcy. While creditors are subject to “automatic stay” when firms file for bankruptcy, derivative counterparties have the right to terminate the contract and collect payment by seizing and selling collateral. Netting privileges and the treatment of “eve-of-bankruptcy” payments further strengthen the position of the derivative counterparty with a positive credit balance.\(^10\) Therefore, derivative counterparties are in a much stronger position than other claims under the U.S. bankruptcy law. Bolton and Oehmke (2014) discuss the economic consequence of the super-senior treatment of CDS in bankruptcy. They analyze the problem in the incomplete contracts framework in corporate finance. In their three-period model, firms raise funds by issuing debt and hedge their exposure by

\(^{9}\) See Mahadevan et al. (2014) for a detailed discussion of these changes.

\(^{10}\) As discussed in Bolton and Oehmke (2014), derivative counterparties can net offsetting positions and avoid payments to a bankrupt firm. Moreover, they have stronger rights regarding eve-of-bankruptcy payments. For example, derivative counterparties can keep any collateral posted to them at the time of bankruptcy filing.
purchasing derivatives. If there is no default at an interim date, firms obtain the continuation value at the final date. The super-senior treatment of derivatives transfers default risk from derivative counterparties to creditors. It also decreases the going-concern value of the firm. Hence, firms must promise higher payments to the debt holders to compensate for this decrease in the value of the underlying assets of the firm. As a result, firms may, ex-ante, have an incentive to rely on funding sources that benefit from this super-senior treatment, which is comparatively cheaper.

2.2 CDS Market

The CDS market was relatively modest in 1997 with gross notional amounts outstanding in the order of $180 billion. Figure 1 provides a time-line with the major developments in the CDS market over the last two decades. The plot starts with the creation of CDS by J.P. Morgan in 1994. It shows the year of the publication of the first ISDA standardized CDS contract in 1999, with the subsequent Restructuring Supplement in 2001, as well as the Conseco restructuring event that we previously discussed. The CDS market experienced exponential growth since the early 2000s. The primary reasons behind this rapid increase in trading are likely twofold. On the one hand, ISDA published a new set of standardized CDS contract definitions in 2003. On the other hand, 2004 witnessed the onset of trading in a broader class of credit derivative index products, including synthetic collateralized debt obligations (CDO), for which CDS contracts are a crucial element. At the end of 2004, the total gross notional amount of CDS outstanding was roughly $6 trillion, as can be seen in Panel A of Figure 2. The market witnessed three digit growth rates in the following years to reach about $60 trillion just prior to the onset of the financial crisis in 2007. The subsequent sharp drop in gross notional amounts of CDS outstanding is only partly due to the fact that CDS contracts were central to the credit crisis, in particular after the Lehman default. Another major determinant of the size of this drop was the regulators’ concerns about central clearing and counterparty risk, following the Lehman bankruptcy, which led to significant portfolio compressions with the associated netting of counterparty risk exposures. However, a similar decline was also

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11 The gross notional amount outstanding may inflate the net outstanding amount substantially, and should be interpreted with caution. For example, in one prominent example of the default of Lehman Brothers Holdings Inc. in September 2008, a firm had about $72 billion in CDS written on it as obligor. However, when these were settled in October 2008 (with payoffs of $0.92 per $1 of principal), only about $5.6 billion actually exchanged hands.

12 Portfolio compression refers to the process through which two counterparties cancel their existing contracts to replace them with new ones such that they reduce the number of contracts and gross notional value amounts.
witnessed in other derivative markets, although it was not as sharp. Panel B to C in Figure 2 further dissect the CDS market statistics by contract type and credit ratings. Notional amounts for single-name CDS have also fallen from the record level of $33 trillion during the financial crisis to about $13 trillion in 2013. The trend for multi-name CDS, including index products, has been similar, although the decline has not been as strong as for single name CDS. As a consequence, the market is almost equally divided between single name and multi-name products in 2013, while single name products made up the bulk of all transactions back in 2004, when multi-name CDS represented slightly less than 20% of the CDS market. This number increased to 46% by 2013. Panel C illustrates that most CDS contracts reference assets with credit ratings ranging between A to BBB, according to the statistics available from the Bank for International Settlements. The smallest category is subsumed by rating categories AAA to AA.

While the global CDS market has matured, it is still relatively nascent in some regions of the world. For example, China launched its first CDS product, called Credit Risk Mitigation Agreement (CRMA), on November 5, 2010, with a total of 20 transactions on the first trading day. A total of 17 financial firms (12 domestic and five foreign) have been approved as market dealers. Credit Risk Mitigation Warrants (CRMW) started to trade on November 24, 2010. In contrast to a CRMAs, a CRMW is more standardized and transferrable in the market. For example, HSBC China is the first foreign bank in China to issue a CRMW, with a five year bond issued by Petro China Company Limited as the underlying reference entity. Similar to CDS products in the US, it is commonly believed that Chinese CDS products will equip banks with an effective mechanism to transfer credit risk. The hope is that the ability of banks to hedge their credit risk exposures through CDS products will allow them to expand their loan portfolios and increase bank lending. Compared with the US CDS market, Chinese CDS products are significantly simplified with much greater regulatory scrutiny. For example, while a CRMA is a non-tradable bilateral agreement between two parties, a CRM product needs to be simple and standardized. The underlying reference entity outstanding, while they still maintain the same net exposure and risk profile.

We discuss multi-name CDS in detail in section 8.

Before the launch of this product, China had deployed cautious efforts to set the scene for the introduction of credit derivatives. In 2007, the People’s Bank of China formed the National Association of Financial Market Institutional Investors (NAFMI) to help develop the OTC markets. A test run of the CDS pilot project started on July 13, 2010, under the name Optional CBIC 1. At the end of October, in 2010, NAFMI unveiled the Guidance of the Pilot Business for Credit Risk Mitigation Instruments in the interbank market.
is restricted to be a particular loan or bond, the amount of leverage is limited, market participants are classified into key dealers, dealers, and non-dealer participants who can use CMRAs only for hedging purposes.

Prior to the recent financial crisis, CDS were generally viewed as having positively contributed to the development of financial markets. CDS spreads were considered to be a precise measure of firms’ credit quality, widely used by practitioners and by academics\textsuperscript{15}. Many also pictured CDS contracts as a simple and reliable way to trade credit risk, as was similarly argued by many academic papers (Bolton and Oehmke \textsuperscript{2013}). For example, former Federal Reserve Chairman Alan Greenspan argued that “these increasingly complex financial instruments have contributed, especially over the recent stressful period, to the development of a far more flexible, efficient, and hence resilient financial system than existed just a quarter-century ago” \textsuperscript{16}. Such rhetoric has likely contributed to the fact that CDS contracts were essentially exempted from regulation and excluded from the surveillance responsibility of the U.S. Securities and Exchange Commission (SEC) and the Commodity Futures Trading Commission (CFTC), institutionalized through the Commodity Futures Modernization Act of 2000, as we previously pointed out. While some see CDS contracts as an effective tool for credit risk transfer, there have been increasing concerns that “naked” CDS may help speculators destabilize the debt market\textsuperscript{17}. For example, in a striking case, when Delphi Corporation filed for bankruptcy on October 8, 2005, the total amount of CDS contracts outstanding was roughly thirty times the face value of its bonds outstanding. Protection buyers who did not own Delphi’s bonds scrambled to acquire the Delphi bonds to settle their CDS contracts through physical delivery, driving the price of these bonds up quite substantially. The concern was particularly striking during the European debt crisis, which led to a ban on naked CDS for European sovereign debt in 2011. The naked CDS positions on Greek debt also raised concerns about market manipulation by a group of hedge funds who attempted to precipitate a Greek default.

\textsuperscript{15}For example, when GM and Ford were downgraded in May 5, 2005, the CDS spreads on the two companies had already been increasing since October 2004, and they exhibited a substantial run-up prior to the downgrade (Acharya \textit{et al.} \textsuperscript{2007}). Similarly, WorldCom’s CDS spread had been creeping up in anticipation of its bankruptcy on July 21, 2002 (Jorion and Zhang \textsuperscript{2007}).


\textsuperscript{17}A naked position refers to a position in the CDS without having any exposure to the underlying reference entity. The position is said to be uncovered, or naked.
The financial crisis has highlighted some shortcomings in the existing CDS market, some of which may arise because of the current structure of the CDS market. A primary concern is that there is little transparency in the CDS market because transactions in OTC markets are typically bilateral trades. For example, using data from OCC’s Quarterly Report on Bank Trading and Derivatives Activities, Atkeson et al. (2013) find that the CDS market is highly concentrated with only a small number of financial institutions acting as market makers, including HSBC, Bank of America, Citigroup, Morgan Stanley, Goldman Sachs, and JPMorgan Chase.\footnote{Bolton and Oehmke (2013) express concerns over the potential collusion among these six large market makers.} The authors model the CDS market as a matching market with free entry of buyers and sellers. They find that fixed entry costs, trading frictions, and the benefits of netting explain the high concentration in this market. Peltonen et al. (2014) test the network structure of the CDS market using recently available DTCC data of bilateral CDS exposures on 642 sovereign and financial reference entities in 2011. They find that the CDS market is highly concentrated around 14 dealers, which suggests that the market is “robust but fragile.” The failure of any one single dealer may impose significant contagion effects and create systemic risk. The authors further document that CDS contracts are used for both hedging and trading purposes, and that end-users typically trade through dealers. Getmansky et al. (2014) also study the interconnectedness in the CDS market using DTCC data in 2012. Consistent with previous studies, they find that CDS trading activities are concentrated among a select number of counterparties. Compared to single name CDS, trading in sovereign CDS appears to be comparatively more concentrated.

A related concern is counterparty risk in the CDS market.\footnote{For a thorough discussion on counterparty risk, see Gregory (2010).} Zawadowski (2013) shows that unhedged counterparty risk in OTC market may lead to systemic run of lenders due to the idiosyncratic failure of a bank. As discussed in Acharya et al. (2009), CDS and other OTC contracts deal with counterparty credit risk by requiring collateral to be posted by both parties to the transaction. But the terms are not standardized and no account is taken of the substantial risk externality imposed by one transaction on the risk exposures of other market players. In this vein, the massive CDS exposure of AIG around the time of the Lehman default also raised concerns about the collateral call risk and the lack of transparency, including the counterparties’ overall exposure.\footnote{The London unit of AIG Financial Products sold CDS protection on a massive scale with a huge net exposure of $441 billion by mid-2008.}
managed to avoid posting a substantial amount of collateral because of its AAA rating. However, when its credit rating was downgraded later in 2008, it was required to post additional collateral, which drove AIG into serious trouble, as described by Stulz (2010). Thompson (2010) formally investigates counterparty risk when the protection buyer is better informed, taking the perspective of a protection seller. The protection seller has an incentive to impose higher counterparty risk on the protection buyers by holding less liquid capital. Otherwise, the protection seller may charge a higher insurance fee. However, Thompson shows that there exists a mitigating factor if the protection buyer is better informed. Thus, the protection buyer faces a tradeoff between the cost of insurance and counterparty risk. There will be a separating equilibrium where high risk exposure buyers will buy CDS with lower counterparty risk, and vice versa. Biais et al. (2014) investigate the effect of derivatives on the risk-taking behavior of protection sellers. They develop a three-period model with a risk-averse protection buyer and a risk-neutral protection seller with limited liability. A negative signal regarding the value of the reference assets observed at the interim date increases the chance of an insurance payment. Observing the bad signal, the protection seller may choose to gamble. This risk-taking behavior of protection sellers accentuates the endogenous counterparty risk for protection buyers. This deterioration in counterparty risk could be mitigated by a margin call after the bad signal, which would improve the protection seller’s incentive.

The discussions that derived from the uncovered shortcomings of the existing CDS contracts during the financial crisis were useful in the sense that they promoted substantial changes in the CDS market. One of the key debates that has emerged from the turmoil surrounds the central clearing of CDS contracts through clearing houses, known as Central Counter Parties (CCPs). Central clearing operations began in March 2009. In July 2010, the Dodd-Frank Act set the regulatory framework for derivative markets, which substantially expanded their role of clearing. In 2013, CDS indices were the first to implement the mandates, driven mainly by the Commodity Futures Trading Commission (CFTC). By the end of 2013, CDS contracts with central clearing accounted for 26% of all gross notional amounts of CDS outstanding (BIS2014). The Netting of contracts has been more popular for CDS contracts cleared through central counterparties. The Inter-continental Exchange (ICE), a subsidiary of the NYSE, is already recording growing market share in the clearing process, and both academic and political voices call for a move towards
organized exchanges, more transparency and more orderly price dissemination.\textsuperscript{21} The Dodd-Frank-mandated central clearing, electronic trading and trade reporting are already providing a boost to market transparency, and the benefits of this improvement will be evident in the coming years.\textsuperscript{22}

A number of papers examine how the introduction of CCPs affects risk in the CDS market.\textsuperscript{23} Acharya et al. (2009) propose three different types of central clearing, each offering a different level of market integration and transparency. Acharya and Bisin (2014) argue that the lack of transparency in the OTC market can create a counterparty risk externality. Insurance sellers may excessively take short positions that lead to an increased counterparty risk to all trades. A model shows that the existence of a CCP can eliminate this externality. Biais et al. (2012) examine the costs and benefits of bilaterally settled OTC markets relative to centrally cleared markets using a CCP. They conclude that a market structure with an optimally designed CCP dominates. However, they are doubts as to whether the currently proposed CCPS are optimally designed.\textsuperscript{23} Loon and Zhong (2014) document a reduction of counterparty and systemic risk following central clearing using a sample of single-name CDS that voluntary selected to be centrally cleared.

Regulators seem to actively push CDS towards centralized clearing. Within this context, a number of papers debate an apparent trade-off that arises through changing collateral demands linked to central clearing.\textsuperscript{24} On the one hand, a CCP leads to multilateral netting gains among market participants across a single class of derivatives. On the other hand, clearing through a CCP results in a loss of bilateral netting benefits across different contract types, for example CDS and interest rate derivatives. Therefore, for a CCP to be valuable, the benefits from multilateral netting need to be sufficiently large. Duffie and Zhu (2011) provide a detailed discussion of this trade-off. They find that a CCP may not reduce counterparty risk exposure if there are multiple central counterparties for different classes of derivatives, or if the loss in bilateral cross-asset netting is substantial. However, Cont and Kokholm (2014), using a similar framework, find that the gains from multilateral netting outweigh the losses of bilateral netting if they account for the correlations

\textsuperscript{21}Another growing CCP for CDS is provided by the CME.
\textsuperscript{22}Loon and Zhong (2014b) investigate how CDS market liquidity is affected by different aspects of Dodd-Frank reforms, including central clearing, swap execution facility (SEF), non-financial hedgers (“end-users”), bespoke contracts, and block trades. The results from the univariate and regression analysis suggest that the various Dodd-Frank reforms improve liquidity, and have distinct and incremental effects on trading costs.
\textsuperscript{23}See also Pirrong (2009), Singh (2010a), Hull (2010) and Jones and Pérignon (2013) for a discussion on the clearing of derivative markets using CCPs.
\textsuperscript{24}Singh (2010b) expressed concern about collateral demand under CCP.
and heterogeneous risk characteristics of cleared assets. Anderson et al. (2013) compare the default exposures and netting efficiencies of linked and unlinked CCP configurations. They suggest that establishing a link between a small domestic CCP and a larger global CCP might not be desirable. Sidanius and Zikes (2012) and Heller and Vause (2012) empirically investigate the same trade-off and find evidence of increasing collateral demands following central clearing through a CCP. In contrast to this evidence, Duffie et al. (2014) find that central clearing does not increase collateral demand using a comprehensive dataset of CDS bilateral exposures from the Depository Trust and Clearing Corporation (DTCC), covering about 31.5% of the global single-name CDS market.

2.3 CDS Auctions

In the early days of CDS, market participants had the choice of settling “physically” or in “cash” upon the occurrence of a valid credit event. With the introduction of the Big Bang and Small Bang protocols, cash settlements became hardwired into the contractual CDS agreements, whereby the final settlement price would be determined through an auction mechanism. Prior to April 2009, the decision to participate in these credit event auctions was optional. One of the key reasons to move towards a systematic cash settlement was the risk of occasional “market squeezes”, when the net notional amount outstanding would exceed the quantity of deliverable cash bonds. This happened for example in the famous bankruptcy of Delphi Corporation in 2005, mentioned earlier. Delphi, which had an estimated $28 billion in CDS notional outstanding traded, had only $2 billion in deliverable cash bonds afloat in the secondary market.25

The CDS auction process was designed jointly by ISDA, Markit and CreditEx, which administers the auctions. Data on each bankruptcy event and the related auctions are publicly available on the company’s webpage since 2005.26 Loosely speaking, CDS auctions are two-stage auctions, whereby an initial market midpoint and then the net open interest are determined in the first round when the participating dealer banks submit indicative prices and physical settlement requests on behalf of themselves and their clients. In the second stage of the “Dutch-style” auction, the final price, which can deviate by no more than a pre-specified quantity from the initial market midpoint, is determined based on new limit orders submitted by the dealers, and on the net open interest

25See Summe and Mengle (September 29, 2006), and Choudhry (2006).
26See http://www.creditfixings.com/CreditEventAuctions/fixings.jsp
determined in the first stage of the auction.

There are several studies analyzing the various aspects of the CDS auction mechanism. Three of these are empirical (Helwege et al. (2009), Coudert and Gex (2010), Gupta and Sundaram (2013)), while two other studies investigate the process from a theoretical perspective (Chernov and Makarov (2012), Du and Zhu (2013)). The most complete picture to date is probably given by Gupta and Sundaram (2013), who study a total of 76 auctions over the period 2008-2010. The authors conclude that the auction prices are significantly biased relative to the pre- and post-auction bond prices and that the underpricing is on average about 20%. The conservative bidding behavior seems to be partially explained by a winner’s curse, in that the magnitude of the underpricing appears positively related to the pre-auction variance in bids. It also turns out that pre-auction market variables have no ability to explain the auction price mechanism. Nevertheless, the auction itself seems to be useful for price discovery as the final auction price on its own appears to be a key determinant of the post-auction price-formation. This view is partly shared by Helwege et al. (2009), who conclude that “the first stage process plays an informative role in determining the final recovery price. Based on a sample of 43 credit events from 2005 through March 2009, the authors further conclude that the auction mechanism seems to be efficient, as it achieves two of its primary goals: a reduction in payments due to the netting effects obtaining from offsetting long and short positions, and the establishment of a fair recovery price for the underlying debt obligation. In addition, the “recovery basis”, the difference between the recovery implied by the CDS final auction price and the recovery implicit in bond prices, is typically close to zero. Similar conclusions are shared by Coudert and Gex (2010), who study 27 senior CDS auctions from 2005 to 2009. However, their work uses the bankruptcies of Lehman Brothers, Washington Mutual, CIT, Thomson and Government Sponsored Entities as individual case studies to throw additional lights on some oddities in the determination of the final recovery price. Overall, their sample suggests an average recovery rate of 31% throughout the 2005-2009 period (26% if the GSEs are excluded), with significant variations over time.

An important theoretical contribution for this topic is provided by Chernov and Makarov (2012), who theoretically model the two-stage auction process and show that strategic bidding may result in either under- or overpricing relative to the fair bond price. Their empirical evaluation, however,
suggests that historically, bonds have on average been underpriced by 6%. This mirrors the findings in [Gupta and Sundaram (2013)], although the magnitude of the underpricing is significantly smaller. While their model does not consider asymmetric information of the bidders or risk aversion, other potential reasons for the mispricing, the model sets important groundwork for future theoretical analysis and mechanism design. Another theoretical analysis of the current auction design, which is now hardwired into CDS contracts, is conducted by [Du and Zhu (2013)]. They too conclude that auction price outcomes are biased and result in inefficient allocations. In contrast to the other references, the proposed model consistently results in overpricing. While such cases exist, the empirical evidence suggests that underpricing is more common. One focus of this paper is the proposal of a double auction design, in which both price biases and inefficient allocations could be restored to their fair values. According to this analysis, bidders should thus be able to submit quotes in both directions in the second stage of the auction, regardless of their open interest determined in the first step.

3 CDS Pricing

CDS are essentially insurance contracts that allow a protection buyer to purchase insurance against a contingent credit event on an underlying reference entity by paying an annual premium to the protection seller, generally referred to as the CDS spread. Similar to other swap contracts, at the initiation of a CDS contract, there is no exchange of cash flows between the two parties to the transaction. If a credit event occurs, the CDS protection seller pays the CDS protection buyer the difference between the face value and market value of the underlying reference obligation. The settlement of this obligation can be made either through a cash payment or through physical delivery of the underlying bond. The periodic spread payments in exchange for the credit protection purchased occur typically until the earlier of the maturity of the CDS contract or the occurrence of credit event. If a credit event occurs between two payment dates, the CDS protection buyer is in addition obliged to pay the accrued premium since the last coupon payment. In general, similar to other traded derivative contracts, CDS are assets in zero-net supply, i.e., they are side bets, with protection buyers and sellers having identical numbers of contracts outstanding. Thus, both the
premium and protection legs must be priced equal at inception, using the principles of arbitrage-
free derivatives pricing, in order for the buyer and seller to reach agreement. In this section, we
review the literature relating to alternative approaches to CDS pricing.

3.1 Basic Arbitrage Pricing

The pricing framework for credit derivatives is first discussed in [Das (1995)]. [Duffie (1999)] presents a
simple arbitrage-free pricing model for CDS by making a correspondence with a portfolio comprising
a default free and defaultable floating-rate bond. He shows that a protection buyer’s cash flows
on a CDS contract can be replicated by purchasing a par default free floating-rate note, and
simultaneously shorting the underlying par floating rate note. An investor with the replicating
portfolio receives a floating interest rate from the default-free note and pays a floating interest rate
plus spread on the defaultable bond. The net payment corresponds to the credit spread. Absent
any credit event, both notes mature at par and there is no additional cash flow at maturity. In case
of a credit event before maturity, the investor liquidates his position and receives the difference
between the market value of the default free floating-rate note (which is par on a coupon date)
and the market value of the underlying par defaultable floating rate note. Since the payoff of this
portfolio is the same as that obtained from buying protection with a CDS contract, the absence of
arbitrage implies that the CDS spread must equal the spread over a risk-free rate on the underlying
floating rate note issued by the reference entity, i.e., the par floating-rate spread.

This no-arbitrage relationship is, however, only an approximation, as several frictions may pre-
vent the relationship from holding perfectly. In such cases, appropriate adjustments are needed to
value CDS spreads through the no-arbitrage approach. The most important friction is the diffi-
culty in shorting corporate bonds, which may complicate the no-arbitrage argument. In practice,
investors may short bonds through a combination of a reverse repurchase agreement and a cash
sale. Through a reverse repurchase, the investor can obtain the reference note as collateral on a
loan made to the repo counterparty. The investor can simultaneously sell the collateral notes in
the market, thereby creating a short position in the reference bond. At the maturity date of the
repurchase agreement, the investor will purchase the bond in the market in order to return it to

\[27\] Other early works on CDS pricing that are directly related to this approach include [Lando (2004)] and [Hull and
White (2000a)].
the repo counterparty. The repo counterparty will repay the previously borrowed funds plus an interest rate on the loan, which corresponds to the repo rate. The term *repo specialness* refers to the difference between the term general collateral rate (which is the general interest rate for such loans prevailing in the market) and the term repo rate. The term repo specialness is positive especially when the liquidity of the reference note is poor. The positive term repo specialness represents an extra annuity payment when the arbitrage portfolio is created. In other words, if bonds are *special*, then the absence of arbitrage implies that the CDS spread must equal the sum of the par floating-rate bond spread and the term repo specialness.

Duffie (1999) discusses other cases when adjustments are needed, including the payment of accrued CDS premia, the accrued interest on the underlying notes, the difference between floating-rate notes and fixed-rate notes, and so forth. He finally suggests that “the model-based pricing may be useful because it adds discipline to the measurement and use of default probabilities and recoveries”.

### 3.2 Structural Approaches

The structural approach to credit risk pricing is influenced by the Black and Scholes (1973) and Merton (1974) arbitrage pricing framework. In models of this type, the value of a firm’s assets is assumed to evolve randomly over time, and is typically modeled by a stochastic process such as a geometric Brownian motion. A firm is assumed to default when its asset value falls below the default boundary. In structural models, credit spreads are determined mostly by leverage, asset volatility, and market condition such as interest rates, which are suggested by the underlying theory.

The structural approach is widely used in credit risk modeling. However, several papers find...
that structural models do a poor job in empirically explaining the magnitude of credit spreads, a
result commonly referred to as the credit spread puzzle. For example, Eom et al. (2004) test the
performance of five different structural models in a sample of bond prices from 1986 to 1997. The
results indicate that structural models tend to overestimate the credit risk of riskier firms, and
underestimate the credit risk of safer firms. They conclude that the accuracy of the structural
models needs to be improved.

Huang and Zhou (2008) test the structural model using CDS spreads for 93 firms during 2002-
2004. They conduct GMM-based specification tests of five structural models including Merton
and Huang and Huang (2012). They find that the first three models are strongly rejected by
the specification test, while the model in Collin-Dufresne and Goldstein (2001) gives the best fit.
However, they show that these structural models still fail to predict CDS spreads accurately and
that they cannot accurately capture their time-series changes.

In parallel with the direct pricing of credit spreads using a formal model, several academics have
attempted to explain credit spreads empirically using observable variables suggested by structural
models. Collin-Dufresne et al. (2001) investigate the determinants of credit spread changes in a
sample of 688 bonds from 261 distinct issuers during 1988 to 1997. They find the variables to have
limited explanatory power for the changes in credit spreads. A principal component analysis of the
residuals indicates that there remains a large systematic component that cannot be captured by
the covariates suggested by structural models. Similarly, Campbell and Taksler (2003) also use a
regression framework to investigate the effect of observable factors on bond spreads and find that
equity volatility further helps to explain bond spreads.

Zhang et al. (2009) attempt to explain CDS spreads using volatility and jump risk measures
computed based on high-frequency equity returns. Their sample covers five-year CDS contracts with
modified restructuring (MR) clauses for 307 distinct U.S. entities over the period spanning 2001 to
2003. The authors’ approach to using high-frequency return data to explain CDS spreads differs
significantly from previous research that relied on long-run equity volatility or traditional jump risk
measures such as historical skewness and kurtosis to explain credit spreads. The regression of CDS

31 Other tests of structural models are carried out by Hull et al. (2004) and Chen et al. (2006), among others.
32 See also Cremers et al. (2008) for a similar empirical study of the determinants of bond spreads.
spreads on volatility and jump risk measures yields an $R^2$ of 53%, which can be increased to 73% if other standard structural factors are controlled for. This evidence suggests that high frequency return-based volatility and jump risk measures have significant explanatory power for the levels of CDS spreads. While short-term realized volatility, as measured by one-week realized volatility, also helps to explain the changes in CDS spreads, the authors confirm the findings of Collin-Dufresne et al. (2001) that structural factors have limited explanatory power for credit spread changes. Cao et al. (2010) investigate the explanatory power of option-implied volatility for CDS spreads, rather than historical volatility. Additional calibration results of structural models also point towards the added value of incorporating stochastic volatility and jumps into such a framework in order to better explain the level and time series variation of CDS spreads, in particular for highly rated firms.

The results of Collin-Dufresne et al. (2001) contrast strongly with those of Ericsson et al. (2009), who similarly investigate the explanatory power of structural variables for credit spreads in a linear regression framework in a sample of CDS rather than bond spreads. The analysis suggests that the structural covariates such as volatility and leverage do, in fact, explain a large fraction of the variations in CDS spreads. A principal component analysis of the residuals further confirms little evidence of the existence of an additional omitted common factor. Bharath and Shumway (2008) find that the distance-to-default measure from Merton (1974) is insufficient in predicting CDS spreads. Bai and Wu (2013) examine cross-sectional variation of CDS spreads by combining distance-to-default with a long list of firm fundamental characteristics. Their approach raises the average explanatory power by a significant amount up to 77%.

3.3 Reduced-form Model

An alternative approach to structural pricing frameworks for CDS is given by reduced-form models. While these have proven practically more successful, one drawback is that they typically assume a latent default process, and are thus silent as to the economic determinants of spreads. Reduced-form models assume that the default time for a firm is unpredictable, and that it follows a Poisson process, which occurs randomly based on an underlying probability distribution. This approach has

33 A related reference is Fabozzi et al. (2007).
proven versatile and useful in practical applications. The most widely used reduced-form approach is based on Jarrow and Turnbull (1995). The probability of default within time \([t, t+dt)\) conditional on no earlier default is characterized by

\[
Pr[\tau < t + dt \mid \tau \geq t] = \lambda(t)dt,
\]

where \(\lambda(t)\) is default intensity or hazard rate. It can be shown that the survival probability to time \(T\) conditional on surviving to the valuation time \(t_V\), \(Q(t_V, T)\), is given by

\[
Q(t_V, T) = \exp \left[ -\int_{t_V}^{T} \lambda(s)ds \right].
\]

For CDS pricing, the reduced-form model is used to value both the premium leg and the protection leg of a CDS contract. The premium leg is defined as a series of CDS spread payments made until the earlier of the contract maturity or a contingent credit event. The protection leg is the contingent payment made upon occurrence of the credit event. To estimate the CDS spread, the present values of both legs must equalize at inception in order to derive the fair CDS spread. A number of papers price CDS with reduced-form models. One such example is Longstaff et al. (2005), who use the reduced-form pricing framework developed in Duffie (1999), Lando (1998), Duffie and Singleton (1997) and Duffie and Singleton (1999). Following Duffie and Singleton (1997), the riskless rate \((r_t)\) and default intensity \((\lambda)\) are assumed to follow stochastic processes that evolve independently of each other. The independence assumption implies that the term structure can be specified exogenously, without an explicit modeling of its risk-neutral dynamics. They further assume that a bondholder recovers a fraction \(1-w\) of the par value in the event of default. Assuming continuous payments of the premium \(s\), the premium leg \((P(s, T))\) can be expressed as

\[
P(s, T) = E \left[ s \int_{0}^{T} \exp \left( -\int_{0}^{t} r_s + \lambda_s ds \right) dt \right].
\]

---

34 The structural and reduced-form models can be linked in the case of incomplete accounting information. See Duffie and Lando (2001) for a theoretical framework and Yu (2005) for an empirical test of the theory.

35 Longstaff et al. (2005) assume that illiquidity affects bond prices, but not CDS spreads.
Similarly, the protection leg of a CDS contract can be expressed as

$$PR(w, T) = E \left[ w \int_0^T \lambda_t \exp \left( - \int_0^t r_s + \lambda_s ds \right) dt \right].$$ \hspace{1cm} (3)

Setting the premium leg equal to the protection leg yields the CDS premium

$$s = \frac{E \left[ w \int_0^T \lambda_t \exp \left( - \int_0^t r_s + \lambda_s ds \right) dt \right]}{E \left[ \int_0^T \exp \left( - \int_0^t r_s + \lambda_s ds \right) dt \right]}.$$ \hspace{1cm} (4)

Given the assumptions of the default intensity process, the authors derive closed-form solutions for the CDS premium and fit the model using 5-year CDS spreads for 68 firms over the period March 2001 to October 2002.

In contrast to Longstaff et al. (2005), Chen et al. (2008) allow for a correlation between interest and credit risk by jointly specifying the dynamics of interest rates and credit default intensities. Moreover, their model yields explicit solutions for CDS spreads, which significantly improves computational efficiency. They test the model fit with CDS transaction data for 60 firms from 15 February 2000 to 8 April 2003. However, an average pricing error of 3% indicates that the model can be further improved. Moreover, in their model, the authors assume the recovery rate to be constant and fix it at the industry average rate of 40%, an estimate widely used in practice. More realistic assumptions regarding the recovery rate, including random recovery, could further improve the fit of the model.

In contrast to structural credit risk models, reduced-form models, while easier to implement in practice, lack economic intuition about the determinants of default risk. Doshi et al. (2013) address this weakness by developing a reduced-form, discrete-time, quadratic no-arbitrage model for CDS pricing, where the default intensity is driven by observable covariates. In contrast to a linear specification with Gaussian state variables, this quadratic specification restricts the default intensity to be strictly positive, without any restrictions on the parameter values. The authors use a parsimonious model specification with four observable covariates, including two term structure factors, firm leverage, and historical volatility. The model is estimated using daily data for 95 constituent firms of the DJ.CDX.NA.IG.1 index from 2001 to 2010, for which balance sheet data
are available. The estimation includes CDS spreads for 1-, 5-, and 10-year maturities, while the 3- and 7-year maturities are used for out-of-sample tests. The estimation is conducted in two steps. First, the latent stochastic term structure variables are estimated using an unscented Kalman filter with a quasi-maximum likelihood procedure. Second, the model is estimated firm-by-firm with both the term structure variables and the other observable covariates.

The results indicate that the quadratic no-arbitrage model provides a good statistical fit. Although the model fit worsens during the financial crisis period, the quadratic non-arbitrage model outperforms the linear regression model with an average RMSE of 42.6 basis points. As suggested by structural models, and consistent with Ericsson et al. (2009), both volatility and leverage have positive effects on CDS spreads.\footnote{36}

3.4 Other Factors Affecting CDS Pricing: Counterparty Risk and Liquidity

CDS spreads may be affected by two other factors, counterparty risk and CDS market liquidity. Concerns regarding counterparty risk became more widespread following the default of Lehman Brothers, as the company was a substantial player in the OTC credit derivative market.\footnote{37} The default risk of CDS counterparties may affect the CDS valuation as it reduces the value of the insurance promised by the protection seller. More specifically, if a CDS seller defaults, the CDS buyer may not receive the CDS payment, if the default of the counterparty coincides with or precedes the credit event. The potential inability of CDS sellers with higher default risk to respect their insurance commitments may therefore force them to sell CDS contracts at lower prices compared to similar contracts offered by financially healthier counterparties. On the other hand, the economic impact of counterparty risk on CDS spreads may be offset through the practice of posting collateral in the CDS market.

Indeed, Arora et al. (2012) find counterparty credit risk to be priced, although the magnitude is estimated to be economically small. A counterparty’s credit risk would need to increase by roughly six percentage points in order to reduce spreads by one basis point. The analysis, conducted using a proprietary data set, is based on CDS transaction prices and actionable quotations provided by

\footnote{36} Other related works on this topic include Carr and Wu (2010) for example.  
\footnote{37} We discussed counterparty risk and CCP in section 2. In this section, we focus only on pricing effect of counterparty risk.
14 large CDS dealers on 125 distinct firms in the CDS index during the sample period March 31, 2008 to January 20, 2009. For each reference entity on each date, multiple CDS protection sellers may provide their five year CDS prices simultaneously. A panel regression of the CDS price (or quote) provided by the CDS protection seller on the credit risk measure of the CDS seller is used to detect whether counterparty risk is priced. The CDS protection seller’s credit risk is measured by its own CDS spread. Counterparty risk is priced if there is evidence of a statistically significant negative relationship between the quoted CDS spread and the seller’s credit risk. To be specific, a 645 basis points increase in the CDS seller’s credit spread results in only one basis point decrease in the CDS spread that the seller charges. The authors justify the small economic magnitude of the results based on the common practice of collateralization in the CDS market. The analysis of subsamples reveals that counterparty risk is priced prior the Lehman Bankruptcy, while there is no evidence that counterparty risk was priced for CDS spreads of financial firms. Generally speaking, these findings have important policy implications. For example, the finding of a small economic impact of counterparty risk on CDS pricing indicates that market participants believe the current market mechanism to be effective in managing counterparty risk. Further, this casts doubt on the usefulness of creating a central CDS clearing house structure with the purpose of mitigating counterparty risk. Giglio (2011) measures systemic financial risk using CDS spreads, since CDS spreads contain information about the joint default probability of both the bond issuer and the protection seller.

Another friction that may affect CDS spreads is the illiquidity and liquidity risk in CDS spreads. Early work by Longstaff et al. (2005) argued that CDS spreads are less affected by liquidity due to their contractual nature as, compared with corporate bonds, it is relatively easier to trade large notional amounts of CDS contracts. Thus, this study, as well as a number of others, use CDS spreads as a pure measure of credit risk. More recently, however, empirical evidence suggests that CDS spreads are not a pure measures of default risk, after all, since they also reflect a liquidity premium.\footnote{Jarrow (2012) discusses problems with using CDS to imply default probabilities.}

Liquidity is generally defined as the degree to which assets can be traded quickly in the market without affecting the asset’s current market price. Traders in the CDS market face obstacles due
to information asymmetries, search costs, transaction or funding costs. Both CDS buyers and CDS sellers are affected by these frictions relating to expected illiquidity, although the effects may be asymmetric\(^\text{39}\). Besides the level of illiquidity, CDS market makers potentially face liquidity risk, which should be priced if the variation of expected liquidity affects future trading.

Various liquidity measures can be constructed to reflect different aspects of liquidity. The most common measure of liquidity is the bid-ask spread, which is widely used in the context of CDS markets as well. A rise in the bid-ask spread represents the evaporation of liquidity from the CDS market. An alternative measure of liquidity is the price sensitivity to the size of the trade, or the price impact, as proposed by Amihud (2002). If the market is liquid, we expect that a large volume of an asset can be traded without affecting the asset’s price very much. In a variation of this approach, Tang and Yan (2007) capture this price impact through the ratio of spread volatility to the total number of quotes. In addition, dealers with funding constraints may face inventory risk, which may be proxied using the number of contracts outstanding. Furthermore, matching intensity reflects another liquidity characteristic that can be measured by the ratio of trades over quotes.

Using their measure of liquidity, Tang and Yan (2007) investigate the effect of liquidity characteristics and liquidity risk on CDS prices. They find that liquidity is indeed priced, and that higher illiquidity is associated with higher CDS prices. More specifically, their estimates yield a liquidity premium earned by the protection seller of approximately 11% of the mid quote.

Bongaerts et al. (2011) develop a formal equilibrium asset pricing model to investigate liquidity risk in the CDS market, incorporating both liquidity risk and short selling costs, arising from the hedging of non-traded risk. An empirical test of the model over the sample period 2004-2008 suggests that CDS liquidity, measured by the bid-ask spread, significantly affects CDS prices. The study also confirms the results of Tang and Yan (2007), namely that the compensation for bearing liquidity risk is borne by the CDS protection sellers. Qiu and Yu (2012) examine the effect of CDS liquidity on CDS spreads using depth, defined as the number of dealers providing a daily quote for a given reference entity. These authors try to tease out the “competition” effect, whereby a liquid CDS market indicates increased competition among CDS sellers, and therefore, lower CDS spreads, and an “asymmetric information” effect, whereby the increased number of CDS dealers may indicate

\(^{39}\) Kamga and Wilde (2013) call these frictions liquidity risk.
more information asymmetry, which would result in higher CDS premia. The empirical test, based on a sample of 732 firms from 2001 to 2008, finds that the effect of liquidity on CDS spreads is generally negative. While an increase in liquidity decreases CDS prices on average, the increase in liquidity may increase CDS spreads when the existing number of dealers is large. The number of dealers providing a quote proxies for the degree of asymmetric information.

In contrast to the previous papers on CDS liquidity, Buhler and Trapp (2009) directly incorporate a measure of CDS liquidity intensity into a reduced-form model for CDS pricing. The model, which allows for a correlation between liquidity and default risk, is estimated using bid and ask quotes for a sample of Euro-denominated CDS contracts. The liquidity premium, which is also found to be earned by the protection seller, represents about 5% of the mid quotes. Chen et al. (2010), in contrast, also investigate the CDS liquidity dynamics in a reduced-form model, but assume that the liquidity premium is obtained by the protection buyer. Their findings reflect those of Kamga and Wilde (2013), who explicitly show that the larger proportion of liquidity premium is captured by the protection buyer based on a structural state-space estimation. The estimation, based on ask and bid prices of 118 European CDS names from the iTraxx Europe index, over the sample period 2004 to 2010, supports a significant correlation between default and liquidity risk. This result underscores the need for explicitly allowing the default and liquidity premia to be correlated in CDS pricing models. The authors further investigate the asymmetry in the liquidity premium by separating the total CDS bid-ask spreads into a liquidity premium in both the bid and ask prices. The proportion of the liquidity premium attributed to the ask spread is measured as \[
\frac{(CDS_{\text{ask\ price}} - CDS_{\text{default\ premium}})}{CDS_{\text{ask\ price}} - CDS_{\text{bid\ price}}},
\] which is the ratio of the ask liquidity premium to the bid-ask spread. The results indicate that the bid liquidity premium is, on average, larger than the ask liquidity premium. Therefore, mid-quotes are not a pure measure of default risk. Compared to the protection seller, the CDS protection buyer receives a larger liquidity premium. Moreover, the results suggest that the liquidity premium is state dependent: More liquid markets are associated with higher liquidity premia. Compared with the CDS buyer, the CDS seller acts as a liquidity regulator by decreasing his liquidity premium in periods of lower default risk. Furthermore, the effects are heterogeneous across firms, with lower liquidity premia for financial than for non-financial firms.
Junge and Trolle (2013) also focus on liquidity risk in CDS markets and they define it as the covariation between CDS returns and market-wide liquidity. To investigate if liquidity risk is priced in the cross-section of single-name CDS, they develop a factor pricing model using returns and expected returns rather than CDS spreads. Shachar (2012) and Gündüz et al. (2013) find the price effect of frictions using order flow data from DTCC. Tang and Yan (2013) use transactions data from the GFI Group and focus on the changes in CDS spreads. They document non-trivial effects of excess demand and liquidity changes on movements of CDS spreads. Duffie et al. (2005) and Duffie et al. (2007) show that search frictions affect asset prices in OTC markets. Moreover, Zhu (2012) develops a dynamic model of opaque OTC markets and finds that the supplier’s search efforts affects asset prices. Bao and Pan (2013) find that illiquidity in the CDS market generates excess volatility relative to firm fundamental volatility in CDS returns.40

So far, we have discussed illiquidity, illiquidity risk and counterparty risk as potentially priced sources of risk in the CDS market. In addition, unpredictable time variation in recovery rates of the underlying assets may also affect the CDS premium. While several papers have discussed methods to estimate the recovery rate from the CDS spread, most studies assume constant recovery rates and simply neglect the recovery risk.41 42 This is partially due to the difficulty in jointly identifying the dynamics of default and recovery risk.43 Finally, the delivery option implicit in CDS contracts may also affect the pricing of CDS, as is suggested by Jankowitsch et al. (2008) for corporate CDS, and by Ammer and Cai (2011) for sovereign CDS.

3.5 Term Structure of CDS Spreads

Chen et al. (2013) model interest rate and credit risk jointly to determine the term structure of CDS spreads. One difficulty with the study of the CDS term structure is uneven liquidity across contract maturities. CDS contracts are most liquid in the middle of the spectrum. Five-year contracts are much more liquid than the 1-year and 10-year contracts. The term structure may have information

40 Other papers that focus on counterparty risk and liquidity or liquidity risk include Hull and White (2001), Kraft and Steffensen (2007), Pu et al. (2011), Dunbar (2008), Chen et al. (2013) and Lei and Ap Gwilym (2007).

41 See for example, Schneider et al. (2011).

42 Other papers analyzing this issue include Das and Hanouna (2006), Schlaefer and Uhrig-Homburg (2014), Conrad et al. (2013), Doshi (2011), and Redounane El-Kamhi and Pan (2014).

43 A recent paper by Jankowitsch et al. (2014) documents the variation in recovery rates across different types of default events, industries, and debt seniority, among other characteristics.
for equity pricing. Han and Zhou (2012) find that CDS term spreads can predict stock returns. The term structure can also be used to estimate the recovery rate, as discussed by Redouane Elkamhia and Pan (2014). The term structure of CDS spreads is mostly studied for sovereign CDS. One representative study is Pan and Singleton (2008). We discuss this issue in details in Section 7.

3.6 Loan-Only Credit Default Swap (LCDS)

While the above papers mainly focus on the pricing of single-name CDS, several other references discuss pricing models for other types of CDS contracts, such as Loan-Only CDS (LCDS), sovereign CDS and synthetic CDOs. In this section, we focus on LCDS pricing.\[44\]

LCDS were launched in both Europe and North America in 2006. The LCDX index was launched in April 2007, which sped up the standardization of the LCDS market. LCDS allow investors to trade credit risk embedded in the underlying syndicated secured loan, rather than any other underlying assets for traditional CDS contracts, such as bonds or unsecured loans.\[45\] Differences in the characteristics of the underlying assets are an important ingredient to be considered for the pricing of LCDS. For example, the recovery rate for LCDS is much higher than for CDS on bonds, because the underlying assets for LCDS are syndicated secured loans. Moreover, according to ISDA (2010), credit events for LCDS generally include bankruptcy of a reference entity and failure to pay.

An important distinguishing feature for LCDS pricing is the cancellability feature embedded in such contracts, as loans can be prepaid through refinancing. LCDS contracts can terminate as a result of either default or cancellation. However, only default triggers an insurance payment. Furthermore, while LCDS contain two swap legs, similar to standard CDS contracts, each leg has a different trigger probability. Thus, it becomes important to consider the default process, the cancellation process, as well as the correlation between the two, when we think about LCDS pricing.\[46\] The cancellation feature may be valued either based on historical data or using a ratings-based approach.\[47\] Intuitively, we should observe a negative correlation between cancellation and

\[44\] We discuss sovereign CDS pricing in section 7 and synthetic CDO pricing in section 8.

\[45\] Benzschawel et al. (2008) find that while investment-grade names are more likely to have CDS traded on their debt, LCDS are dominated by non-investment grade names.

\[46\] See Ong et al. (2010) for a survey of the LCDS pricing models.

\[47\] For the valuation of cancellable LCDS, see Wei (2007), and Shek et al. (2007)
the default probability. Bandreddi and Shchuchinov (2007) develop a double-barrier model with Gaussian distribution, instead of Poisson process for modeling the default and cancelation process. Wu and Liang (3) have introduced correlated stochastic processes for default, prepayment and recovery, which are technically more challenging.

CDS and LCDS typically share the same underlying reference entity, although the reference assets are different. Ignoring the cancellability feature, one simplifying assumption is that CDS and LCDS should share the same probability of default. In this case, the following relationship should hold (Ong et al. (2010)):

\[
\frac{\text{spread}_{LCDS}}{1 - \text{recovery}_{LCDS}} = \frac{\text{spread}_{CDS}}{1 - \text{recovery}_{CDS}}.
\]

Kryzanowski et al. (2014) discuss the pricing-parity deviation between CDS and the loan CDS market. They use the daily CDS and LCDS data for 120 single names from Markit during the period of April 2008 to March 2012. To eliminate the pricing difference due to the cancelation feature, they only focus on non-cancellable LCDS. To investigate the research question, they first identify a parity relation between CDS and LCDS under no arbitrage assumptions, and then they construct a simulated portfolio that exploits the pricing-parity deviations. They conclude that there is market segmentation between CDS and LCDS market, with the possibility of making significantly positive payoffs from exploiting the pricing-parity deviations, which can be explained with firm-level variables. While such price discrepancies arise in the LCDS market, it may be difficult to arbitrage this basis, due to insufficient market liquidity when one needs to simultaneously trade in both the CDS and LCDS markets.

4 CDS and Related Markets: Corporate Bonds, Stock Market

4.1 CDS and Corporate Bonds

4.1.1 CDS-bond Basis

In frictionless and complete markets, credit risk should be priced similarly across the cash and synthetic credit derivative markets. In other words, as discussed in Section 3, the CDS spread on
a given risky company should be exactly equal to the risky bond yield spread of a par floating rate note in excess of the appropriate risk-free rate, or bond yield spread (see Duffie (1999)). The difference between these two spreads, the so called CDS-bond basis, should essentially be zero and should not present any arbitrage opportunities. Empirically, however, we do observe pricing differences in the cash and the bond market, in different periods for different bonds. The so-called CDS-bond basis, which measures the difference between the CDS and bond-implied credit spreads, has been used as a measure of the non-default component of the bond yield, i.e., the premium for other factors such as liquidity, taxes, and other frictions. CDS facilitate the study of the non-default component of corporate bond yields, as CDS spreads provide a direct measure of the market price of a firm’s credit risk. A number of academic papers, as well as practitioners, use the CDS spread as a pure proxy for the bond yield’s default component and investigate the determinants of the CDS-bond basis.

There are, in fact, multiple ways to calculate the CDS-bond basis. The simplest method is to use the difference between the CDS spread of a company and a maturity-matched bond yield. However, Duffie and Liu (2001) show that this simple, model-independent approach can often be biased. Therefore, a second approach is to directly use a credit risk model to simultaneously price the bond yield and CDS spreads. This approach depends, however, largely on the choice of the credit risk model used, which itself may not generate quantitatively realistic credit spreads. To make the bond spread more comparable with the CDS spread, a third approach calculates the CDS-bond basis by deriving a par-equivalent CDS spread, which is essentially a bond-implied CDS spread that takes into account the term structure of CDS default probabilities and recovery rates.

In theory, a non-zero CDS-bond basis implies an arbitrage relation between CDS and the underlying bond. When the basis is negative, a strategy of taking a long position in the cash bond and purchasing CDS protection should generate a positive excess return that is free of any default risk. On the other hand, when the basis is positive, the appropriate strategy involves selling CDS protection and shorting the underlying bond.\footnote{Duffie (1999) and Nashikkar et al. (2011) discuss why this arbitrage relation might not exactly hold.} By exploring the arbitrage relationship, arbitrageurs may help close the basis gap and push it toward zero. However, the empirical evidence to date suggests that the CDS-bond basis is slightly positive during normal times, and that it was
significantly and persistently negative during the global financial crisis period, as is illustrated in Figure 3 for a selected sample of 177 bonds. A number of papers investigate the drivers of the CDS-bond basis, and further try to identify factors that prevent arbitrageurs from closing the basis gap. We discuss this literature in detail below.

Longstaff et al. (2005) were the first to provide new evidence relating to the corporate yield spread and the CDS-bond basis, using CDS data for 68 firms from March 2001 to October 2002. Assuming that the CDS spread reflects a pure measure of default risk, the authors use the difference between the bond yield and CDS spreads as a proxy of the non-default component, and show that it is strictly related to various bond liquidity measures, both in the time series and in the cross-section. Blanco et al. (2005) test the relationship between CDS spreads and bond yield spreads in a sample of 33 U.S. and European investment grade firms from January 2001 to June 2002. Their results suggest that CDS and bond markets price credit risk more or less similarly. In cases when there is a deviation between the CDS and bond yield spreads, they show that the CDS spread leads the bond yield spread in the price discovery process.

Nashikkar et al. (2011) study the CDS-bond basis over a much longer time period than previous studies, covering the period from July 2002 to June 2006 for over 1,167 firms. To investigate the non-default component of bond spreads, they conduct regressions of the CDS-bond basis on measures of bond liquidity and other factors. The CDS-bond basis is calculated as the difference between the CDS spread and the par-equivalent spread of a bond. Bond liquidity is measured as latent liquidity, which is calculated based on institutional bond holdings, rather than the actual bond transactions. Specifically, the latent liquidity measure is the weighted average turnover of fund bond holdings, where the weights are the fraction of bonds held by a particular fund. In addition to bond latent liquidity, the authors also control for other bond-specific transaction based liquidity measures, CDS liquidity, firm specific credit risk variables, and bond characteristics. The study finds that latent liquidity has significant explanatory power for the CDS-bond basis, even after controlling for the bond transaction based liquidity measures. They also show that the CDS bid-ask spread has strong explanatory power for the basis and conclude that the basis is driven by both bond market and CDS market liquidity.

Zhu (2006) also documents that the CDS market leads the bond market in terms of price discovery.
The results further show that the CDS-bond basis is also related to firm credit risk characteristics, such as leverage and tangible assets, as well as covenants or tax status. This indicates that CDS spread does not fully capture the credit risk of the bond, because of frictions that affect the arbitrage relationship between the CDS and bond markets. They also find that the cost of shorting bonds significantly increases the basis.

While the above mentioned early studies of the basis find the basis to be slightly positive prior to the financial crisis, the CDS-bond basis turned significantly negative during the crisis period (See Fontana (2012).). This has led many recent papers to investigate the drivers of the negative basis during the 2007-2009 crisis. Anecdotal evidence shows that the deleveraging activity of financial institutions may drive the basis into negative territory. During the crisis period, a rise in funding costs allegedly forced investors to free up their balance sheets and led many financial institutions to sell off their corporate bond holdings. This selling pressure may have decreased bond prices, and further pushed the basis into negative territory. Garleanu and Pedersen (2011) develop a margin-based asset pricing model, where the funding constraints can give rise to price differences between two financial instruments with identical cash flows, but different margin requirements. Their model generates interesting predictions for the basis, which are empirically tested using the CDS-bond basis over the period 2005-2009. The authors show that the time series variation in the CDS-bond basis is closely related to the shadow cost of capital, which can be captured through the difference between collateralized and uncollateralized interest rates. Cross-sectional differences in the basis between investment grade and high yield bonds are captured by their differential margin requirements.

Mitchell and Pulvino (2012) explicitly focus on the debt financing risk and investigate its impact on the arbitrage activities of hedge funds. They argue that the CDS-bond basis trade is one of the most common arbitrage strategies employed by hedge funds. Such arbitrageurs obtain their debt financing from rehypothecation, which effectively means collateralized loans obtained from prime brokers, who themselves post this collateral against borrowed funds. Specifically, according to the standard prime brokerage agreement, hedge funds receive financing from their prime brokers, and grant the prime brokers the right to rehypothecate the hedge funds’ securities. By rehypothecating, the prime brokers obtain a loan from a third party, i.e., rehypothecation lenders, who
are the ultimate financers in the transaction. During the global financial crisis period, however, rehypothecation lenders terminated their financing lines, and forced the sale of securities provided as collateral, including corporate bonds, causing their prices to sharply decline and their yields to spike up. As a consequence, arbitrageurs experienced a sudden withdrawal of their prime source of debt capital. Prime brokers and hedge funds were also forced to deleverage, which further widened the negative CDS-bond basis, due to the spike in the cash bond yield spread.

After identifying factors that drive the CDS-bond basis, a relevant question that remains is why these factors have a persistent impact on the basis. If arbitrageurs implement the arbitrage trade fairly expeditiously, we should not observe a persistent non-zero basis in the market. Therefore, there must be some other frictions that prevent arbitrageurs from closing the basis gap. However, given the difference in arbitrage strategies for long and short positions in the bond and CDS protection, it may be that the factors driving the “limits to arbitrage” might be different for the case of a positive versus a negative basis. When the basis is positive, arbitrageurs can profit from selling the CDS protection and shorting corporate bonds. However, bonds can be difficult to short (as argued by Nashikkar et al. (2011)). The optionality arising out of the ability of the short position to deliver the cheapest bond would also serve to make the basis seem larger than otherwise (as pointed out by Blanco et al. (2005) and Nashikkar et al. (2011)), since it may be traded “special,” i.e., command a larger repo rate.\(^{50}\)

When the basis becomes negative, the appropriate arbitrage strategy involves taking a long position in the cash bond and purchasing CDS protection. The main risks associated with this negative basis trade include funding risk, sizing the long CDS position, liquidity risk, and counterparty risk of the protection seller. These risk factors may prevent arbitrageurs from implementing a negative basis trade, which is consistent with frictions and “limits to arbitrage” theories. Arbitrageurs will choose basis trades with the most negative basis after controlling for such risks. For example, to implement the arbitrage strategy, arbitrageurs need to have access to financing. As discussed in Mitchell and Pulvino (2012), debt financing risk can not only drive the basis into negative territory, but also prevent arbitrageurs from profiting from such arbitrage opportunities.\(^{50}\)

\(^{50}\)For details about cheapest-to-deliver option, see Jankowitsch et al. (2008) for corporate bonds, and Ammer and Cai (2011) for sovereign bonds.
the crisis and post-crisis periods. Based on several “limits to arbitrage” theories, they expect the risk characteristics of basis trades to be related to the cross-sectional variation in the size and sign of the basis. They test their hypothesis using a sample of 487 firms with single-name CDS from the Markit database over the period January 2006 to December 2011. To explain the violation of the arbitrage condition between CDS contracts and bonds (i.e., the non-zero basis), they first construct a set of proxies for trading frictions, including trading liquidity, funding cost, and counterparty risk. Consistent with the “limits to arbitrage” theories, they find that their proxies for trading frictions can explain the basis during the crisis period. However, most of the factors lose their explanatory power during the post-crisis period.\footnote{Fontana (2012) also studies the CDS-bond basis during the 2007-2009 crisis period. Other relevant papers on the CDS-bond basis include Adler and Song (2010), Wit (2004), Zhu (2006), Li and Huang (2011), Bhanot and Guo (2011) and Augustin (2012). A survey of the literature on the CDS-bond basis for sovereign bonds follows in section 7.}

Choi and Shachar (2014) challenge the common wisdom that deleveraging by dealers was responsible for the negative CDS-bond basis, using data from the Federal Reserve Bank of New York on dealers’ aggregate bond inventories. The authors argue that, after the Lehman crash, dealers were actively “providing liquidity” by purchasing corporate bonds (but selling non-agency CMBS and RMBS) from hedge funds, who were running for the exit and unwinding basis arbitrage trades. Thus, while dealers were “leaning against the basis”, their activity was insufficient to close the gap. Feldhutter et al. (2014) find the pricing difference between bond and CDS may also be explained by credit control premium in bond prices, which is especially important as firm’s credit quality declines. This may explain the violation of arbitrage for CDS and bond spreads.\footnote{See section 5.3 for more discussion.}

\subsection*{4.1.2 The Effect of CDS on Bond Market}

The introduction of CDS contracts has created an alternative trading venue for investors in the fixed income market to trade credit risk. However, this begs the question of whether and how the initiation of CDS contracts affected the underlying cash bond market, in terms of pricing, liquidity or market efficiency, among other economic characteristics. Alternatively, the introduction of CDS may have altered the way in which new information gets impounded into prices.\footnote{In this section, we leave aside the issue of whether the introduction of CDS trading alters the borrowing cost of the underlying entity, an important question that we take up in Section 5. We discuss the evidence on price discovery,
find strong evidence that the CDS market leads the bond market in determining the new price of credit risk, albeit in a very limited sample, in the early days of CDS trading, and well before the crisis. The authors argue that price discovery occurs in the CDS market because of its synthetic nature, which makes the CDS market a more convenient venue to trade credit risk. Moreover, they also argue that the clienteles that participate in the CDS and bond markets are likely to be different. In particular, institutional investors, who are typically well informed, are likely to trade in both the cash and CDS markets, while retail investors trade mostly in the cash market. Hence, the introduction of an alternative venue for trading credit risk improves price discovery and, in turn, the efficiency of the cash bond market.

Recent studies investigate these issues using larger samples. Nashikkar et al. (2011) find evidence of a liquidity spill-over effect from the CDS market to bond market, whereby CDS liquidity affects both bond liquidity and bond prices. In a similar vein, Das et al. (2014), investigate the effect of CDS trading on the secondary corporate bond market, using a sample of 350 firms from 2002 to 2008, both in the time series and in the cross-section. In order to investigate the effect of CDS trading on bond market efficiency, contemporaneous bond returns are regressed on contemporaneous and lagged values of stock returns and the corresponding changes in CDS spreads. If lagged values are jointly significant in determining bond returns, this indicates that the bond market is relatively inefficient in incorporating relevant information compared to other markets. To address the endogeneity issue, the authors further implement a two-stage Heckman (1979) approach and difference-in-difference tests. When testing the bond market quality, the authors construct and compare the market quality measures of Hasbrouck (1995), which is based on the discrepancy between efficient prices and transaction prices, for bonds both before and after the inception of CDS. To study the impact of CDS contracts on bond market liquidity, several liquidity proxies are used, such as trading volume or turnover. In a nutshell, the results suggest that CDS trading hurts bond market efficiency. After the inception of CDS trading, there is no reduction in pricing errors, and no improvement in liquidity in the bond market. These findings may be explained by the shift in the clienteles of investors trading bonds. Since the more liquid CDS market is an attractive place for informed trading, institutional investors, who typically have better information, migrated to liquidity and bond market quality in this section.
the CDS market, resulting in a decline in the cash bond market efficiency, quality and liquidity.

4.1.3 Instruments for Shorting Credit Risk: Shorting Bonds, Loan Sales, and CDS

When investors have a negative view about the firms credit risk, they can implement that view by either shorting bonds or purchasing CDS protection. This choice is especially relevant for informed traders who wish to profit from their private information. For example, Acharya and Johnson (2007) find evidence of informed trading in the CDS market. However, Asquith et al. (2013) find no evidence that bond sellers have private information. They investigate the market for borrowing corporate bonds, mainly for the purpose of shorting, and the effect of CDS trading on such bond shorting. Their analysis is conducted with a large proprietary database on bond inventory and bond loans provided by a major custodian of corporate bonds from 2004 to 2007. They find that the cost of borrowing bonds is comparable to the cost of borrowing stocks, which has decreased steadily over time. The borrowing costs change with factors such as loan size, percentage of inventory lent, credit rating, and borrower identity. The recent credit crisis seems to have increased the variance of borrowing costs across bonds. Moreover, the authors fail to find evidence of informed trading by bond short sellers, since bond sellers do not earn excess returns in their analysis. They further find that bonds with traded CDS tend to be more actively lent. Borrowing costs such bonds are slightly higher for bonds with traded CDS. Overall, they conclude that CDS contracts are statistically related to bond shorting, but do not substantially substitute for it.

Besides shorting bonds and buying CDS protection, investors may profit from insider information through loan sales. Alternatively, these instruments might be used for hedging purposes. The choice between loan sales and purchasing CDS protection has been discussed in the previous literature, among which a number of papers theoretically investigate the choice between loan sales and the purchase of CDS protection. Duffee and Zhou (2001) provide an early discussion of the benefits of CDS contracts as risk transfer tools, but also express caution on the potential downside of CDS trading for firms. They model the impact of introduction of CDS contracts from the perspective of creditors, particularly banks. The banks’ information advantage regarding borrower credit quality can cause both adverse selection and moral hazard concerns. In particular, CDS trading may reduce other types of risk-sharing, such as secondary loan sales, with ambiguous wel-
fare consequences. [Parlour and Winton (2013)] present the efficiency implications of CDS contracts in terms of risk transfer and monitoring, and suggest that, overall, CDS contracts as a risk transfer mechanism, are more likely to undermine monitoring. [Allen and Carletti (2006)] show that the credit risk transfers can be beneficial when banks face a systemic demand for liquidity. However, when they face idiosyncratic liquidity risk and hedge this risk in the inter-bank market, credit risk transfer can be detrimental to welfare. Further, such hedging via CDS contracts may lead to contagion between the banking and the real sectors and increase the risk of financial crises.

Empirically, [Beyhaghi and Massoud (2012)] find that banks’ choices between loan sales and CDS relate to the characteristics of both borrowers and lenders. They document that banks use loan sales to hedge the risk of low quality borrowers, and CDS contracts to hedge the risk of high quality borrowers defaulting, especially if monitoring costs are high. Moreover, reputable lenders are less likely to hedge credit risk of high quality borrowers with either loan sales or CDS.

4.2 Credit Default Swaps and Equity Market

The traditional [Merton (1974)] structural framework characterizes the corporate capital structure as a series of contingent claims on a firm’s assets. Both debt and equity values are determined by the risk-free borrowing rate, the value of firms’ assets as well as firms’ asset volatility. In other words, debt and equity prices, and hence returns, are determined by the same company-specific information. Absent any frictions, both asset markets should be perfectly integrated. Moreover, there exists a no-arbitrage pricing relationship between equity and credit spreads, which should theoretically carry forward to the relationship between equity and CDS spreads. In this section, we will review the literature that has, explicitly or implicitly, verified or challenged these theoretical predictions of the classical Merton model and its extensions. For this purpose, we classify the existing literature into two main categories: those papers that study the information flow between equity and credit markets, and those papers that study capital structure arbitrage across the two markets. In a third sub-section, we review the research that examines whether the introduction or existence of CDS contracts created any externalities for the equity market. Under the assumption of complete markets, CDS spreads are redundant assets. Yet, their fairly recent creation relative to stocks, and their tremendous growth over the past two decades, suggests that the
addition of corporate credit derivatives to the investor opportunity set may provide complementary information.

4.2.1 Information Flow between Equity and CDS Market

Equity prices and CDS spreads of a firm are exposed to the same fundamental shocks relating to information about its future cash flows. However, informed investors may choose to trade in only one of the two asset classes, which would lead to earlier price discovery in the market that is the chosen venue for informed trading.\textsuperscript{54} A number of papers investigate such a hypothesis by studying the lead-lag linkage between CDS and equity markets. Acharya and Johnson (2007) find that changes in CDS spreads negatively predict stock returns for a sample of 79 U.S. firms during the period from January 2001 to October 2004. The information flow from the CDS market to the bond market is restricted to firms that experience adverse credit news and on days with negative information. Further, they show that the intensity of the information flow is stronger if the company has a greater number of bank relationships. The authors interpret this evidence in favor of insider trading in the CDS market by banks that exploit their private information obtained in bank-lending relationships. However, they find no evidence that the degree of asymmetric information adversely affects the prices or liquidity in the equity market. The reason may be that the negative effects of informed trading are balanced against the gains in liquidity provision coming from the informed traders.\textsuperscript{55} In a follow-up paper, Acharya and Johnson (2010) find evidence of localized information flows within markets. They show that, for leveraged buyouts, the presence of more insiders leads to greater levels of insider activity, in the sense that a larger number of equity participants in the lending syndicate is associated with greater levels of suspicious stock and option activity.

Ni and Pan (2011) also find that changes in CDS spreads can predict stock returns over the following few days. However, the pattern of predictability is asymmetric and driven mostly by those stocks that experience negative information in the CDS market. In their view, this empirical evidence is economically explained by short-sales restrictions in the stock market. In the presence of equity short-sale constraints, pessimistic investors can express their views only in the credit market.\textsuperscript{54,55}

\textsuperscript{54}Informed investors may choose to trade in one market versus the other because of various considerations such as capital constraints, disagreement, asymmetric information, leverage, price impact, and transaction costs.\textsuperscript{55} Berndt and Ostrovnaya (2007) find significant information flows from the CDS market to the equity and option markets for high yield firms.
Thus, stock returns become predictable by CDS spread changes because the negative information in CDS markets gets slowly incorporated into equity prices. Marsh and Wagner (2012) focus on daily lead-lag patterns in equity and CDS markets, and find that the equity market leads the CDS market.

In addition to the level of CDS spreads, Han and Zhou (2012) document that the slope of the term structure of CDS spreads, defined as the difference between the five-year and one-year CDS spreads, negatively predicts stock returns. Moreover, the predictability is more persistent compared to that of changes in the levels of spreads. In a sample of 695 U.S. firms, they show, with CDS data from August 2002 to December 2009, that stocks with flatter CDS slopes outperform those with steeper CDS slopes by more than one percent per month over the following six months period. In contrast to previous studies, they do not find that the predictability pattern is asymmetric. They further find that CDS slopes positively predict changes in the level of CDS spreads. The predictive power stems from the information diffusion from the CDS market to the stock market. Hence, the slope of the term structure of CDS spreads contains valuable information about the future credit quality of the firm, but this information is not contemporaneously reflected in the stock price.

In contrast to Acharya and Johnson (2007), several studies find that informed traders primarily trade in the equity market rather than the CDS market. Hilscher et al. (2014), for instance, document that the equity market leads the CDS market at daily and weekly frequencies. They hypothesize that informed traders self-select into a market venue based on considerations of price impact, leverage, and transaction costs. According to this choice-of-market theory, they predict a separating equilibrium in which, because of the high bid-ask spreads in the CDS market, informed traders primarily trade in equity market. Liquidity traders, on the other hand, do participate in the CDS market. The authors test their hypothesis using a sample of 800 firms from 2001 to 2007 by using equity returns to predict spread returns, proxied by the percentage changes in quoted CDS spreads, and vice-versa. The analysis is conducted within rating categories, i.e., AAA-A, BBB and non-investment grade. In line with their hypothesis, the authors find that equity returns predict credit returns at daily and weekly frequencies, up to a time lag of four weeks. However, they find

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56 Norden and Weber (2009) also document in a sample of 58 firms during 2000-2002 that the equity market leads the CDS market and the bond market.

57 This is different from the evidence of a pooling equilibrium in the option and the equity market as in Ni et al. (2008), for example.
that credit returns cannot predict equity returns. Such findings have implications for regulatory proposals to ban naked corporate CDS trading, for example. Moreover, they find a significant delay in the adjustment of CDS spreads to the information released in the equity market. This delay in adjustment is explained by transaction costs and mispricing, created by investor inattention. On the one hand, transaction costs may make it difficult to profit from the predictability of CDS returns, which explains the slow adjustment of CDS spreads. On the other hand, the delayed adjustment may be related to mispricing created by investor inattention, as liquidity traders in the CDS market may not watch events as closely as those in the equity market. This interpretation is backed by the fact that the CDS market responds much faster to the equity market when CDS traders are more likely to pay attention to corporate events such as earning announcements.

The findings in Hilscher et al. (2014) strongly contradict the evidence of insider trading in the CDS market supported in Acharya and Johnson (2007). The former authors therefore provide additional arguments to justify the differential results. They argue that the results in Acharya and Johnson (2007) are restricted to a small sample of distressed firms. In addition, they emphasize that a firm’s distress is measured with ex-post information, which violates the assumptions for predictability tests. CDS returns fail to predict equity market returns if distress is measured using only ex-ante information, or if the standard errors are adjusted for heteroskedasticity. While the equity market plays a significant role in price discovery, the authors find that the CDS market volatility may lead the volatility in the equity market. Fung et al. (2008) investigate the relationship between the CDS market and the equity market using CDX indices. Their results indicate that the direction of information flow between the two markets depends on the credit quality of the reference entity. For sub-investment grade firms, they find evidence of mutual information feedbacks. For investment-grade firms, in contrast, the equity market leads the CDS market in terms of price discovery. This suggests that market participants should seek information from both the equity and the CDS market in making their investment decisions.

Other studies have investigated the informational efficiency of the CDS and the equity market.

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58 The authors measure transaction costs using CDS market depth. The market depth of a CDS contract measures the number of CDS quotes traded in a given period. In this paper, low depth is an indicator for firms in the lowest quartile of CDS quotes. Then the authors regress the fraction of credit protection return response on various transaction cost measures. They find firms with low depth (high transaction cost) have lower response rates. Consistent with the prediction from the transaction costs, they further find that CDS spreads adjust more quickly if the equity return is large in absolute value.
by comparing the price response in both markets to corporate events such as bankruptcy filings or rating changes. Using a sample of 5-year CDS spreads for 820 obligors from 2001 to 2004, Zhang (2009) document that contagion effects are better captured in the CDS market than in the stock market. Norden and Weber (2004) focus on the response of the CDS and the stock markets to credit rating announcements and find evidence that the CDS market reacts earlier to reviews for downgrade.

4.2.2 Arbitrage between Equity and Credit Markets

Structural models following Merton (1974) directly imply perfect integration between the equity and the credit market. As discussed in Friewald et al. (2014), the Merton model predicts that the “market price of risk (the Sharpe ratio) must be the same for all contingent claims written on a firm’s assets. Hence, risk premia in equity and credit markets must be related.” The authors directly estimate risk premia from CDS data and investigate the link between equity and credit markets. Specifically, in a sample of 491 U.S. firms from 2001 to 2010, they identify risk premia for individual firms from the CDS forward curve and relate the estimated risk premia to the excess equity returns. They find a significant positive relation between credit risk premia and equity excess returns in portfolios sorted monthly based on the estimated risk premia.

Although Merton (1974) implies that equity and credit should be similarly priced on a risk-adjusted basis, several studies provide empirical evidence of significant short-term pricing discrepancies that could be exploited for capital structure arbitrage. Capital structure arbitrage refers to a trading strategy that explores the mispricing between a firm’s CDS and its equity. Such a trading strategy could be implemented by selling (buying) credit protection and selling (buying) the stock when the theoretical model-predicted CDS spread is substantially lower (higher) than the market-observed CDS spread. The arbitrageur profits when the observed CDS spread converges to the model predicted CDS spread. A delta-hedged equity position can be used to offset the changes in the value of the CDS spread. While such a strategy is, in theory, market-neutral, the arbitrageur may suffer from mark-to-market losses if both CDS spreads and equity prices increase simultaneously, for and investor with a short position in both assets.

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59 Theoretically, if there is price discrepancy between two related markets, arbitrageurs should engage in arbitrage activities and eliminate the mispricing.
The existing literature attempts to explain the pricing discrepancies from different perspectives such as, among others, wealth transfers across share- and bondholders, and differential risk factors, or limits to arbitrage across markets.\footnote{For example, Bakshi et al. (2000) explain the pricing discrepancies between call option and equity prices using changes in equity volatility.} Alternatively, the returns in each market may be spanned by different pricing factors, which would explain persistent pricing discrepancies. For example, a number of studies find that CDS spreads are not a pure measure of credit risk, but that they contain a liquidity component.\footnote{Several references include Tang and Yan (2007), Bongaerts et al. (2011), Qiu and Yu (2012), Junge and Trolle (2013).}

\cite{Longstaff2007} focus on the limits to arbitrage explanation between the equity and the credit market. They study the risk and return characteristics of a capital structure arbitrage strategy implemented using 5-year CDS of a sample of 261 firms from 2001 to 2004. The authors simulate a trading strategy where, for each CDS firm during the sample period, an arbitrageur would sell insurance protection and short the stock when the observed CDS spread in the market is above a threshold percentage of the model-implied CDS spread. The position is closed either after 180 days or when the theoretical and observed spreads converge. The transaction cost is assumed to be 5%, reflected in the bid-ask spread. Besides the transaction costs, initial capital is required to finance the equity position. The excess returns earned from the individual capital structure arbitrage strategies are regressed on a set of equity and bond market factors, as well as a proxy for default risk to examine whether capital structure arbitrage profits are abnormal. The authors find that the initial capital required for a capital structure arbitrage strategy to generate a return with 10% annualized standard deviation is several times higher than for other fixed-income arbitrage strategies. Besides the initially required capital, the arbitrage trade also requires a high level of “intellectual capital” to identify the arbitrage opportunity and to hedge out the risks using complex models. Moreover, the capital structure arbitrage is only profitable when the deviation between the observed and model-implied CDS spread is substantial, i.e., the threshold percentage above which the arbitrage trade is initiated must be large. However, the authors document that, in their sample, convergence between market and model-implied spreads only occurs for a small fraction of the individual arbitrage strategies. The regression analysis nevertheless suggests that the capital structure arbitrage generates risk-adjusted excess returns.
Kapadia and Pu (2012) also explain the lack of integration between the CDS and equity market through a “limits-to-arbitrage” argument. They argue that, in principle, capital structure arbitrage strategies implemented by market participants should improve the equity and credit market integration. However, as the arbitrage is not costless because of frictions related to illiquidity and/or idiosyncratic risk, investors cannot perfectly exploit the arbitrage opportunities and pricing discrepancies remain. Therefore, limits to arbitrage may explain the low correlation between equity and credit markets. The authors investigate their hypothesis using a sample of 214 firms during the period from 2001 to 2009. To identify short-term pricing discrepancies, they use the concordance of price changes in the equity and CDS markets. Pricing discrepancies are then related to empirical measures that are reflective of limits to arbitrage, such as idiosyncratic volatility and funding liquidity. The authors use various econometric specifications and control for other risk factors suggested by prior literature to rule out alternative explanations to the pricing discrepancies between the CDS and the equity market. Overall, the results indicate that illiquidity, idiosyncratic risk and equity volatility jointly explain about 29 percent of the discrepancy between stock and CDS spread returns, which ought to capture the integration between these two markets. At the same, the modest explanatory power of the regressions suggests that equity volatility and the level of debt, the two most important determinants of CDS spreads (Ericsson et al. (2009)), cannot fully explain the pricing discrepancies.

The shortage of arbitrage capital available to investors during the financial crisis is proposed as explanation for the no-arbitrage pricing violations across markets, possibly applicable to the equity and CDS markets setting as well. Duffie (2010c), for example, suggests that the depletion of dealer capital may explain the distortions in the CDS-bond basis. Similarly, Mitchell and Pulvino (2012) use the argument of limited arbitrage capital to explain the wide negative CDS-bond basis during the crisis period.

The relationship between equity price and CDS spreads is affected by multiple factors in addition to limits to arbitrage. For example, previous papers have shown that mergers and takeovers, or systematic factors can affect the integration between CDS and equity markets.
4.2.3 The Effect of CDS Trading on the Equity Market

In complete markets without any frictions, CDS contracts are redundant assets. However, in the presence of frictions and incomplete markets, the addition of CDS contracts to the investor opportunity set may enhance price efficiency and market liquidity. The significant growth of the corporate CDS market since its inception in the early 90s thus warrants asking the question how the introduction or the existence of the credit derivative market has altered various characteristics of the equity market.

Boehmer et al. (2014) focus on the effect of CDS trading on equity market characteristics such as market liquidity and price efficiency. From an ex-ante perspective, CDS contracts may improve equity market liquidity because they represent efficient tools for risk sharing. CDS protection sellers can dynamically hedge their positions in equity markets through a delta hedging strategy. Thus, trading in the CDS market increases trading in the equity market. In addition, the ability to hedge may endogenously attract more investors into both markets. Alternatively, investors may choose the CDS market instead of the equity market to express negative views, thereby decreasing liquidity in the equity market. Moreover, Acharya and Johnson (2007) suggest that the CDS market provide a venue for insider trading. Informed trading in the CDS market may improve the informational efficiency in the equity market due to the positive effect of information spillovers. Alternatively, CDS trading may reduce the equity price efficiency because of negative trader-driven spillovers. More precisely, if informed traders trade in multiple markets, it may become more difficult for market makers to learn from these trades. Such informational externalities may induce additional second order effects. On the one hand, the improved equity price efficiency may attract investors to trade these securities and, therefore, improve equity market liquidity. On the other hand, the expanded opportunity set may make informed traders more aggressive, which could cause uninformed traders to exit the market altogether and, therefore, decrease the market liquidity. Whether the net impact on the equity market from the existence of CDS markets is negative or positive remains ultimately an empirical question.

Boehmer et al. (2014) investigate these hypotheses using a sample of corporate CDS contracts during 2003-2007. The authors find that CDS contracts have significant negative effects on equity market liquidity and price efficiency. Overall, however, these effects are state-dependent. In bad
states, negative information spillovers dominate, while in good states, CDS seem to complement the market with net positive effects. Several tools are used to avoid concerns that the results are driven by unobserved characteristics that determine both equity market characteristics and selection into CDS trading. To address such endogeneity and sample selection issues, they use propensity score matching techniques, difference-in-difference analysis and an instrumental variable approach. More specifically, the trading activity in the bonds of the underlying reference firms’ competitors should capture investors’ credit trading demand and not directly influence the quality of the equity market. Another possibility may be that the results are biased because of the existence of an active equity option and bond market. Comparing the impact from the CDS market with that of other related markets, the authors further show that the equity option market has positive effects on the equity market quality. In contrast the effect from the bond market on the equity market is negative.

4.3 CDS and Equity Options

Equity derivatives such as exchange-traded options were hedging tools before the existence of CDS. Carr and Wu (2010) discuss the similarities between options and CDS. In particular, they point out a simple link between deep out-of-the-money put options and CDS. Following such a logic, CDS and options can be priced jointly, as shown by Carr and Wu (2010). Carr and Wu (2007) study the comovement of sovereign CDS spreads and currency option implied volatilities using data on Brazil and Mexico. They find that the default intensity is more persistent than the currency return variance. In practice, some arbitrage trades are based on CDS and options. Fonseca and Gottschalk (2013) discuss cross-hedging strategies between CDS spreads and option volatility during crises.

There are several notable differences between those two types of derivatives. First, options have typically a shorter maturity. The most frequently traded options have a 3-month maturity while 5-year CDS contracts are the most liquid. Second, options are exchange-traded but CDS are traded OTC. Third, the CDS market consists of purely institutional investors while both institutional and individual investors trade options. The introduction of CDS may also impact the option price, liquidity, and market efficiency. However, there exists currently no research along this dimension.

\footnote{Raman et al. (1998) also find that option trading improves the stock market quality.}
5 CDS and Corporate Finance

The discussion in the section on the pricing of CDS contracts, Section 3, was based on the assumption that the cash flows of the underlying entity are unaffected by the existence of credit derivatives contracts referencing a future default event, i.e., the credit derivatives are merely redundant assets. However, the validity of this assumption is an empirical issue. In this section we discuss how the existence of CDS contracts affects the financing and investment decisions of the reference entities underlying the derivative contracts. There are plausible reasons to believe that the introduction of hedging instruments on the underlying entity’s credit may affect the real side by altering the strategic behavior of the entity. Any such externality, whether positive or negative, should ultimately be reflected in firms’ operating and financial performance, their access to capital and the cost of finance. Since much of these papers relate to corporate credit, in the first subsection, we will focus our attention on how CDS affect the credit supply and borrowing costs of firms. In the next subsection, we then discuss how CDS affect bankruptcy risk, in particular by influencing creditors’ incentives in the restructuring process. Although there are many other aspects of the impact of CDS contracts on the real side of a firm, our understanding of the intersection of CDS and corporate finance, thus far, has likely progressed the most around these two research topics. We will then discussion the intersection of CDS and corporate governance in the third subsection.

While this section focuses on how companies with traded CDS on their outstanding debt are affected by the existence of such hedging products, a fair question to ask is how the existence of CDS affects their end-users, as well. To this end, a detailed discussion on such implications is provided in section 6.

5.1 Credit Supply and Cost of Debt

At the broadest level, corporations raise capital by issuing either equity or debt. Debt financing typically takes the form of either bank loans or publicly traded bonds. Prior to the creation of the credit derivatives market, risk mitigation and sharing for bank lenders and bond holders through the credit risk transfer channel was quite limited. Loan sales were rare and corporate bonds are

\[64\text{For example, derivative contracts enjoy privileged treatment in bankruptcy and derivative counterparties are essentially senior to all other residual claimants. Oehmke and Bolton (2014) study theoretically how this privileged treatment of derivatives in bankruptcy affects derivative users’ borrowing cost and incentives for efficient hedging.}\]
often illiquid. The cost of limited risk sharing must ultimately be borne by corporate borrowers. CDS fundamentally alter the risk sharing mechanism and thereby affect the behavior of lenders and hence affect corporate borrowing costs. We start by reviewing the theoretical predictions of this literature and the related empirical evidence.

5.1.1 Theory

Morrison (2005) is among the first to model the effect of CDS on corporate financing decisions. The key message of this paper is that credit derivatives may lead to financial disintermediation and reduced bank monitoring. He develops a static two-period investment model where managers are able to extract private rents from an investment project. Managers choose to finance the project either by borrowing from a bank, or by issuing a publicly traded corporate bond. Without credit derivatives, companies would partially fund the investment through a bank loan with the associated benefit of bank monitoring. This signals the quality of the project and reduces the overall borrowing costs of the mixed financing strategy. However, in the presence of credit derivatives, banks may divest part of the credit risk in order to reduce their concentration of risk in their portfolio. This, in turn, reduces the monitoring incentives of banks. In this case, the bank’s role in the certification of the firm’s financial condition to permit the firm to obtain cheaper bond market financing is no longer as important. As a consequence, entrepreneurs may instead issue speculative-grade bonds and engage in second-best behavior. Thus, in this framework, bond investors lose the benefits associated with bank monitoring after the introduction of credit derivatives.

One feature of CDS contracts is that they permit the separation of creditors’ cash flow rights from their control rights. As a consequence, lenders may potentially become tougher with borrowers during the debt renegotiation process. The source of this motivation is the ability of lenders to retain control rights in a firm, even as they eliminate economic exposure by hedging the credit risk with CDS contracts. In other words, these lenders become “empty creditors”, a term coined by Hu and Black (2008) to refer to creditors whose exposures are hedged by CDS.65 Thus, creditors who

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65 While Hu and Black (2008) are associated with the concept of the empty creditor, it is closely related to the concept of “empty voters,” which has previously existed in the equity market literature, referring to the separation of cash-flow rights from voting rights. See for example Kahan and Rock (2007) and Hu and Black (2007). This concept of empty creditors is also closely connected to the notion that credit insurance alters lenders’ incentives during periods of financial distress, which was discussed even earlier by Pollack (2003), p.46. Pollack (2003) is concerned with “the
hold CDS protection may have different incentives than unhedged creditors. They may use their control rights strategically to force companies into bankruptcy in order to receive a more handsome insurance payment. This would be more favorable for the creditor than accepting a haircut in a debt renegotiation process, even though it may be socially inefficient because of job losses and welfare destruction. In equilibrium, the existence of a CDS contract may, therefore, lead to ex-ante commitment benefits, whereby the borrowing companies default less often. Bolton and Oehmke (2011) illustrate this mechanism in a three-period investment model with periodic payments to the creditors. Interim cash-flows are unobservable so that borrowers may decide to strategically default. In response to missed interest payments, creditors can decide whether to pursue the project or to liquidate the firm. The results suggest that creditors are more inclined to liquidate, which reduces the strategic default incentives. The flip side of the coin is that creditors sometimes overinsure, and enforce too many defaults, as a consequence. Such excessive defaults are socially inefficient and welfare decreasing, given that certain positive net present value projects are liquidated rather than restructured.

We use a simple framework to demonstrate the basic intuition of Bolton and Oehmke (2011). Consider first the case that creditors lend $X$ to the firm. When there are no CDS traded on a firm, if the firm is in financial distress and consequently declares bankruptcy, creditors will recover $r \times X$, where $r$ is the recovery rate in bankruptcy. Consider, on the other hand, that the creditors allow the firm to restructure the debt, since the recovery value of the assets in bankruptcy is less than its value as a going concern. Suppose the firm offers the creditors part of the difference between the “going concern” value and the recovery value of the assets in bankruptcy, and agrees to pay them, say, $R \times X$, with $R > r$. Clearly, the creditors would consider such a restructuring favorably, and try to avoid bankruptcy. In general, restructuring would dominate bankruptcy.

Suppose now that the creditors can also buy CDS protection against the firm’s credit events. Clearly, bankruptcy will always be defined as a credit event. However, restructuring may or may not be defined as a credit event, as per the clauses of the CDS contract. If restructuring is included moral hazard problem that may arise if a credit default swap contract does not include the Restructuring clause as a credit event and the protection buyer forces the Reference Entity into bankruptcy in order to trigger a default under the swap.” See also Kiff et al. (2009) on this topic.

The precise size of $R$ would be determined in a bargaining process between the creditors and the shareholders of the firm.
as a credit event, we call the contract a “Full restructuring” (CR) CDS. If it is not, we call it a “No restructuring” (XR) CDS. In the case of CR CDS, assume that the CDS premium (price) is $F$, in present value terms, at the time of default and that the creditors buy CDS against $Y$ of the notional value of the CDS. If the firm defaults, the creditors’ total payoff with CDS protection is $[r \times X + (1 - r - F) \times Y]$ in the event of bankruptcy, and $[R \times X + (1 - R - F) \times Y]$ if the debt is restructured. Therefore, the creditors are better off with bankruptcy than with restructuring if

$$[r \times X + (1 - r - F) \times Y] > [R \times X + (1 - R - F) \times Y],$$

i.e., when $Y > X$, since $R > r$. Hence, bankruptcy dominates restructuring as a choice for creditors for whom the amount of CDS purchased exceeds the bonds held (“empty creditors”), even when restructuring is covered by the CDS. In the equilibrium model of Bolton and Oehmke (2011), CDS sellers fully anticipate this incentive of CDS buyers, and price it into the CDS premium. Although CDS sellers may have an incentive to bail out the reference firms (by injecting more capital as long as it is less than the CDS payout) in order not to trigger CDS payments, they cannot do so unilaterally; the empty creditors who are the CDS buyers, and other creditors, will mostly decide the fate of the company, as any new financing would require the existing creditors’ approval, and CDS sellers are not part of this negotiation process.

Now consider the case of XR CDS. Assume that the CDS premium, in this case, is $f$ in present value terms, where $f < F$. Suppose again that the creditors buy CDS against $Y$ of the notional value of the CDS. Therefore, if the firm defaults, the creditors’ total payoff with CDS protection is $[r \times X + (1 - r - f) \times Y]$ in the event of bankruptcy, and $[R \times X - f \times Y]$ if the debt is restructured. Bankruptcy is a preferred outcome for the creditors if

$$[r \times X + (1 - r - f) \times Y] > [R \times X - f \times Y],$$

or if

$$Y > \frac{R-r}{1-r} X,$$

67Other types of CDS contracts also exist, but are not relevant for the purpose of this simple illustration. See Subrahmanyam et al. (2014) for a discussion of contract clauses.
which can be true even when \( Y < X \), since \( R < 1 \). Thus, for XR CDS, bankruptcy is preferred when even a relatively small amount of CDS are purchased; hence, bankruptcy is the preferred outcome for a larger range of holdings of XR CDS by the creditors. It is also evident that buying CDS protection with XR CDS contracts is more profitable in the event of bankruptcy than restructuring without CDS protection, so long as

\[
[r \times X + (1 - r - f) \times Y] > R \times X,
\]

which is equivalent to saying that

\[
Y > \frac{R - r}{1 - r - f} X.
\]

The above condition is met when \( Y > X \), as long as \( R < 1 - f \), which is almost always true as the cost of CDS protection is usually lower than the loss in the event of restructuring. Even if \( Y < X \), the condition is likely to hold, for reasonable values of \( R \) and \( f \). Further, the greater the difference between \( Y \) and \( X \), the greater will be the incentive for creditors to push the firm into bankruptcy.

To recap, we demonstrate that a) creditors have an incentive to over-insure and push the firm into bankruptcy, b) this incentive increases with the difference between \( Y \) and \( X \), i.e., the amount of CDS contracts outstanding relative to the firm’s debt, and c) the probability of bankruptcy occurring is greater for XR CDS contracts.

Che and Sethi (2014) theoretically show that the CDS market benefits borrowers by increasing their debt capacity and lowering interest rates in the case when CDS can only be purchased against an insurable interest. However, since the CDS market provides lenders with an alternative venue to trade credit risk (Oehmke and Zawadowski (2014a)), lenders may also be less willing to extend credit to the firm if investors are allowed to hold naked CDS positions, i.e., they are CDS buyers who have no exposure to the underlying borrower so that they have no insurable interest. Che and Sethi (2014) argue that CDS “induce investors who are most optimistic about borrower revenues to sell credit protection instead of buying bonds, which diverts capital away from potential borrowers and channels it into collateral to support speculative positions.”

68 The calculation for the CR CDS is the same, except that the fee is \( F \) instead of \( f \). The precise range of values for \( Y \) relative to \( X \) will be smaller than for the XR CDS, as argued above.

69 Portes (2010), Goderis and Wagner (2011) and Sambulaibat (2011), among others, discuss the externalities arising...
CDS positions reduce firms’ debt capacity as investors shift their money away from financing real investments to collateralizing speculative positions. This further reduces debtors’ power to negotiate the terms of a loan. Moreover, the model suggests the emergence of multiple equilibria, whereby firms may find it more difficult to roll over maturing debt, i.e., they face “rollover risk”. Hence, borrowers may be adversely affected by CDS trading, especially if it is naked, i.e., without ownership of the underlying bonds.

Oehmke and Zawadowski (2014b) theoretically model the effect of introduction of CDS trading on the bonds issued by the underlying entity. In their framework, CDS are non-redundant assets and can affect the underlying bonds due to the liquidity differences between the two markets. In their formulation, it is assumed that the CDS market is relatively more liquid than the underlying bond market. They identify a tradeoff between a “crowding-out” effect and an improvement in the allocation of risk in the bond market. Thus, the effect of CDS trading on the underlying bond price depends specifically on this trade-off. On the one hand, the availability of CDS protection may induce some investors to switch from the bond market to the CDS market. On the other hand, the presence of leveraged basis traders after the CDS introduction may allow long-term investors to hold more of the illiquid bonds due to the ready availability of hedgers. For example, “negative basis traders” would take both a long position in the bond and purchase CDS protection, which would tend to push up bond prices. When the liquidity differential is substantial, and when basis traders are able to leverage their positions, the introduction of CDS trading is more likely to raise bond prices.

The previously highlighted predictions are primarily unconditional, although both the causes and consequences of CDS trading may vary over time. Campello and Matta (2013) predict that the empty creditor problem is indeed procyclical, based on a static three-period investment model. Managers borrow from a financial intermediary to finance a project. They have discretion over their

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70 Oehmke and Zawadowski (2014b)
71 Campello and Matta (2013)
72 Sambalanbat (2013)
effort level, which is unobservable, but can be inferred from the outcome of the investment project. The precision of the inference depends on market conditions. The manager may also strategically default by missing interim payments, as cash flows are unobservable, as in Bolton and Oehmke (2011). Lenders, on the other hand, decide whether to hedge their credit risk exposure by buying CDS protection or not, after the manager has made his effort. If the borrower fails to make an interim payment, lenders can either negotiate a haircut on the loan and continue the project, or liquidate the firm. The model predicts that CDS contracts could increase the debt capacity of the firm during economic booms and for more successful firms, as their managers are more likely to exert higher efforts. Campello and Matta (2012) also argue that, in the presence of CDS trading, managers can invest in riskier projects. Such “risk-shifting” behavior increases the borrowers’ probability of default. Finally, Fostel and Geanakoplos (2013) show that the introduction of naked CDS may generate under-investment, and that financial innovations such as CDS can change the collateral capacity of durable assets, which may further alter investment decisions, ex-ante. This prediction contrasts Bolton and Oehmke (2011) in which investments may increase due to better credit supply.

The above-cited theoretical models have several implications for corporate financing decisions. For example, in the generalization of the classic Modigliani-Miller formulation, firm leverage is determined by the tradeoff between bankruptcy costs and the tax shield, information asymmetry between insiders and outsiders, as well as the overall market conditions. If the presence of CDS contracts changes the debt capacity of the firm for other reasons and also alters the risk of bankruptcy, the optimal capital structure of the firm would also be affected. We discuss the empirical evidence on CDS, debt capacity and credit risk in the following subsection.

5.1.2 Empirical Evidence

Saretto and Tookes (2013) show that firm leverage and debt maturity increase after CDS trading. In other words, they argue that the credit supply to firms is greater when lenders can hedge their credit exposures with CDS. The study focuses on non-financial S&P 500 firms. More precisely, the authors

\footnote{In Bolton and Oehmke (2011), CDS enhance creditors’ bargaining power in ex-post renegotiations. This raises the debtor’s pledgeable income and helps reduce the incidence of strategic default. Through these commitment benefits, CDS may relax firms’ borrowing constraint and increase investment.}
study a sample of 3,168 firm-year observations from 2002 to 2010, among which 1,578 firm-year observations are associated with active CDS trading. A comparison of company characteristics between firms with and without traded CDS suggests that CDS firms have, on average, similar credit ratings to non-CDS firms, but higher leverage and longer debt maturities. Both separate and joint analysis yields that leverage and debt maturity increase after the onset of CDS trading. To mitigate concerns that the results are driven by unobserved firm characteristics that are correlated with CDS trading, the authors incorporate the amount of banks’ foreign exchange derivatives usage as an instrumental variable in their regression design. The effect of CDS trading on leverage and maturity remains significantly positive even after controlling for the selection into CDS trading using this instrument. In addition, the authors verify their results using two exogenous shocks to credit supply: within-state defaults and write-downs during the 2007-2008 financial crisis. The conclusion from this study is that the presence of CDS trading increases firms’ financing capacity. Hirtle (2009), on the other hand, finds limited evidence that CDS increase bank credit supply. More precisely, he shows that while the use of CDS by bank lenders increases their credit supply to large corporate borrowers, this benefit is offset by increased credit spreads. The analysis in this study is based on aggregate bank lending and derivative usage data.

The Saretto and Tookes (2013) study suggests that CDS induce an overall increase in credit supply. Whether this supply shift benefits all borrowers equally is debatable. Ashcraft and Santos (2009) find that, following the initiation of CDS trading, borrowing costs increase for high-risk borrowers, while they decrease for low-risk borrowers. This suggests that CDS trading reduces asymmetric information such that credit-worthy borrowers are easier to identify, thereby mitigating, if not eliminating, the proverbial “lemons problem.” The sample in this study stretches from the second quarter of 2001 to the second quarter of 2005. It contains 51 firms that initiated CDS trading and 152 matching firms without any CDS trading. The data used by Ashcraft and Santos (2009) is a combined dataset from the Federal Reserve Survey of the terms of business lending, the Federal Reserve Senior Loan Officers Opinion Survey, and the quarterly Consolidated Reports of Condition and Income, generally referred to as the Call Reports.

The identification of the CDS initiation dates is based on Markit. Firms with CDS trading prior to January 2001 (the beginning of the sample period) are removed as the starting date cannot be precisely determined in those cases.
may be noisy, as their classification into CDS and non-CDS firms is based on the Markit database only. Markit started its data coverage in 2001. Thus, some firms may already have had traded CDS prior to 2001, but they would not be classified as CDS firms until they are quoted for the first time in the Markit database.

Kim (2013) uses Markit data from 2001-2008 and a sample of 227 firms with CDS quotes to find evidence that firms with high strategic default incentives experience a relatively larger reduction in their corporate bond spreads following the introduction of CDS. This suggests that firms are more likely to face a limited commitment problem prior to the introduction of CDS. Massa and Zhang (2012) show that CDS can reduce fire sale risk. Regulations often impose significantly greater capital requirements for insurance companies on their holdings of speculative-grade bonds. Thus, the necessity to sell issues downgraded below investment-grade status may induce temporary price pressure (Ellul et al. (2010)). The opportunity to hedge the capital requirements through CDS reduces the need to divest fallen angels (bonds that were initially investment grade, but were subsequently downgraded to speculative-grade ratings). This mechanism decreases bond yield spreads and increases bond liquidity. The sample in this study covers US corporate bonds with CDS information from Markit data during the time period 2001 and 2009. Shim and Zhu (2014) analyze how the existence of CDS trading affects corporate bonds in Asian economies over the period January 2003 to June 2009. They find that bond yield spreads at issuance are 18 basis points lower when the issuer has CDS contracts based on it with quoted prices 30 days before the bond is issued. Their sample covers 1,091 corporate bond issues from 236 firms, among which 643 issues from 116 firms have traded CDS.

Since 2008, some issuers have started to issue corporate bonds and loans with coupon payments linked to their CDS spreads. Ivanov et al. (2014) analyze such market-based pricing schemes. They identified 117 loans, issued by 51 firms and 18 banks, which had an interest rate tied to the CDS

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78 This critique more generally applies to studies using Markit as the single source of information to identify the CDS initiation dates. It is far better for studies to combine multiple sources of CDS information to identify the CDS initiation dates, in particular those that have information prior to 2001. For a more detailed discussion, see Subrahmanyam et al. (2014b).
spreads of the issuer.\footnote{Their sample also includes 28 loans from 11 firms and 8 banks with interest rates linked to the CDX index. The sample period starts in the second quarter of 2008 and ends in the fourth quarter of 2012} They find that such loans have lower spreads at origination and fewer covenants than otherwise similar standard loans. The savings on loan spreads is estimated to be 32 basis points, after having controlled for borrower and lender characteristics. The characteristics of most of these loans are revolver-type debt contracts from investment-grade borrowers.

Surveying the previous references highlights the conclusion that the overall empirical evidence about the effects of CDS trading on a firm’s cost of debt is rather mixed, with results pointing towards both benefits and costs from the existence of CDS contracts on a firm, with some studies reporting no effects whatsoever. A possible explanation for these contradictory findings is that we still lack large-sample evidence, over a sufficiently long time. Also, the onset of the global financial crisis, and the consequent structural shifts in financial markets in general, and CDS markets in particular, may have caused a regime change that confounded the effects, to some degree. The reduced transparency due to the fact that CDS are not traded on an exchange or were even cleared until very recently, and the previously highlighted difficulty in identifying the dates of CDS initiation, further complicate these studies.

While borrowers certainly care about the price, quantity, and maturity of their debt, they also care about other borrowing terms such as debt covenants. While Morrison (2005) suggests that the existence of CDS may reduce banks’ monitoring incentives, this could be reflected in more stringent covenants tied to bond issues. Alternatively, CDS may serve as an ex-ante commitment device, as suggested by Bolton and Oehmke (2011), thereby allowing creditors to loosen these covenants. On the other hand, borrowers may demand looser covenants if they are concerned about tougher creditors in debt renegotiation or loan rollovers. Shan, Tang and Winton (2014) provide evidence in favor of the latter arguments by finding that loan covenants are loosened after CDS trading. The covenant loosening effect associated with CDS trading is most pronounced for firms with less information problems and for firms with better credit quality.

Finally, if CDS can serve as efficient monitoring tools, they may also replace credit ratings as a proxy for access to capital markets. Such an argument is sustained by the evidence in Chava et al. (2013). If credit ratings affect firm capital structure, then CDS will substitute for the role of ratings. The authors use a sample from 1998 to 2007, covering 1,293 firms, of which 390 have
traded CDS. They find that a firm’s stock price reacts significantly less to a credit rating downgrade after a CDS contract starts trading on its debt.

5.2 Restructuring and Bankruptcy

In traditional banking relationships, lenders are concerned about the borrowers’ ability to repay their debt. In case of financial distress before the loan has been repaid, lenders are typically willing to renegotiate with the borrowers in order to keep them as a going concern. However, when lenders can buy CDS protection and receive insurance payments from protection sellers rather than accepting a haircut in debt renegotiations, their incentives for helping the borrowers to overcome financial distress may be undermined. In particular, lenders can become empty creditors who have superior negotiating power, even though they are not necessarily negatively exposed to the borrower’s default (Bolton and Oehmke 2011). Such creditors clearly decrease a firm’s likelihood of survival.

Subrahmanyam et al. (2014b) empirically test this hypothesis. Bankruptcies are rare events and naturally require a long time series to draw meaningful conclusions. The authors, therefore, construct a comprehensive bankruptcy record from 1997 to 2009, including 940 bankruptcies from both large and small firms. They also compile CDS trading records using actual transaction data over the same time period. Their CDS sample covers 901 CDS initiations for North American firms. They find that firms are more likely to be downgraded or to go bankrupt after CDS trading. Their findings are robust to the inclusion to two instrumental variables for CDS trading, lenders' amount of foreign exchange hedging and lenders’ tier one capital ratio. Moreover, CDS trading arguably affects already distressed firms the most. The decisive influence of empty creditors does not materialize until creditors and borrowers arrive at the negotiation table, in the event of distress, to discuss potential restructuring of the debt. Subrahmanyam et al. (2014b) indeed show that CDS firms are more likely to go bankrupt once they are in financial distress, and this effect is most pronounced when the traded CDS contracts do not include the restructuring clause as a credit event. Without the restructuring clause in the CDS contract, CDS buyers have a preference for bankruptcy over restructuring. The authors also find that the number of creditors increases.

after CDS trading. Creditor coordination is more difficult for larger number of creditors, leading to a higher likelihood of bankruptcy. Peristiani and Savino (2011) study the implications for bankruptcy using a comparatively smaller sample. They find consistent (albeit weaker) evidence than Subrahmanyam et al. (2014b) in that firms are more likely to go bankrupt after the inception of CDS trading.

Most distressed firms attempt to restructure their debt to stay out of bankruptcy. Several studies examine the success of restructuring in the presence of CDS trading. The evidence on whether CDS trading improves or worsens the restructuring prospects is mixed. Bedendo et al. (2012) analyze 163 defaults over the period from January 2007 to June 2011, covering 65 out-of-court distressed exchanges and 98 Chapter 11 bankruptcy filings. They do not find evidence that CDS influence restructuring outcomes. Debt issuers may allegedly cooperate strategically with select creditors to minimize the impact of pressure from empty creditors. Narayanan and Uzmanoglu (2012) use data on 84 distressed exchanges (25 CDS and 59 non-CDS) from 2004 to 2011 to conclude that CDS trading does not play a significant role in restructuring outcomes. Therefore, they argue that even though the influence of CDS for restructuring is taken into account by borrowers and lenders, in equilibrium, CDS may not have observable effects on distress resolution because borrowers “work around” empty creditors.

Besides the voting outcome for restructuring proposals, another interesting aspect is how creditors with vested interests behave in the voting process. If creditors are protected by CDS, they may not care about the outcome and may not bother with voting at all. Danis (2012) analyzes participation rates in the restructuring voting records from 2006 to 2011. His sample covers 210 corporate bonds involved in 80 exchange offers. He finds that 29% fewer creditors vote for restructuring when there is a CDS contract referencing the bonds compared to a situation without a CDS. He uses the changes following the CDS Big Bang in 2009 as an exogenous shock to mitigate various endogeneity concerns.

Trading CDS in the secondary market could potentially also affect primary market securities issuance. For example, Arentsen et al. (2014) argue that “since issuers and investors in mortgage-backed securities (MBS) could hedge the credit risk of the subprime loans underlying MBS with CDS contracts, this helped fuel the demand for subprime loans, which were supplied by loan originators.
who reduced lending standards to meet demand.” They examine data on the privately securitized subprime mortgages originated during the period from 2003 to 2007. The findings suggest that CDS coverage significantly increased the probability of loan delinquency by more than 10% during the financial crisis. CDS also facilitated the issuance of lower quality securities, thereby increasing the overall default rate for all offered securities.

Despite all this mixed evidence, it is probably fair to conclude that CDS influence the restructuring versus bankruptcy decision in some way. In any case, these results should be considered in light of the selection issue in the restructuring analysis. Some distressed firms may self-select into pre-packaged Chapter 11 bankruptcy instead of restructuring their debt outright. Probably, a more useful debate to have is whether any noted effects are economically meaningful. Also, one issue to keep in mind in addressing this question is, data problems aside, the various dimensions in which the existence of CDS and CDS trading can affect corporate finance decisions. This raises various policy questions. For example, some argue that bankruptcy law should be changed to adapt to the existence of CDS. Lubben and Narayanan (2012) specifically discuss the implications of CDS trading on reorganization methods. They suggest that creditors’ CDS positions must be disclosed during the debt renegotiation process of financially distressed firms in order to be consistent with the spirit of the bankruptcy law. Pollack (2003) suggests that CDS protection sellers should be involved in the distress resolution process. Overall, we believe that further research, based on larger and more complete samples, are needed to conclude in favor of a specific policy recommendation.

5.3 Corporate Governance

If CDS trading affects the incentives and strategic behavior of firms with regard to their debt obligations, it stands to reason that it ought also to affect their corporate governance. In particular, if external governance is weakened after CDS trading, especially since lenders have lower monitoring incentives, then internal governance may need to be more vigilant to offset such effects. Colonnello (2013) provides empirical evidence that board independence increases after CDS trading over the period from 2001 to 2011, using a sample of 347 CDS and 1,127 non-CDS firms. With a similar insight, Bolton et al. (2011) propose to link executive compensation to firm’s CDS spreads in order to address excessive managerial risk-taking, in particular risk-shifting. Feldhutter et al. (2014) use
CDS as a benchmark for bond spreads to measure the value of control rights. They find that CDS prices reflect the cash flows of the underlying bonds, but not the control rights. As firm’s credit quality declines, the value of creditor control increases since creditor control can affect managerial decisions. Then they measure the creditor control premium in bond spreads as the difference in the bond price and an equivalent non-voting synthetic bond that is constructed using CDS. In a sample of 2,020 publicly traded bonds of 963 U.S. companies, they find that control rights affect bond prices and liquidity. The creditor control premium monotonically increases towards the default, to over 6% by the time of default.

While the empirical evidence seems to support the view that firms can raise more external funding after CDS start trading on their debt, it is unclear how those funds are deployed. Moreover, firms may find their financial flexibility increased after CDS trading and, therefore, may hold less cash. On the other hand, firms may also be concerned about the previously discussed empty creditor problem and debt rollover risk. This would incentivize them to hold more cash. Subrahmanyam et al. (2014a) support the latter hypothesis by finding that firms hold more cash after CDS trading. Their finding suggests that the concerns over losing creditor support in times when it is most needed may dominate the increased financial flexibility or perceived credit supply. This conservative cash policy may serve as a buffer against heightened risk-taking and aggressive accounting practices. How exactly these actions balance out is still unclear and an interesting avenue for future research. Presumably, all corporate policies will be reflected in the performance of firms over the long run, and their liquidity policy is certainly an important aspect of firm strategy.

The empirical literature on the relationship between CDS and corporate finance has grown tremendously over the recent years, and there are other interesting implications of CDS trading in terms of corporate policy and external corporate governance. For example, Martin and Roychowdhury (2014) find that the borrowing firms’ accounting conservatism reduces after the onset of CDS trading as lenders are less vigilant in monitoring the borrowers. This is, in particular, evidenced by asymmetric timeliness of loss recognition. In other words, firms become more aggressive in their accounting practices after CDS start trading on their debt. The effect is more pronounced when lenders have lower reputation costs from reducing monitoring, when outstanding contracts have more financial covenants, and when lenders are more active in monitoring before
CDS introduction. Karolyi (2013) studies the effects of CDS trading on borrowers’ behavior and finds evidence consistent with increased risk-taking. In a sample of 49 homebuilders from 2001 to 2010, among which 22 have CDS trading, he finds that borrowers increase both operational and financial risk-taking after CDS initiation. On a brighter side, Kim et al. (2014) find that managers are more likely to issue earnings forecasts when firms have actively traded CDS.

While many studies identify the effect of CDS trading on the underlying reference firms, it turns out that only a small fraction of firms, typically larger in size, actually have CDS referencing their debt. However, there exist rich economic linkages between CDS and non-CDS firms, which could possibly introduce spillover effects between the two groups. One such relevant and important economic link is the customer-supplier relationship. Li and Tang (2013) construct the economic linkages between industrial firms to study this issue. The authors focus on the specific situation when the customer’s debt has traded CDS, but the debt of the supplier does not. If customers become riskier after CDS trading, then suppliers may want to reduce their leverage to maintain their credit profile. The findings suggest that the supplier’s leverage is lower following the onset of CDS trading on the customer’s debt. In contrast, customers may also be concerned with their supplier’s CDS trading. Hortasu et al. (2013) find that products are selling at lower prices when a company’s CDS spread is higher. This evidence suggests that consumers use information implied by CDS spreads. Moreover, such use of CDS may create a feedback loop and potentially induce a downward spiral: distressed firms have higher CDS spreads, their product market competitiveness is reduced, which further deteriorates their credit quality.

To summarize, the existing empirical evidence paints a consistent picture that CDS trading allows firms to borrow more, most likely at lower interest rates, potentially at longer maturities, and with looser covenants. However, firms may not always access this additional source of financing in the best possible way, by holding, for example, inefficient cash balances. Borrowers could very well be negatively affected by such availability of additional financing and face increased bankruptcy risk. Finally, the existence of CDS contracts seems to affect both external and internal corporate governance in various dimensions. A clear conclusion on these topics is premature, but given their broad relevance, further empirical research in order to validate or invalidate the existing theoretical predictions is warranted.
6 CDS and Financial Intermediaries

The CDS market is dominated by institutional investors, as evidenced by the fact that approximately 85% of all transactions are classified as dealer-to-dealer trades, according to the Depository Trust and Clearing Corporation (DTCC). This is confirmed by Chen et al. (2011), who report that the largest 14 dealers account for about 90% of all CDS transactions, with more than half of these being executed between these 14 dealers.\footnote{As is to be expected, banks are the major players in the credit derivative market. In fact, they were the main group among the proponents of CDS who lobbied for the contracts to be recognized as hedging instruments in obtaining capital in bank regulations. In August 1996, the Federal Reserve Board published a Supervision and Regulation report to discuss the hedging role of CDS for bank credit risk.} As is to be expected, banks are the major players in the credit derivative market. In fact, they were the main group among the proponents of CDS who lobbied for the contracts to be recognized as hedging instruments in obtaining capital in bank regulations. In August 1996, the Federal Reserve Board published a Supervision and Regulation report to discuss the hedging role of CDS for bank credit risk.\footnote{In June 1999, CDS were formally proposed to be included in the Basel II capital accord, which was officially approved in 2004, and effectively implemented in 2006. The inclusion of CDS as hedging tools in regulatory capital directives makes it reasonable to hypothesize that these changes have affected the incentives and behavior of CDS end-users. In this section, we discuss the use of CDS contracts by financial intermediaries, in general, and how they have impacted the performance of lenders and the debtor-creditor relationship, in particular.}

6.1 Performance of Banks

Several papers have examined the effect of CDS trading on the incentives and the behavior of lenders to firms, in particular banks. \cite{Acharya:2007} suggest that financial intermediaries potentially purchase credit insurance based on superior information they obtain from their lending relationship with clients. This results in informed trading, effectively insider trading, that is revealed in CDS prices before it gets incorporated in the borrower’s stock prices. They further show that this evidence becomes stronger if the borrower has a higher number of bank relationships. \cite{Acharya:2010} also provide similar evidence in the context of leveraged buyouts, by showing that such insider trading becomes stronger as the number of parties involved in the transaction increases.

\footnote{The major CDS dealers and Markit are facing anti-trust lawsuits for alleged collusion.}

\footnote{The OCC, which governs national banks, also did the same around the same time.}
Although the evidence provided by Acharya and Johnson suggests that banks exploit insider trading opportunities in the CDS market, Minton et al. (2009) find that banks’ use of CDS is limited, possibly due to a lack of liquidity in trading CDS contracts. According to the discussion in Minton et al. (2009), only 23 out of the 395 large banks in their sample used credit derivatives in 2005. For U.S. bank holding companies with assets above one billion dollars, during the period from 1999 to 2005, a substantial proportion of the CDS positions are for dealer activities and the hedging positions are rather small compared to their loan portfolios. Their findings imply that banks did not become effectively less risky after their use of CDS for hedging. Their conjecture of the ineffectiveness of CDS positions to substantially mitigate credit risk is, to some extent, supported by the well-known “London Whale” trading fiasco in early 2012, when J.P. Morgan lost $6.2 billion in CDS index trading at its chief investment office in London. Since that well-publicized episode, regulators have been justifiably skeptical about the claims of bankers about the risk reduction potential of CDS trading.

Hakenes and Schnabel (2010) present a banking model showing that, if banks have private information about the quality of loans, they have an incentive to make unprofitable loans whose risks can be transferred to other parties via CDS, using an “originate and distribute” model. Such bank behavior leads to an increase in aggregate risk and a decrease in welfare. A similarly negative view is shared by Biais et al. (2014), who show that, although CDS are designed for hedging, they can breed excessive risk-taking. Their logic is as follows. Protection sellers facing potentially large CDS payouts may engage in risk-shifting by selling more CDS and reduce their efforts, which may have implications for other unrelated firms. Therefore, financially weak firms, in particular, should not act as protection sellers.

In the current regulatory dispensation in most countries, CDS are generally permitted to be used to lower capital requirements, which may potentially induce regulatory arbitrage, if the regulatory rules are not in line with market realities. In this spirit, Yorulmazer (2013) analyzes the use of CDS for regulatory capital relief and its consequences for systemic risk. In his model, the bank and the CDS seller (insurer) prefer high correlation in their returns and jointly shift the risk to the regulator. He shows that CDS can help banks expand balance sheets and fuel asset price bubbles. Another prediction of his model is that CDS can be traded at a price higher than their fair value, the
“mispricing” reflecting the value of capital relief. Empirical support for the model by Yorulmazer (2013) can be found in Shan, Tang and Yan (2014), who examine the effects of CDS on bank capital adequacy and lending behavior. They find that banks use CDS to improve the appearance of their capital adequacy as stipulated by regulations, while consequently engaging in more risky lending. While banks that use CDS appear resilient to internal shocks on loan portfolios, they are more vulnerable to external shocks in the CDS market. Banks that were active CDS users at the onset of the 2007-2009 credit crisis raised capital and reduced lending to a greater extent than banks that did not use CDS. CDS-using banks enjoyed better stock returns than their non-CDS-using peers during the pre-crisis period, but they suffered sharper stock price declines during the crisis. The findings suggest that regulatory capital regulation on the use of CDS enabled banks to mask their real capital inadequacy: they became more aggressive in their lending practices and more vulnerable to external shocks.

Hirtle (2009) uses a proprietary bank micro data set of individual corporate loans to explore whether the use of credit derivatives is associated with an increase in bank credit supply. She finds only limited evidence that greater use of credit derivatives is associated with a greater supply of bank credit. In fact, the strongest effect in her sample is found for large term loans - newly negotiated loans extended to large corporate borrowers - with a largely negative impact on (previously negotiated) lending commitments. Even for large term borrowers, increases in the volume of credit are offset by higher credit spreads. The use of credit derivatives appears to be complementary to other forms of hedging by banks, although those banks most active in hedging appear to charge relatively more for additional amounts of credit. These findings suggest that the benefits of the growth of credit derivatives may be limited, accruing mainly to large firms that are likely to be “named credits” in these transactions. The conclusion in Hirtle (2009) seems contradictory to other studies, such as Saretto and Tookes (2013), but to some extent consistent with Shan, Tang and Yan (2014). It is important to point out though that Saretto and Tookes (2013) look at the entire capital structure of firms (i.e., not just bank loans) and find that most of the impact of CDS on firms’ capital structures arises through corporate bonds, rather than through bank loans.

While there are justifiable concerns that financial intermediaries may exploit the private information obtained from their access to firms in the context of their corporate loan book to trade
in the CDS market, CDS are still considered to be effective tools for transferring credit risk. Buy buying default protection, lenders can use CDS to mitigate their credit risk exposure. On the other hand, CDS may affect lenders’ monitoring incentives and make them more lax in containing such risks. Duffee and Zhou (2001) provide an early discussion of the benefits of CDS contracts as risk transfer tools, but also express caution on the potential downside of CDS trading for firms. They model the impact of the introduction of CDS contracts from the perspective of creditors, focusing on banks. The banks’ informational advantage regarding the borrower’s credit quality may lead to adverse selection and moral hazard concerns. More specifically, CDS trading may reduce other types of risk-sharing, such as secondary loan sales, with ambiguous welfare consequences. This view is supported by Morrison (2005), who argues that CDS can lead to disintermediation as banks may lose their incentives to closely monitor borrowers once their exposures are hedged with CDS.

Also Arping (2014) shows that credit risk transfer alters the incentives of both lenders and borrowers. He similarly shows that lenders may be less willing to monitor the borrowers if they had purchased default protection. He argues, however, that the problem can be mitigated by imposing a shorter maturity on the CDS contract than the maturity of the hedgeable investment project. Thompson (2010) extends the work of Duffee and Zhou (2001) by allowing for informational asymmetry in the CDS market, and by relaxing the maturity mismatch assumption. In this augmented model, it is no longer clear whether the use of CDS as credit risk transfer tools would be beneficial. The outcome depends on the interplay between the nature of the moral hazard problem, the relationship between the bank and the borrower, the cost of loan sales and the cost of capital. Allen and Carletti (2006) show that credit risk transfer can be beneficial when banks face systematic demand for liquidity. However, when they face idiosyncratic liquidity risk and hedge this risk in the inter-bank market, credit risk transfer can be detrimental to welfare. Further, such hedging via CDS may lead to contagion between the banking and real sectors and could potentially increase the risk of financial crises.

The effect of CDS mimics the impact of loan sales on the creditor’s monitoring incentive. Loan sales provide an alternative tool for credit risk transfer. Gorton and Pennacchi (1995), for example, focus on the moral hazard problem after loan sales. They conclude that banks can overcome the moral hazard problem by continuing to hold on to a fraction of the loan, and hence, have “skin
in the game. Parlour and Plantin (2008) emphasize the impact of a liquid loan sale market on a bank’s ex-ante incentive to monitor the debtor firm. They provide conditions under which a liquid credit risk transfer market can be socially inefficient. Parlour and Winton (2013) focus on a bank’s decision to lay off credit risk through loan sales versus CDS protection. They explicitly present efficiency implications in terms of risk transfer and monitoring, and suggest that CDS, as a risk transfer mechanism, are overall more likely to undermine the monitoring of banks. Beyhaghi and Massoud (2012) find that banks are more likely to hedge with CDS when monitoring costs are high.

In contrast to the largely negative effects documented above, Norden et al. (2014) argue that banks benefit from improved risk management enabled through CDS, and that these benefits are passed on to borrowers. They investigate whether, and through which channel, the active use of credit derivatives changes bank behavior in the credit market. Their principal finding is that banks with larger gross positions in credit derivatives charge significantly lower corporate loan spreads, while banks net positions are not consistently related to loan pricing. They also find that the magnitude of the risk management effect remained unchanged during the crisis period of 2007-2009, when banks with larger gross positions in credit derivatives cut their lending by less than other banks during the crisis, and had consistently lower loan charge-offs.

In Section 5 we discussed how CDS may create “empty creditors.” Furthermore, CDS can also affect banks’ lending behavior, including the amount, cost and contract terms of their credit supply. Although CDS provide creditors an avenue to protect their loan exposures, the unintended consequence is that creditors may become excessively tough and borrowers may be concerned. Such forces may have an ex-ante perverse effect on debt contracting such as covenants which enhance future creditor control. Shan, Tang and Winton (2014) find that debt covenants are less strict if there are CDS contracts referencing the borrower’s debt at the time of loan initiation. This finding remains robust after taking into account the selection of CDS trading. The loosening of covenants is more pronounced when the lenders are active CDS users, and for borrowers with higher credit quality. Their findings are consistent with the view that CDS substitute covenants for creditor protection. Hence, credit derivatives represent outside options that affect financial contracting, which could have positive welfare consequences.
6.2 Other Financial Institutions

In addition to financial intermediaries such as commercial and investment banks, and insurance companies, shadow banks such as hedge funds, and mutual funds are also active users of CDS and influential players of the CDS market. In fact, the current market trends suggest that hedge funds are becoming increasingly important players in the CDS market. An example of the increasing influence of hedge funds in the CDS market is that they are even represented on ISDA Credit Derivatives Determinations Committees.

Since CDS are insurance-like contracts, it is only natural that insurance companies are natural market facilitators and participants in this market. It should be pointed out that financial intermediaries have been sellers of CDS protection from the early days of this product. Indeed, in the early years of the CDS market, insurance companies tended to sell naked credit protection, and were severely affected during the global financial crisis. However, after the crisis, insurance companies appear to be net buyers of protection, as they use CDS to hedge their bond portfolio holdings. It could be argued that banks have become even more “too big to fail” and are net sellers, rather than buyers, of CDS protection. Hedge funds are on both sides of the market, depending on their portfolios and their market views.

Besides regulatory capital relief and hedging opportunities, relaxing collateral constraints can be another motivation for institutional investors to participate in the CDS market (as argued by Shen et al. (2014)). This motive is particularly strong for shadow banks such as hedge funds. The model in the Shen et al. (2014) paper analyzes the banks’ choice between buying bonds, making loans, and selling CDS. Similarly, Oehmke and Zawadowski (2014b) also argue that CDS provide an alternative trading avenue for institutional investors.

The evidence in Yu (2006) and Longstaff and Yu (2007) suggests that hedge funds can use CDS to conduct capital structure arbitrage and earn abnormal risk-adjusted returns. One vivid anecdotal example of this evidence is the activity of the the Paulson Hedge Fund during the subprime mortgage crisis, as is illustrated by Lewis (2011) and Zuckerman (2010). They dubb the Paulson CDS trades as, respectively, the big short” and the “biggest trade ever”. Despite this evidence, the growing literature on the CDS-bond basis, especially during crisis period, also suggests that hedge funds

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engaging in capital structure arbitrage activities are vulnerable to large losses. (See for example the discussion on “arbitrage crash” related to CDS-bond basis trades in Mitchell and Pulvino (2012)). Some anecdotes include the in-house hedge funds at Deutsche Bank and Merrill Lynch, and the once famous Boaz Weinstein, which lost $2 billion in 2008. After the credit crisis, hedge funds partially retreated from the CDS market, despite an initial active participation and the popularity of capital structure arbitrage since 2002. One reason, although speculative, may be that CDS have become less attractive to hedge funds, especially bond mutual funds, as CDS are often fully collateralized, which removes the leverage embedded in CDS contracts. CDS, as a synthetic way of trading cash bonds, also face potentially higher volatility and clearing requirements. In addition, there are legal uncertainties as to whether a particular event or risk will be deemed to be a credit event, and covered by the CDS contract.

Hilscher et al. (2014) provide evidence that equity returns lead CDS returns at daily and weekly frequencies. Kapadia and Pu (2012) also show that CDS trading can be innocuous, as CDS spreads and stock prices often move independently (possibly due to limits of arbitrage). The above evidence casts doubt on the pervasiveness of insider trading in the CDS market and the effectiveness of CDS as trading opportunities for hedge funds.

Insurance companies, in particular AIG, were a major players in the CDS market, and were arguably the driving force behind its explosive growth, in the pre-crisis years. AIG provided insurance to the famous JPMorgan synthetic CDO “Bistro” deal via selling insurance on the “super senior” tranche of the deal in early 1998 (“Bistro” was marketed at the very end of 1997). Joe Cassano, then an executive at AIG Financial Products, called this transaction a “watershed” event that forever changed the insurance business and the credit derivatives market. Since then, AIG FP and other insurance companies sold many more CDS contracts. In 2007, AIG had outstanding short CDS positions valued at $546 billion.

One reason for the success of bank-insurance companies involved in CDS transaction is their ability to conduct regulatory arbitrage. Banks can buy CDS from insurance companies for regulatory capital relief. However, insurance companies are not subject to banking regulations. Moreover, although the insurance industry has its own regulatory capital requirements, insurance regulatory authorities regulated CDS significantly less stringently than traditional insurance products. For
example, the State of New York in 2004 amended its insurance laws and specifically excluded CDS from their coverage. The alleged logic is that insurance is meant to protect consumers, while the CDS market is comprised entirely of institutional investors. Thus, there is no consumer interest in need of protection. Many other states followed New York and insurance companies did not need to hold capital when they sold CDS protection.

The Office of Thrift Supervision (OTS), a relatively weak bank regulator, nominally had responsibility for AIG’s non-insurance financial operations, because AIG owned a small thrift. But the OTS had no way of regulating a sophisticated operation like AIG. Moreover, AIG could choose which regulator to work with depending on its own advantage. Irrespective of the regulatory oversight, CDS are still subject to ISDA Master Agreements and the insurance companies need to honor their contractual obligations to their counterparties. Some allege that Goldman Sachs required AIG to post a large amount of collateral for the CDS that AIG had sold to Goldman Sachs. AIG was not able to provide the collateral with the time specified. Eventually, AIG had to be bailed out by the U.S. Government in September 2008. In June 2012, AIG remained the largest investment of the Troubled Asset Relief Program. Sjostrom (2009), Boyd (2011) and Greenberg (2013) discuss the AIG bailout. They highlight that AIG’s collapse was largely caused by its $526 billion short CDS positions sold through AIG Financial Products. Around $379 billion of its 2007 short CDS positions were used by banks for regulatory capital relief, “a perfectly legal ploy that allowed banks to free up money to make more loans,” as Cassano mentioned to the FDIC when he explained AIG’s procedure in selling CDS.

The lawsuit SEC vs. Goldman Sachs on the Abacus 2007-AC1 CDO involving the Paulson Fund and Royal Bank of Scotland (Fraser (2014) explains the RBS downfall) also illustrates the interactions between banks and insurance companies (in this case ACA). Goldman paid $550 million to settle the case. Another interesting case is the Amherst hedge fund’s canny trade against JPMorgan, Bank of America etc., reported in 2009. Amherst sold sufficient CDS to be able to use some of the premiums to pay off the failing loans, effectively preventing the credit events from being triggered.

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Overall, there are many disputes between insurance companies, banks, and hedge funds involving CDS transactions, even though at the time of signing the contract, both sides believed that they were taking advantage of the other side. For example, the hedge fund Paramax sold $1.31 billion CDS protection to UBS in May 2007, after it was approached in February 2007, even though Paramax only had $200 million of capital. Paramax started receiving margin calls from UBS in July 2007, and by November, Paramax had depleted its capital, although it hadn’t yet satisfied all of UBS’s claims. UBS filed a lawsuit against Paramax in December 2007 for breaching contractual agreements. In May 2009, MBIA alleged that Merrill Lynch attempted to offload $5.7 billion in deteriorating U.S. subprime mortgages and other collateral from its books by packaging them as CDOs or hedging their exposure through swap agreements with insurers. The swap contracts between MBIA and Merrill were written between September 2006 and March 2007. In a counter-suit, Merrill Lynch alleged that Financial Guaranty SCA subsidiary XL Capital Assurance Inc (XLCA) would be attempting to avoid obligations of up to $3.1 billion in CDS positions.

Fung et al. (2012) examine the effects of CDS usage on the risk profile and performance of Life and Property/Casualty (PC) insurance companies. Using a transactions data set of insurers for the period 2001-2009, they find consistent evidence that the utilization of CDS for income generation purposes is associated with greater market risk, deterioration of financial performance, and lower firm value, for both Life and Property/Casualty insurers.

Unlike insurance companies and commercial banks, mutual fund penetration into CDS market is gradual. However, they increasingly use CDS to either hedge their credit risk exposures or to synthetically take on credit risk exposures. In particular, bond funds recently became active in the CDS market. Adam and Guettler (2014) examine bond funds and find no performance differences between CDS users and CDS non-users in general. However, funds that were net short CDS during the crisis suffered from severe underperformance. Team-managed funds exhibited poor market-timing abilities using CDS. They were, on average, net long before the crisis and net short during the crisis. As a result, team-managed funds underperformed funds managed by a single manager.

Overall, the evidence shows that financial institutions use CDS strategically, consistent with the

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85Cite the news article on PIMCO’s use of CDS.
discussions in [Bolton and Oehmke (2013)]. Moreover, underperforming institutions have stronger incentive to use CDS. CDS usage is more of risk-taking than risk management. We note that there is a need for more research in this area as, so far, we know little about how hedge funds exactly use CDS.

7 Sovereign CDS

Sovereign CDS moved into the spotlight of financial markets during the European sovereign debt crisis when speculators were blamed for artificially increasing sovereign borrowing costs by buying *naked* credit insurance against a contingent government default. This led to a temporary ban on naked sovereign CDS positions by the German financial regulator Bundesanstalt fuer Finanzdienstleistungsaufsicht (BaFin) in May 2010, and to a permanent ban by the European Union in November 2012. While the major development of the credit insurance market for government debt occurred only at the beginning of the twenty-first century, [Tett (2009)] provides anecdotal evidence of early sovereign CDS trading in 1994 when J.P. Morgan and Citibank asset management traded the credit risk of Belgian, Italian and Swedish government bonds.

From a high level perspective, sovereign CDS are very similar to corporate CDS. There are some important differences between the two types of credit derivative contracts, which we discuss in subsection 7.1. In subsection 7.2 we highlight the only three auction-settled sovereign CDS credit events: those of Ecuador, Greece and Argentina. We also provide a brief description of the evolution and growth of the sovereign CDS market and its key characteristics in subsection 7.3. In subsection 7.4 we review the literature on the determinants of sovereign CDS, followed by a review of the emerging literature on spillovers and contagion in subsection 7.5. We discuss the relationship between sovereign CDS and sovereign bonds and review the evidence about frictions in this arbitrage mechanism in subsection 7.6. Part of this chapter on sovereign CDS builds on the survey of the empirical literature on sovereign CDS in [Augustin (2014)], which provides more detail and discussion on recent research in this area.
7.1 Major Differences from Corporate CDS

One of the fundamental differences between corporate and sovereign CDS contracts relates to the nature of credit events that trigger a contingent default insurance payment. Whereas standard corporate credit events are bankruptcy, failure to pay, and, if covered, restructuring, bankruptcy is typically replaced with repudiation/moratorium for sovereign reference entities. Broadly, this occurs if the reference entity repudiates one or more relevant obligation(s) or declares a moratorium in respect of one or more relevant obligation(s) in excess of an agreed default requirement. Moreover, while European corporate CDS typically trade under the MMR clause, and North American corporate CDS under the XR clause since the Big Bang Protocol, sovereign reference entities typically trade with (FR). This means that there is no maturity limitation on deliverable obligations beyond the usual 30 years in the event of a restructuring credit event.

A second difference relative to corporate CDS is that for sovereign reference entities, trading is less concentrated in the 5-year contract. The total volume of gross notional amount outstanding with maturities above one and up to five years, was $18.25 trillion in 2012, representing a market share of 67.76%. Pan and Singleton (2008) and Packer and Suthiphongchat (2003), in contrast, reproduced BIS statistics to document that the 3- and 10-year contracts each accounted for roughly 20% of the volumes in sovereign markets, and the 1-year contract accounted for an additional 10% of the trading.

Another detail of CDS contracts that is relatively more important for sovereign reference entities is the currency denomination of the contract. The reason is that there is a high risk of currency depreciation, or even re-denomination, by the sovereign in the event of default. For example, were the United States to default, an insurance payout in USD would likely be much less attractive than a payout denominated in EUR. This risk also seems to be priced into credit insurance agreements as price quotes on the same underlying sovereign government differ across currency denominations. Market participants can even trade these differences directly in so-called quanto swaps, which provide protection against a credit event and currency depreciation at the same time. We believe that the information embedded in sovereign quanto swaps is a fit topic for more detailed future

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86 As previously mentioned, other corporate credit events include obligation default and obligation acceleration.

87 While this currency risk also affects the corporate CDS contracts on firms domiciled in the country in question, in this case the United States, it is likely to be more severe in the case of sovereign CDS.
research.

Last, sovereign CDS are special as they can be used as a proxy hedge to offset a portfolio’s country exposure. The use of such proxy hedges is particularly critical in the context of the permanent ban on naked CDS positions implemented by the European Union in November 2012. However, the regulation specifically permits the purchase of uncovered CDS contracts if it is meant to hedge a portfolio of assets whose value had a historical correlation of at least 70% with the government bond price over 12 months (or more) prior to the CDS purchase.

7.2 Default Events: Ecuador, Greece and Argentina

There have been multiple sovereign defaults over the last two decades, ranging from Russia in 1998 to Argentina in 2014.\textsuperscript{88} However, we are aware of only three default events that effectively triggered a sovereign CDS credit event and that were subsequently auction-settled: Ecuador in 2008, Greece in 2012 and Argentina in 2014.\textsuperscript{89} Whether CDS payouts were bilaterally settled in other default events is publicly unknown. But several industry reports, such as Morgan-Stanley (2011), provide opinion pieces about whether such defaults should have triggered a CDS payout or not. We are personally aware of at least one legal settlement in relation to the 1998 Russian default, which involved a dispute, between Lehman Brothers International Europe and Morgan Guaranty Trust Company, contesting the payout on a CDS transaction negotiated in 1997.

As usual, the devil lies in the details and legal contract clauses matter in the definition of the credit event, and consequently the pricing of the CDS contract. Issues to be considered include whether the default references foreign currency or local currency denominated debt, and whether the default occurred on publicly traded debt or inter-government liabilities. In general, sovereign CDS are written on foreign currency denominated debt, and as such, a missed payment on local outstanding debt would not necessarily represent a valid credit event. One interesting case is that of the aforementioned Russian default of 1998, in which part of the dispute related to the type of


\textsuperscript{89}The details of all CDS auction settlements, both corporate and sovereign, since 2005 are available at http://www.creditfixings.com/CreditEventAuctions/fixings.jsp.
debts where the default occurred, domestic versus foreign, publicly traded versus inter-government debt. Another interesting case in this context is Kazakhstan. According to anecdotal evidence, a hedge fund manager was allegedly asked to sell one-year CDS protection on Kazakhstan at a time when the country had no foreign currency debt outstanding. Even though issuance-to-default within one year is extremely unlikely, the trader did not sell the CDS because he worried that the country could potentially inherit foreign denominated debt through bank nationalization, which would significantly increase its default risk. This actually occurred. On the other hand, the country could repudiate the bank debt, instead imposing risk on the CDS of the banks, as in the case of the Dutch bank SNS Reaal.

Another important aspect is that a restructuring credit event should in principle be binding on all bondholders. Thus, it matters whether sovereign debt restructuring is voluntary or forced upon the creditors. Such issues introduce uncertainty to the contingent CDS payout, which has become particularly relevant since the introduction of collective action clauses (CACs) into contracts of sovereign bond issues. This subject became heavily publicized during the Greek default in 2012, when the existence of a CAC was ultimately responsible for triggering a credit event, as more than the required 66.7% of all bondholders agreed to a voluntary debt restructuring. This activated the CAC and coerced the remaining private holders of Greek bonds to exchange their securities for new bonds with a lower face value and longer maturities. In any case, the final judgment about a credit event was to be made by the ISDA Credit Derivatives Determinations Committee (DC), which played a key role in this arbitration process. Verdier (2004) provides a legal treatment of how credit derivatives may affect the sovereign debt restructuring process. Also, Wright (2011) discusses potential problems with the role of credit default swaps in discouraging creditor participation in voluntary exchange offers.

Payments on Ecuador’s CDS were triggered when President Rafael Correa refused to meet an interest payment due on December 15, 2008 on the country’s 2012 global bond. At the same time, Correa also declared a default on all of Ecuador’s $3.8 billion global bond debt, citing a government ruling that the bonds were hitherto contracted illegally. Following this, Ecuador’s government did not make a $30.6 million interest payment within the 30 day grace period that started after the

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90 See also http://www.ft.com/intl/cms/s/0/61533508-722f-11de-ba94-00144feabdc0.html#axzz2wRqJoClX.
country failed to make its payment for the original due date, which was November 15, 2008. Ecuador, which also defaulted in 1999, owed approximately $10 billion to bondholders, multilateral lenders and other countries. Ecuador’s CDS auction, which was the first publicly known sovereign CDS auction, was completed on January 14, 2009, and CDS sellers were required to pay buyers 68.625 cents per dollar of debt, based on the recovery price set at the auction.

The second publicly known sovereign CDS auction is the one triggered by the default of the Hellenic Republic (Greece). The auction was held on March 19, 2012 and the final recovery price for the CDS settlement determined by the auction was 21.5 cents on the dollar. The gross and net notional CDS amounts outstanding for contracts written on the Hellenic Republic during Greece’s default episode were of the order of magnitude of, $72 billion and $3 billion, respectively. The Greek default event is noteworthy as it highlighted the legal uncertainty surrounding the triggering of sovereign credit events. As is discussed in Salomao (2013), the EMEA DC met twice in 2012 to vote on whether or not the Greek debt restructuring process and the subordination of existing debt by new debt issued to the European Central Bank (ECB) constituted a credit event. In their first meeting on March 1, the Committee ruled against calling a credit event, arguing that both the subordination of private Greek bond holders to the ECB and the restructuring reflected a voluntary renegotiation. In their second meeting on March 9, however, the Committee ruled that the exchange offer for existing Greek debt constituted a credit event as the activation of the CAC coerced the 14.2% of private holders who did not accept the exchange offer to accept the debt restructuring. Salomao (2013) formally includes this legal uncertainty about CDS payouts into a model of endogenous sovereign default.

A key precedent for future sovereign distress episodes was recently set by the ruling of a U.S. federal judge that Argentina was legally required to pay all outstanding creditors from the 2001 default before it could repay any other creditors. While, in 2001, most investors agreed to a substantial haircut and accepted restructured bonds, a minority of creditors did not agree to the newly proposed terms. A part of this debt has been purchased over the years by a consortium of hedge funds, which, under the lead of Elliott Management Corporation, has persistently been trying to sue Argentina in U.S. courts. The ruling marks a milestone in longstanding disputes between

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91See the statistics from DTCC reported in Augustin (2014).
the Argentine government and the plaintiffs, commonly referred to as “vulture funds.” The failure by Argentina to respect the ruling has led to missed interest payments and a de facto default. The formal auction, which was held on September 3, 2014, yielded a recovery rate of 39.5%.

While we are not aware of any other sovereign defaults that have triggered a sovereign CDS payout, it may be useful to allude to potential future CDS payouts that could be triggered in case of technical default. For example, the spikes in CDS trading volumes traded on US Treasury debt during the US government lock-out periods in summer 2011, and again in late 2013, suggest that a credit event could have been triggered if the US had failed to meet its debt obligations on time, despite its creditworthiness. Significant legal uncertainty also arises about the evolution of CDS spreads in the case of sovereign split ups, as was recently demonstrated by the discussions around the UK CDS contract in light of the Scottish independence vote.\(^\text{92}\)

### 7.3 The Market for Sovereign Credit Default Swaps

In this subsection, we first review the market size and structure of the sovereign CDS market. We then discuss the type of participants, followed by an overview of trading patterns in the market.

#### 7.3.1 Market Size

As mentioned earlier, the overall market for credit derivatives exploded from roughly $6 trillion in 2004 to a peak of $58 trillion in the second term of 2007, and dropped subsequently to $24 trillion, in gross notional amount outstanding, in June 2013.\(^\text{93}\) Of these, the notional amounts outstanding for sovereign credit derivatives, which are reproduced in Panel A of Table 1, represent with $3.43 trillion in 2013 approximately 13% of the overall market for OTC credit derivatives. While a large fraction of corporate CDS trading is in multi-name instruments (roughly 42% of the market in 2012), sovereign CDS trading is largely concentrated in single-name products, which, at $3.24 trillion in gross notional amount outstanding, account for a substantial fraction (96%) of the

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\(^\text{93}\)The Bank for International Settlements (BIS) publishes semi-annual reports on the notional amounts outstanding and gross market values of OTC derivatives and statistics, and are available for CDS since 2004. The notional amounts are likely to slightly underestimate the total value of the market, as until the end of 2011, only 11 countries, including those with major markets, are reporting their OTC derivative statistics to the BIS: Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States. From December 2011, Australia and Spain also contributed to the semiannual survey, bringing to 13 the number of reporting countries. Source: www.bis.org.
total CDS market in June 2013. Notional amounts outstanding provide a measure of market size and a reference from which contractual payments are determined in derivatives markets. Gross market values, on the other hand, reflect the sum of all market values in a current gain or loss position. This latter figure provides a more accurate measure of the scale of financial risk transfer taking place in derivatives markets. If we make the simplifying assumption that the fraction of gross credit exposure to total notional amount traded is the same for sovereign reference entities as for the overall market, then gross market value of all outstanding contracts is approximately $97 billion in June 2013, while the total net exposure reduces to roughly $20.2 billion.  

### 7.3.2 Market Participants

OTC markets lack transparency, which makes it challenging to infer the ultimate risk holder in the large network of bilateral risk exposures. Hedge funds, in particular, are often blamed during sovereign crises for artificially increasing public borrowing costs by taking one-sided speculative bets on governments’ default. Doubts regarding such claims are justified by looking at a snapshot of the counterparties involved in sovereign CDS trading in Panel B of Table I. First, these statistics suggest that reporting dealers make up the bulk of the market, with a gross notional amount outstanding of approximately $2.33 trillion in June 2013, which corresponds to a market share of 75.03%. Second in line are banks and security firms with a gross notional amount outstanding of $374 billion or a market share of 12.07%. The fact that hedge funds, with a gross notional amount outstanding of $116 billion, represent a much smaller fraction (3.74%) of the market, suggests that sovereign CDS are used primarily for hedging purposes. Nevertheless, we emphasize that dealer positions increased by more than 76% from 2010 to 2012, which may reflect arbitrage opportunities linked to the European sovereign debt crisis, whereas banks and security firms reduced their exposure from $828 billion to $378 billion over the same time period.

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94BIS defines gross market value as the sum of the absolute values of all open contracts with either positive or negative replacement values evaluated at market prices prevailing on the reporting date. Gross market values are not reported in the BIS document, but are available on the BIS web site.

95Related evidence that banks are primarily net buyers of (corporate) CDS, overall, while insurance companies and funds are mainly net sellers, is provided by Bongaerts et al. (2011).
7.3.3 Trading in the Sovereign CDS Market

Another useful source of information on CDS trading patterns is the Depository Trust and Clearing Corporation (DTCC), which, through its Trade Information Warehouse, started publishing detailed weekly reports on stocks and flows in CDS trading in October 2008. In addition to aggregate positions, DTCC reports current and historical positions for the 1,000 most traded reference contracts. The average gross and net notional amounts outstanding in (million) dollar equivalents on all sovereign CDS contracts (excluding sovereign states in the US) among the 1,000 mostly traded contracts over the time period 31 October 2008 through 12 April 2013 are reported in Table 2. In addition, the table provides information on the average number of contracts, the ratios of gross to net notional amount outstanding, and the net notional amount outstanding to the number of contracts. The countries are classified into five geographical regions following the practice of Markit: Americas, Asia Ex-Japan, Australia and New Zealand, Europe-Middle East-Africa (EMEA) and Japan. The sum of the cross-sectional averages in gross notional amounts recorded for sovereigns in the data repository is approximately $2.3 trillion. The net economic exposure, which accounts for offsetting effects between buyers and sellers of $213.5 billion, represents about 9.23% of that amount. This represents approximately 81% of the sovereign single name CDS outstanding as reported by BIS in the first semester of 2012, or 75% of the amount reported in 2013 (see Table 1).

96 During the first five years that DTCC has been reporting this information, the countries with the highest average net notional amounts outstanding include Italy ($22.5 billion), Germany ($15.1 billion), France ($15.0 billion), Brazil ($14.8 billion) and Spain ($14.5 billion). The total number of traded contracts, over all country-specific averages, is 165,089 and the average ratio across countries of gross to net notional amount outstanding is 11.70. Column (7) further shows that the net credit exposure per contract is $1.8 million, on average, but there is a significant amount of cross-sectional dispersion. Interestingly, emerging market economies tend to trade with a smaller net exposure per contract, while developed economies have fewer contracts outstanding with larger net exposure per contract. The US and Germany, the world’s two biggest reference bond markets, lead the list with,

96 We note that this number does not report the values for US states and other non-government supranational bodies.
97 The ratio of gross to net exposure has remained stable and in the ballpark of 11 over time.
respectively, $5.42 and $6.34 million per contract. At the bottom of the list are the Philippines and Ukraine with an average of $390,000 and $380,000 per traded contract, respectively.

The gross amount of public debt (in billions of $) and the debt-to-GDP ratios for each country in 2012 are reported in columns 8 and 9 of Table 2. Unreported calculations highlight that the net economic exposure of traded insurance contracts relative to public debt is, for many countries, below 2%, with an average and median value of, 2.2% and 1.3%, respectively. The statistics are heavily skewed, in particular, by Estonia and Bulgaria, which have values of 23.3% and 11.4%, respectively. While Duffie (April 29 2010a, 2010b) provides empirical evidence based on the DTCC statistics that the amount of CDS outstanding is unrelated to the level of spreads, Augustin (2014) highlights a statistically significant relationship between the net notional amount of CDS outstanding and the gross amount of government debt and the level of GDP. However, the relationship appears much weaker if debt levels are compared against gross amounts outstanding and the number of contracts outstanding. So far, three empirical studies have explicitly analyzed this database for corporate and sovereign reference entities respectively. Berg and Streitz (2012) analyze the data on sovereign reference entities for 57 countries over the sample period October 2008 to July 2010. They show that higher ratios of net notional amounts outstanding normalized by total debt (size) are associated with smaller countries, and for countries with a credit rating, just above the investment grade cut-off, while larger countries and those with a speculative grade rating are associated with higher levels of turnover, normalized by net notional amounts outstanding. In addition, only negative rating changes and negative rating watches are associated with increases in turnover, but not with size.

In order to complete the picture about trading patterns in the sovereign CDS market, it may be useful to report the results from earlier studies and reports that summarize information from various dealer and broker sources. In a Federal Reserve Bank of New York staff report, Chen et al. (2011) document a three-month sample from May 1, to July 31, 2010 including 29,146 single

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98 The debt-to-GDP ratios are obtained from the World Economic Outlook Database.
99 Duffie (April 29 2010a) illustrates this evidence in his testimony to the United House of Representatives.
100 As discussed in section 2, Oehmke and Zawadowski (2014a) study the determinants of corporate trading, while Peltonen et al. (2014) use the data to analyze the network structure between financial and sovereign entities. Oehmke and Zawadowski (2014a) find that higher amounts of (corporate) CDS outstanding are associated with investment-grade companies that have more assets, more bonds outstanding, or that have recently lost their investment-grade status, and that have higher analysts’ forecast dispersion.
name sovereign CDS transactions recorded for 74 reference entities. This snapshot, which reflects a period of low trading activity compared to historical averages, suggests that the most actively traded reference entities traded, on average, 30 times per day, the less frequently traded 15 times per day, on average, and the infrequently traded reference entities traded only twice per day, on average. The dollar denominated trades were mostly traded in $5 million ticket sizes, with a median and mean trade of $10 million and $16.74 million respectively, while the highest frequency for euro denominated trades (which amounted to only 574 transactions) was a trade size of $10 million, with a median and mean trade size of $5 million and $12.53 million respectively. One of the surprising conclusions from this staff report is that the market concentration is low, as the authors report a Herfindahl-Hirshman concentration index, based on the regulatory definitions of the Department of Justice, ranging between 885 and 965. In contrast, anecdotal evidence suggests that the market is rather concentrated, which is also emphasized by Giglio (2011), who, based on industry reports, states that in 2006, the top 10 counterparties (all broker/dealers) accounted for about 89% of the total protection sold. In connection with the transition to Swap Execution Facilities (SEFs), it may be interesting that the market is confirmed to be already highly standardized, as 92% of all single-name CDS contracts within the sample had a fixed coupon and 97% had fixed quarterly payment dates. Finally, market participation seem to have been active during this three-month period, as 50 market participants, on average, are reported to have traded at least once a day, 200 traded at least once a week, and 340 traded at least once a month. Among these investors, dealers were more likely to be sellers of protection and the four most active dealers were involved in 45% of the buying and selling of all CDS trades and in 50% of the overall notional amount.

Earlier evidence using transactions and quote data from CreditTrade on 77 sovereign reference entities from January 1997 to June 2003 is provided by Packer and Suthiphongchai (2003). The authors emphasize that there was a low trading volume in this early period of sovereign CDS trading by indicating that, in 2002, only 6% of all quotes resulted in transactions, with a strong concentration in a few reference entities. More than 40% of all quotes were accounted for by 5 countries: Brazil, Mexico, Japan, the Philippines and South Africa. This evidence was complemented in a study by Lei and Ap Gwilym (2007), who provided descriptive statistics on the characteristics of sovereign single name CDS trades were on average twice as large as their corporate counterparts.
and evolution of credit default swap trading for a sample of American (North America and Latin America) quotes and trades, of which roughly 12% correspond to sovereign reference entities (the majority of which (85.2%) comes from Brazil, Mexico, Columbia and Venezuela). Overall, their statistics suggest that the market has become more liquid over time with decreasing quote-to-trade ratios, and a shift in the most commonly traded/quoted notional amounts from $10 to $5 million (possibly due to the development of the CDS index market).

7.4 Determinants of Sovereign CDS spreads

The search for the empirical determinants of corporate credit risk has occupied industry professionals and academics ever since Merton (1974) published a structural model for the pricing of risky debt in a contingent-claims framework. For sovereigns, however, this issue is further complicated since a government can strategically default at its own discretion. Therefore, even if we could clearly identify asset volatility and leverage for a sovereign government, it is not clear whether these theoretically predicted determinants of corporate credit risk would be binding government constraints. The emergence of actively traded sovereign CDS contracts has allowed researchers to obtain high-frequency data that are less plagued (than publicly traded sovereign bonds) by legal and contractual differences in order to address this question.

Another feature that complicates the modeling of sovereign credit risk is the strong factor structure observed in sovereign CDS spreads, and their changes, in particular, at higher trading frequencies. While intuitively one would expect the fluctuations in sovereign spreads to be driven by country-specific fundamentals, there is abundant evidence that a major fraction of the variation in sovereign CDS spreads is determined by global variables unrelated to a country’s economy. Such global risk factors are most commonly associated with the United States. However, the European sovereign debt crisis has revived the attention paid to domestic risk factors by highlighting a strong

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102 The data is provided by CreditTrade and the sample period goes from June 10, 1997 to March 3, 2005. The dominating currency denomination is US dollars for 99% of the contracts. 98.32% of the sample references senior unsecured debt and 90.36% of the sample uses the MR clause. (Note that this was prior to the Big Bang protocol in 2009.) Five-year maturities are the most heavily quoted (83%). In addition, the average number of reference entities quoted/traded has steadily increased over time, with an average number of 56 per day in 2005. Also note that in every year, the minimum amount of reference entities traded/quoted was 1 (except 2005, when it was 4). The ratio of quotes to trades is substantial, but decreasing over time. Finally, the total number of quotes and trades exhibits an inverse U-shape pattern during the week, peaking on Wednesdays.

103 Ericsson et al. (2009) uses corporate CDS data to validate the role of theoretical variables suggested by structural credit risk models.
link between the financial health of governments and that of their financial institutions. Correctly identifying the risk factors underlying the variation in sovereign yield spreads is important as it provides insights into the usefulness of political intervention to bring down public borrowing costs and the diversification benefits implied by dynamic asset allocation. It also provides inputs to risk management models and influences financial hedging decisions.

7.4.1 Global Risk Factors

There are two reasons why researchers have treasure-hunted for sources of global risk: Sovereign CDS spreads tend to co-move significantly over time and they “jump” together in event of global events that ought to affect risk premia. The co-movement suggests that a strong factor structure is present, which is confirmed, among others, in Pan and Singleton (2008) and Augustin and Tédongap (2014) at the daily frequency, and in Longstaff et al. (2010) and Augustin (2013) at the monthly frequency. The first common component is typically able to explain between 78% and 96% of the variation in spread changes at the daily level, and between 57% and 64% at the monthly frequency. This factor structure is much stronger compared with what we know from international equity markets.

Striking evidence on the role of global financial risk factors is given by Longstaff et al. (2010). Using 5-year CDS of 26 countries from October 2000 to January 2010, the authors show that, not only spread changes, but also the expected loss component in spreads is relatively better explained by U.S. equity, volatility, and bond market risk premia than by variables related to the local economy. This work builds on a theoretical CDS pricing model developed in Pan and Singleton (2008), who show that risk premia of Korea, Mexico and Turkey co-move strongly over time and are cyclically related to the CBOE VIX option volatility index, the spread between the 10-year return on US BB-rated industrial corporate bonds and the 6-month US Treasury bill rate, and the volatility in the own-currency options market. Ang and Longstaff (2013) compare sovereign

104 The most telling case was Ireland, which guaranteed the debt of its banks. The feedback loop between the credit risk of banks and sovereigns is analyzed by Acharya et al. (2013).

105 In fact, one of the main contributions of Pan and Singleton (2008) is to show that the term structure of CDS spreads contains identifying information for disentangling the default and loss processes if recovery rates are defined as a function of face value. Their results suggest that the common practice of setting a constant recovery rate of 25% for sovereign reference entities works well for medium sample sizes. The importance of accounting for stochastic recovery rates in the pricing of CDS spreads, especially for sovereign reference entities, is emphasized in Bilal and
CDS spreads on US states to those of EU countries and decompose spreads into a common systemic and country-specific non-systemic component. The authors conclude that systemic risk originates in financial markets rather than in macroeconomic fundamentals. This conclusion rests on the argument that the US is economically more integrated than the European Union, but that the systemic risk component is larger for the EU countries. Moreover, systemic appears to be correlated with financial market variables.

Contrasting the empirical evidence on US financial risk, Augustin and Tédongap (2014) show that expected consumption growth and macroeconomic uncertainty in the United States are strongly associated with the first two principal components extracted from the entire term structure of yield spreads of 38 countries. These results are robust to the influence of global financial market variables such as the CBOE volatility index, the variance risk premium, the U.S. excess equity return, the price-earnings ratio as well as the high-yield and investment-grade bond spreads.

Additional evidence regarding the influence of the economic factors in the United States on global sovereign CDS premia is provided by Dooley and Hutchison (2009), who show that both positive and negative real and financial news during the 2007-2009 subprime crisis channeled through to a sample of 14 geographically dispersed countries. In particular the Lehman bankruptcy and the expansion of Federal Reserve swap lines with the central banks of industrial and emerging countries uniformly moved all country spreads. After the Lehman event, developed economies also seem to have become more integrated with the United States according to Wang and Moore (2012), who study the dynamic correlations between the sovereign CDS spreads of 38 emerging and developed economies with the U.S. from January 2007 to December 2009. This tighter link with the U.S. seems to be driven mainly by the U.S. interest rate channel.

A different explanation for the co-movement in sovereign spreads is given by Benzoni et al. Singh (2012). Related is also the study of Zhang (2008), who develops a CDS pricing model to infer differences in expectations about recovery rates and default probabilities with an application to Argentina. In this case study, risk-adjusted and historical default probabilities are associated with changes in the business cycle, both the U.S. and Argentine credit conditions, as well as the overall local economy.

Augustin and Tédongap (2014) rationalize these findings in a recursive preference-based model with long-run risk that embeds a reduced-form default process. The process is animated by global long-run expectations of future consumption growth and macroeconomic uncertainty, and matches higher order moments of spreads in the term structure, and in the cross-section, across rating categories.

On October 13, 2008, the Fed removed its USD swap limits to industrial countries, and on October 29, 2008, the FOMC established swap lines with the central banks of Brazil, Mexico, Korea and Singapore for up to $30 billion each.
who suggest that after negative country-specific shocks, agents update their beliefs about the default probabilities of all countries, which, in turn, generates correlations in credit spreads that are significantly higher than if spreads were functions of the macroeconomic conditions alone.\footnote{Benzoni et al., 2012} Another plausible channel for the strong co-movement is suggested by Anton et al., 2013, who show that commonality in dealer quotes for sovereign CDS spreads is a powerful predictor of cross-sectional CDS return correlations. Given the strong concentration of CDS trading among US dealers, this commonality would also explain the tight relationship with U.S. risk factors.

### 7.4.2 Local Financial Risk Factors - The Sovereign-Bank Nexus

The European sovereign debt crisis that followed multiple bank bailouts during the global financial crisis has motivated new research on the relationship between sovereign and domestic financial risk. Acharya et al., 2013, for example, illustrate how the financial strain of excessive debt burden from public bank bailouts may feed back into the financial sector by diluting the value of bank bailout guarantees and by causing collateral damage to their sovereign bond holdings. While the authors emphasize how the two-way feedback effect between sovereign and financial risk leads to a co-movement in CDS spreads of sovereign countries and their financial companies, Dieckmann and Plank, 2011 underscore the unilateral private-to-public risk transfer through which market participants incorporate their expectations about financial industry bailouts. Their results suggest that both the state of a country’s financial system and of the world financial system explain sovereign CDS spreads, but the magnitude of the relationship depends on the importance of a country’s financial system pre-crisis and is stronger for member countries of the Economic and Monetary Union. Evidence of a private-to-public risk transfer is also documented by Ejsing and Lemke, 2011, who show that financial bailouts decreased banks’ CDS spreads at the expense of rising sovereign spreads during January 2008 and June 2009.

Kallestrup et al., 2011 confirm that contingent liabilities arising from implicit or explicit guarantees of the banking system influence sovereign CDS premia by showing that cross-country finan-\footnote{Benzoni et al., 2012 use the fragile beliefs framework of Hansen and Sargent (2010) to illustrate their mechanism. In addition to the hidden contagion factor that characterizes the state of the underlying economy, spreads are modeled to depend also on global financial uncertainty (VIX and the U.S. high-yield bond spread defined as the difference between the BB and BBB indices of corporate bond effective yields provided by Bank of America Merrill Lynch) and a country-specific macroeconomic conditions index. The model is applied to daily 5-year sovereign CDS spreads of 11 Euro zone countries over the sample period 12 February 2004 to 30 September 2010.}
cial linkages can explain the variation in sovereign CDS spreads beyond what can be accounted for by common and country-specific risk factors. Measures of cross-country linkages, which are based on consolidated BIS banking statistics, reflect banks’ exposures to both the domestic and foreign public, bank and private (non-bank) sectors. In a related study, Kallestrup (2011) documents an association between sovereign credit risk and macrofinancial risk indicators calculated based on bank balance sheet variables. Altman and Rijken (2011) do not focus on financial companies per se, but apply the credit scoring methodology to evaluate sovereign default probabilities based on public companies’ balance sheet information in a “bottom-up” approach. This suggests that the profitability and financial condition of the local economy significantly impacts default risk.

Sgherri and Zoli (2009) confirm the dominance of a common time-varying factor for sovereign CDS spreads of ten European countries over the time period January 1999 to April 2009, but argue that the solvency of the national banking systems has become an increasingly important factor over time. Alter and Schüler (2012) find that prior to a financial rescue package of the ECB, the International Monetary Fund (IMF) and the European Union (EU), default risk was transmitted primarily from the bank to the sovereign sector, while post-bailouts, risk was also transmitted the other way round, from sovereigns back to banks.\footnote{Further evidence on the relationship between sovereign and bank CDS is also provided by Aktug et al. (2013). Chan et al. (2009) documents negative correlations between the sovereign CDS and domestic stock market returns in seven Asian Economies. Zhang et al. (2013), who replicate the analysis of Longstaff et al. (2010) for (mostly) Asian economies, also find that both global and local risk factors have explanatory power for sovereign CDS spread changes. Proxies for global risk aversion are the Tsatsaronis and Karamptatos (2003) effective risk appetite indicator, the VIX index and a Risk Tolerance Index by JP Morgan Chase. Fundamental variables in the analysis include inflation, industrial production, GDP growth consensus forecasts, and foreign exchange reserves.}

7.4.3 Global and Local Risk Factors

Remolona et al. (2008) plausibly argue for the co-existence of both global and local risk factors.\footnote{Deomposing monthly 5-year emerging markets sovereign CDS spreads into a market-based measure of expected loss and a risk premium, the authors find empirical evidence that global risk aversion is the dominant determinant of the sovereign risk premium component, while country-specific fundamentals and market liquidity matter more for default probabilities.\footnote{Examining total spreads rather than the decomposition, Carlos Caceres and Segoviano (2010) argue that risk aversion was responsible for the widening of sovereign spreads during the early period of the crisis.}}

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As the storm unfolded, however, country-specific factors such as public debt levels and budget deficits played a dominant role. In a similar spirit, Arghyrou and Kontonikas (2012) find evidence in favor of a regime-shift in sovereign debt pricing towards country-specific macro-fundamentals, since differential macro-fundamentals are only able to explain cross-sectional differences in spreads during the crisis. Finally, Aizenman et al. (2013) focus on the fiscal health of the sovereigns and find that a 1 percentage point rise in the debt-to-tax ratio increases 5-year CDS spreads by between 15 and 81 basis points, while a 1 percentage point rise in the fiscal balance to tax ratio predicts a decrease in spreads by 194 to 829 basis points.\footnote{While Aizenman et al. (2013) study 60 countries from 2005 to 2010, they focus primarily on the GIIPS countries.}

A rather different country-specific channel is suggested by Cosset and Jeanneret (2013), who propose that governments that are more efficient in collecting tax revenues are less likely to default and face lower borrowing costs as reflected in sovereign CDS spreads. In another study, Lee et al. (2013) provide preliminary evidence that average annual sovereign CDS spreads are negatively related to the degree of property and creditor rights and disclosure requirements (i.e. spreads are on average lower for countries with stronger property and creditor rights and more stringent disclosure requirements).\footnote{Eyssell et al. (2013) argue that both local (the China stock market index and its real estate interest rate) and global determinants (VIX, US default spreads, global stock market returns) are important determinants of China’s sovereign CDS spread, but that the role of global factors has become more important over time.}

A role for currency volatility in sovereign credit risk is advocated by Carr and Wu (2007), who develop a joint valuation framework for sovereign CDS and currency options with an empirical application to Mexico and Brazil. Strong positive contemporaneous correlations between CDS spreads and both the foreign options delta-neutral straddle implied volatilities and risk reversals are suggestive of the fact that economic or political instability leads to both higher sovereign credit risk and currency return volatility.\footnote{An interesting finding in light of the debate on the role of global and country-specific risk factors is that there are additional systematic movements in the credit spreads that the estimated model fails to capture.} Hui and Chung (2011) reverse the analysis and document information flow, in times of adverse market conditions, from the sovereign CDS spreads of eleven euro-zone countries to the dollar-euro currency option prices. They further find that sovereign spreads have predictive power for the implied volatility of dollar-euro currency options and this relationship is stronger for deep-out-of-the-money (DOTM) options, which are suggested to reflect euro crash risk during the sovereign debt crisis. Hui and Fong (2011) document evidence of in-
formation flows from the sovereign CDS market to the dollar-yen currency option market during the sovereign debt crisis from September 2009 to August 2011. Similarly, Pu (2012) shows that the difference between US dollar- and euro-denominated sovereign CDS spreads (quanto-spread) of ten eurozone countries can predict the bilateral EUR-USD exchange rate returns up to a period of ten days, while Santis (2013) argues that the difference between the euro-dollar quanto spread of an eurozone member country, and that of a benchmark country such as Germany, can quantify the re-denomination risk, i.e., the risk that a country leaves the EUR. Gray et al. (2007) apply contingent claims analysis to price sovereign credit risk and compare their results to observed CDS spreads. While the public balance sheet is one input to the model, exchange rate volatility appears to be a fundamental factor in the framework. Plank (2010) proposes a structural credit risk model where sovereign default probabilities depend on foreign exchange reserves, as well as a country’s exports and imports.

Ismailescu and Kazemi (2010) find asymmetric effects of credit rating announcements on the sovereign CDS spreads of 22 emerging economies. While investment grade countries are more responsive to negative credit rating announcements that are anticipated and reflected in CDS spreads before the announcement date, speculative-grade countries respond largely to (unanticipated) positive announcements. The authors further show that a one notch rise in the rating of a country increases the CDS spread of another country on average by 1.18%, and this effect is stronger for countries who share a common creditor. Afonso et al. (2012) complement the evidence in Ismailescu and Kazemi (2010) for 24 developed economies from the EU. The authors find, among others, that a negative rating announcement or outlook increases sovereign CDS spreads, on average, by 13 basis points, and that announcements for lower rated countries “spill over” and affect the spreads of other higher-rated countries. Haitao Li and Yang (2014) develop a theoretical rating-based framework for sovereign CDS where both a local and a global factor impact the rating transitions. Finally, Doshi et al. (2014), using the model of Doshi et al. (2013), decompose a panel of 28 sovereign CDS into risk premia and expected losses based on observable covariates, of which two are global (US interest rate and VIX) and two are local (country’s lagged one-year stock market

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115 In a prior paper, Cossin and Jung (2005) shows that credit ratings become more informative after a crisis event. 
116 Arezki et al. (2011) provide further evidence on the relationship between rating changes and sovereign CDS spreads.
return and the currency-implied exchange rate volatility).

7.4.4 The Role of Risk Factors

The debate in the academic literature revolves largely around the question of whether sovereign CDS spreads are driven relatively more by global risk factors, mostly associated with financial or macroeconomic risk factors from the United States, or by country-specific fundamentals, most typically indicators of the health of the domestic economy and financial sector. Surveying the literature, it appears that the role of the risk factors underlying the variation in sovereign spreads is time-varying, with country-specific factors, in particular the sovereign-bank nexus, playing a more important role in crisis periods. This argument is formalized in Augustin (2013), who shows that the term structure of sovereign CDS spreads is an informative signal about the relative importance of the underlying sources of risk. More specifically, a positive slope in good times indicates that variation in spreads is relatively more driven by global risk factors, while a negative slope that we observe in distressed times is associated with country-specific shocks. We anticipate that future research will focus on the time-varying properties of both sources of risk and to incorporate the valuable information embedded in the term structure of spreads. This was first done by Pan and Singleton (2008) to disentangle recovery rates from default probabilities. The surveyed literature almost exclusively focuses on the level of spreads.

Another aspect of the global-local trade-off is that global factors seem to play a greater role at higher frequencies, as in Longstaff et al. (2010) for example, while country-specific fundamental risk factors often seem to dominate at lower frequencies, such as in Hilscher and Nosbusch (2010). They show that the volatility of the terms of trade is fundamental to explaining annual sovereign bond yield spreads. We hope to see in future research a better understanding of how the time-aggregation is related to the transition in the explanatory power from global to local risk factors.

Augustin (2013) rationalizes the empirical relationship between the shape of the term structure and the explanatory power of local risk factors in an equilibrium model with recursive utility and long run risk for CDS spreads. Time variation in the term structure consistent with observed stylized facts arises through the tension between global and local risk.
7.5 Spillovers and Contagion

The popular press repeatedly referred to the danger of contagion and spillovers during the financial and sovereign debt crises. However, a precise definition of contagion has proved to be elusive. Our reading of the literature is that the actual existence of contagion is quite ambiguous and hard to prove; the existing findings depend largely on the precise definition of the concept and are fraught with problems of endogeneity. A crucial issue is the need to differentiate more clearly between the various concepts and ensure that they permit the identification of the contagion channels. To this end, we first study contagion effects across sovereign countries. We then review the literature that studies the relationship between sovereign and corporate CDS spreads.

7.5.1 Contagion across Sovereign CDS

Beirne and Fratzscher (2013), for example, distinguish three types of contagion: Fundamentals contagion, regional contagion and herding contagion. Fundamentals contagion is defined as an increase in the sensitivity of financial markets to country-specific fundamentals, which the authors interpret as a wake-up call by investors. The authors find evidence of such patterns, in particular for the GIIPS countries. There is, however, no indication of regional contagion (not even from the GIIPS to other countries), which is identified as an intensification of cross-country transmission of sovereign risk, in their findings. Moreover, there is only marginal evidence of herding contagion, also dubbed pure contagion, which can be measured at any point in time, based on the cross-country correlations of the residual sovereign risk that is unexplained by any country-specific or common global risk factors. Caporin et al. (2013) are also critical about the existence of sovereign contagion and argue that cross-country linkages in sovereign credit risk of eight European countries are identical in normal and turbulent times. Using quantile regression techniques, they show that, conditional on the influence of common factors, shocks propagate linearly such that the effects of large shocks are no different from those of average shocks. Puzzlingly, robustness tests using bond yields suggest that the intensity of the propagation mechanism may even have decreased. The authors also provide evidence that pairwise correlations of sovereign CDS spreads have decreased.
with the deepening of the sovereign debt crisis. \cite{bai2012} attempt to understand the interaction of credit fundamentals and liquidity shocks during the sovereign debt crisis by studying spillovers and feedback loops between twelve European countries using a structural vector autoregression. They argue that contagion during the sovereign debt crisis was channeled primarily through the fundamental credit risk channel, as domestic credit shocks affected aggregated foreign credit shocks and vice-versa. While the authors find some evidence of liquidity contagion since aggregate liquidity shocks affect domestic liquidity risk and are, in turn, affected by domestic liquidity shocks, there is no indication that these liquidity channels had an impact on country fundamentals. A decomposition of sovereign spreads suggests that the early rise in spreads from August 2008 to April 2010 was driven by a greater illiquidity component, while the second wave of the crisis from May 2010 to May 2012 was due to a rise in fundamental credit risk. \cite{darolles2012}, on the other hand, argue that contagion effects for 18 emerging markets were channeled through liquidity problems in the sovereign debt markets. This argument rests on the estimation of a state-space with time-varying asymmetric volatilities, which suggests that the state probabilities of high cross-country correlations coincide with high market illiquidity, proxied by the CDS-Bond basis.

\cite{benzoni2012} rationalize how contagion may occur through investors’ perception of sovereign credit risk. Uncertainty about sovereign default probabilities leads agents to update their beliefs about all countries’ default distributions, if one individual country is affected by a negative credit shock. This can cause credit spreads to co-move more strongly than would be justified based on macroeconomic conditions alone. \cite{lucas2012} capture spillovers across countries through an increase in conditional default probabilities. Joint and conditional default probabilities of ten European countries are inferred from a copula-based framework that allows for time-varying volatilities and correlations across countries, as well as skewed and fat-tailed distributions of spread changes. \cite{brutti2012} show that the magnitude of spillovers to 11 other European countries arising from financial shocks to Greece depends on the cross-country bank exposures

\footnote{A similar point is also made in \cite{billio2013}. \cite{kalbaska2012}, on the other hand, document an increase in pairwise correlations among nine European sovereigns based on exponentially-weighted-moving-average correlation measures.}

\footnote{More specifically, the model is based on a multivariate mean-variance mixture distribution, where the risk indicators follow jointly a Generalized Hyperbolic skewed t-distribution.
to sovereign debt. Specifically, the difference in transmission rates between the country with the
greatest and lowest credit risk exposure to Greece is approximately 46 percent. Finally, Glover and
Richards-Shubik (2012) endogenize international lending and borrowing relationships in a network
model to show how financial contagion arises in a network structure. The authors use sovereign
CDS spreads to fit their model.

7.5.2 Spillovers between Sovereign and Financial CDS

Several papers that investigate spillover effects between the sovereign and banking sector have
developed in parallel with the literature on the relationship between sovereign and bank risk.
Bruyckere et al. (2013) study contagion/spillovers between sovereign and bank risk for 15 countries
and more than 50 banks through the lens of excess correlations, defined as the correlation in residual
CDS spreads after having removed the influence of country-specific and global risk factors. About
86% of all banks in their sample have statistically significant excess correlations, and the average
excess correlation is 17%. The authors further show that excess correlations are greater between
banks and their home countries (on average 3.2% greater than the excess correlations with foreign
countries), stronger for the GIIPS and more indebted countries, as measured by debt-to-GDP ratios.
Such excess correlations are explained by several bank and country-specific characteristics. Bank
that are larger, less-well capitalized, that rely on wholesale funding and have a high proportion
of non-interest income display stronger excess bank-country correlations. The authors also use
the data from the European Banking Authority stress tests to show that cross-country exposures
arising from public bond holdings affect the excess correlations, which are 1.5 percentage points
higher for a one standard deviation higher public bond exposure.

Alter and Beyer (2014) aggregate spill-over indices, estimated from impulse-response functions
in a VAR setting, between the sovereigns and banks of 11 EU countries to form a contagion index.
A decomposition of the contagion index into excess bi-directional spillovers confirms the existence
of increased interdependencies between sovereigns and banks during the sovereign debt crisis. Billio et al. (2013) evaluate time-varying dependencies and feedback effects across sovereigns, banks
and insurance companies in Europe, the U.S. and Japan. Combining Granger causality, network

\[\text{More specifically, the contagion index is decomposed into four components that capture excess spillovers among sovereigns, among banks, from sovereigns to banks and from banks to sovereigns.}\]
analysis, and contingent claim analysis applied to CDS spreads, the authors attempt to quantify the dynamics of financial system interactions and systemic risk.

7.5.3 The relationship between Sovereign and Corporate CDS

Governments have the discretion of expropriating corporate assets or imposing foreign exchange controls. Given these circumstances, the borrowing conditions of companies are expected to depend on the credit-worthiness of the local government. In addition, other environmental factors that influence the financial performance of the companies, such as the state of the economy and the efficiency of its legal institutions, may be reflected in the sovereigns credit standing. The fact that sovereign borrowing rates represent a lower bound for domestic borrowing rates is termed the "sovereign ceiling." Over the last decade, however, there has been an increasing number of sovereign ceiling violations, which means that companies have managed to decouple themselves and to borrow at better rates than their local government in the country of their domicile. The determinants of these sovereign ceiling violations are studied by Lee et al. (2013), who show that companies are able to delink their risk profile from that of the local government if they hold foreign assets in jurisdictions with better property and creditor protection rights, and if they are cross-listed in countries with better disclosure requirements. The average difference-in-difference between corporate and sovereign CDS rates is reduced by 26 basis points through the combined exposure to these informational and institutional channels, with a stronger effect during the sovereign crisis.

Bai and Wei (2012) study how property and creditor rights influence the direct risk transfer from the sovereign to individual companies, rather than the financial sector. They find that a 100 bps rise in sovereign CDS spreads is associated with a 71 bps increase in corporate CDS spreads. Strong property rights such as executive constraints, expropriation risk or rule of law (but not contracting rights) weaken the association between sovereign and corporate credit risk, while the results are stronger for state-owned institutions. Augustin et al. (2012) exploit the joint effects of the Greek government bailout during the Euro-zone crisis and the violation of the no-bail out clause in the 1992 Maastricht Treaty as an exogenous event to quantify how a rise in sovereign credit risk affects corporate borrowing costs in Europe. They show that a 1 per cent rise in sovereign credit risk raises corporate borrowing costs by 0.1 per cent on average, and these results are stronger for
countries sharing a common currency union, that are more financially distressed, and that have weaker property rights. In the cross-section of firms, the results are stronger if firms are more financially dependent and if they have a greater public ownership. In a later paper, Bedendo and Colla (2013) confirm the results that higher sovereign CDS spreads are associated with higher corporate borrowing costs. They also show that these results are stronger for state-owned firms, for firms whose sales are geographically less diversified, and for companies that rely more heavily on bank financing.

7.6 Frictions and the CDS-Bond Relationship

As argued in Section 4.1.1 above, the CDS spread should be equivalent to the spread of a floating rate note priced at par over a risk-free interest rate (Duffie 1999, Lando 2004 and Hull and White 2000a). Empirically, however, the observed difference between the CDS and bond yield spread, the so-called CDS-Bond basis, can substantially diverge from its theoretical arbitrage relationship because of various market frictions. If the cash and derivative market have differential dynamics, we may ask which market is informationally more efficient and absorbs information at a faster pace. We review this issue in the first subsection below. Next, we review our current knowledge about liquidity in the sovereign CDS market. Following this, we survey the evidence on the determinants of the CDS-Bond basis. We end by reviewing our current knowledge on the economics of sovereign CDS, which addresses how the existence or introduction of sovereign CDS impacts public bonds.

7.6.1 Price Discovery and Informational Efficiency of Sovereign CDS Spreads

A survey of the corporate literature suggests a strong consensus that the derivative market is more informationally efficient than the cash market. Our reading of the mixed results from the sovereign literature, however, highlights disagreement and ambiguity on this issue. Several of the conflicting findings can certainly be explained by differences in the sampling periods, sample sizes, data frequency and data sources. However, details aside, other questions remain, especially given the growing importance of sovereign credit risk, since the global financial and Euro-zone crises. Augustin (2014) provides a comprehensive list of the references studying this topic. Here, we limit
ourselves to the main insights derived from these studies.\footnote{A selection of published references includes Adler and Song (2010), Ammer and Cai (2011), Li and Huang (2011), Delis and Mylonidis (2011), O’Kane (2012), and Arce et al. (2013). Two currently unpublished references that are often cited include Fontana and Scheicher (2010) and Palladini and Portes (2011).}

Several authors argue that the informational efficiency is time-varying and greater in the relatively more liquid of the two markets. Thus, according to Arce et al. (2013), price discovery is state-dependent and a function of the relative liquidity in both markets. The differential liquidity argument for price discovery is also brought to the fore by Ammer and Cai (2011), who show that CDS price leadership correlates positively with the bond-to-CDS ratio of bid-ask spreads, and negatively with the number of bonds outstanding. Coudert and Gex (2013) confirm the liquidity hypothesis for state-dependent price discovery and find that CDS played a more important role during the global financial crisis. These authors link their argument to market participation, given that a bearish bond investor will \textit{stay out}, whereas a bearish CDS investor will \textit{stay in} and purchase insurance. The previous arguments could be one explanation for the fact that the relative informational efficiency of the sovereign CDS market has increased over time, even as the market has matured.

Sapriza et al. (2009) also argue that the relative role of price discovery between the sovereign CDS and bond markets is state dependent, but the authors advocate a different channel than liquidity. In particular, they argue that the bond market displaces the leading role of the CDS market for price discovery in times when a country experiences adverse economic conditions, as measured by the International Country Risk Guide (ICRG) country risk index that combines various political, financial and economic risk indicators.\footnote{Even though there is no formal evidence on this hypothesis, the authors argue that informational efficiency switches across markets because local investors may have superior information in economically bad times, which they can use to trade in the bond market, while they are restricted from trading in the derivatives market. Nevertheless, we believe that this argument does not explain the dynamic relationship, as the same argument would hold even in economically benign times.}

Based on the existing findings of state-dependent liquidity, Calice et al. (2013) study cross-market liquidity spillovers and find evidence of time-variation in the intensity of transmission between maturities and across countries. In et al. (2007) study the intensity of volatility transmission among the two markets. In contrast, Gündüz and Kaya (2013) study the absolute informational efficiency of sovereign CDS spreads, rather than the relative informational efficiency compared to bonds. Studying long-memory properties of spread returns and their volatilities, the authors find...
no evidence of long memory in spread changes, but positive evidence in favor of long memory in volatilities. The conclusion based on these results is that information is impounded into sovereign CDS spreads in a timely manner with weak-form efficient markets, and that default uncertainty is persistent.

7.6.2 Liquidity in the Sovereign CDS Market

The previous subsection emphasizes that the relative liquidity between the cash and derivative market influences their respective roles for price discovery. These analyses implicitly assume that CDS spreads contain a liquidity premium component. This argument is generally accepted and considered in more recent research, even though earlier studies used CDS spreads as pure indicators of default risk, without any adjustments. Yet, our understanding of liquidity and liquidity risk in the credit derivative market is still far from perfect, especially for the sovereign sector.

Pan and Singleton (2008) report anecdotal evidence of the liquidity component of sovereign CDS spreads from discussions with market practitioners, especially at short-term maturities. While a liquidity component is not directly incorporated into their pricing model, the discrepancy between the observed and model-implied spreads of Mexico, Brazil and Turkey is associated with the fact that large institutional investors allegedly express their views on sovereign credit risk by trading in short-term CDS contracts. Lei and Ap Gwilym (2007) study the determinants of CDS liquidity proxied by bid-ask spreads in a two-year sample of daily CDS dealer quotes from CreditTrade, of which approximately 10% are associated with sovereign reference entities. Overall, bid-ask spreads have narrowed over time and are found to be wider when characteristics typically associated with illiquidity or asymmetric information are perceived to be more prevalent. Thus, wider bid-ask spreads are associated with demand-supply imbalances, greater volatility, price clustering, weaker credit ratings, downgrade watch status, less popular maturities, lower notional amounts outstanding, as well as CDS contracts that are written on subordinated debt and that reference

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123 For example, Longstaff et al. (2005) used CDS spreads as a benchmark of pure credit risk in order to infer liquidity characteristics from the bond market. The assumption that sovereign CDS spreads are pure indicators of default risk is also made in Bai et al. (2012) and Beber et al. (2009). Pelizzon et al. (2013) use the sovereign CDS of Italy as the first best, but admittedly imperfect, proxy for Italy’s credit risk.

124 A few recent papers that tackle liquidity and liquidity risk related questions for corporate CDS are, Tang and Yan (2007), Nashikkar et al. (2011), Bongaerts et al. (2011) and Junge and Trolle (2013). Pelizzon et al. (2013, 2014), explicitly incorporate an adjustment for liquidity in their use of the Italian CDS spread as a measure of sovereign credit risk during the Euro-zone crisis.
the full restructuring credit event clause. Interestingly, the authors also find that the bid-ask spreads of speculative-grade *sovereign* reference entities are wider than those of similarly rated *corporate* reference entities, while no such gap exists for investment-grade issuers. The last result is corroborated in a study by Sambalaibat (2013), who documents that percentage bid-ask spreads in the sovereign CDS markets are about ten times larger than those in the underlying government bond market.

Badaoui et al. (2013) decompose sovereign CDS spreads and find a large liquidity risk component that represents about 44.32% of the entire spread in nine emerging countries: The size of the liquidity premium is not much smaller than the credit risk component.\(^{125}\) In their related paper, Badaoui et al. (2012) extract the term structure of liquidity premia form the sovereign CDS spreads of Brazil, the Philippines and Turkey, which they find to be roughly flat, slightly higher at short and long horizons, with inversions during periods of distress.

Finally, Pelizzon et al. (2013) study the dynamic linkages between liquidity in the Italian government bond market and the Italian sovereign credit risk, proxied by the Italian CDS spread. They find that the relationship between credit risk and liquidity depends on the level of credit risk, and also that information flows from credit risk to liquidity. More specifically, both contemporaneous and lagged CDS spread changes explain quoted bid-ask spreads in the interdealer market up to an endogenously determined CDS level of 500 basis points, above which both the speed and the intensity of the credit risk transmission increases.\(^{126}\) Furthermore, they show that the ECB’s announcement of Long-Term Refinancing Operations (LTROs) was successful in attenuating the dynamic linkage a between sovereign credit risk and liquidity.

7.6.3 The Determinants of the CDS-Bond Basis

Liquidity is often considered to be a state variable determining whether the cash or the derivative market is informationally more efficient. On this premise, it is natural to believe that liquidity may be able to explain the short-term deviations from the strict arbitrage relationship that ought to hold

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\(^{125}\)The authors find a negative relationship between credit and liquidity risk, which leads to correlation risk that represents a tiny fraction of roughly of spreads.

\(^{126}\)Quantitatively, a contemporaneous ten basis points increase below (above) the threshold level of 500 basis points increases the quoted bid-ask spread by seven (36) basis points. Lagged CDS spreads affect liquidity only below the threshold.
between the two markets, absent frictions. This insight is exploited by Arce et al. (2013), who show some evidence that counterparty risk and differential liquidity between sovereign bonds and CDS, proxied by the ratios of percentage bid ask spreads in both markets, partially explains the CDS-Bond basis. Levy (2009) finds similarly that both counterparty risk and liquidity have explanatory power for the pricing discrepancies between the two markets. This result about counterparty risk is somewhat at odds with Arora et al. (2012), who show for the corporate market that counterparty risk, while priced, is economically insignificant. Kucuk (2010), attribute importance to liquidity effects and finds that CDS and bond bid-ask spreads, bond trading volume, notional amount outstanding, age and time to maturity can explain the basis gap. Fontana and Scheicher (2010), on the other hand, relates the sovereign basis mainly to common global factors, which reminds us of the debate about global and country-specific risk factors in explaining sovereign CDS spreads discussed above.

There are other frictions that may cause deviations from the no-arbitrage relationship between bond and CDS spreads. Ammer and Cai (2011), for example, document the role of the cheapest-to-deliver (CTD) option, which, following a credit event, gives the insurance buyer the option to deliver the cheapest among a set of defaulted debt obligations. This option is an attractive feature of the CDS contract for the protection buyer, which must compensate the insurance provider for this risk, and more so the closer a country is to default.

Fisher (2010) provides two theoretical explanations for the positive bases that were observed for many sovereign borrowers in recent years. He argues that the variation in the basis over time depends on the time-varying proportion of pessimistic investors. In a market with heterogeneous investors and an inelastic supply of insurance for government default, a large number of pessimistic investors who rush to buy default protection will create price pressure on CDS spreads and induce a positive CDS-Bond basis. Another effect that amplifies the positive basis is the prospect of lending fees, which raise bond prices and lower yield spreads. Because of inelastic supply in the CDS market, pessimistic investors will need to short-sell cash bonds, which allows bond holders to charge higher lending fees to short sellers. Evidence that short-selling costs were partly responsible for persistent

\[127\] Arora et al. (2012) show that counterparty credit risk needs to increase, on average, by 646 basis points to reduce the insurance premium by 1 basis point.

positive sovereign CDS-Bond bases is given by Adler and Song (2010). They also extend the basis pricing framework in Duffie (1999) to correct for biases arising from accrued spread or coupon payments, and bonds priced away from their par value. Their theoretical framework illustrates how accrued payments and bond prices below par can mechanically introduce a negative and positive basis respectively. Finally, Salomao (2013) argues that uncertainty about the triggering of the default event, based on the judgment of the Credit Derivatives Determinations Committee, such as in the recent case of Greece, reduces the insurance value and could, therefore, explain a negative sovereign basis.

### 7.6.4 The Impact of Sovereign CDS on Public Bonds

We have previously highlighted that “naked” speculation in the sovereign CDS market was held responsible for derailing sovereign borrowing costs during the European sovereign debt crisis, by many politicians, regulators and other policy makers. A special report officially commended by the European Commission (Criado et al. 2010) argued that such claims were not sufficiently substantiated and difficult to justify based on the existing empirical evidence. In spite of this recommendation, the German financial regulator BaFin decided to temporarily ban the purchase of uncovered credit insurance on euro-denominated bonds on May 19, 2010. A permanent ban was passed later by the European Union in November 2012[129].

The naked CDS ban has been academically supported by Portes (2010), who argues that naked CDS buying does artificially drive up borrowing costs. This opinion is, according to our interpretation, primarily backed by the statistical evidence in Palladini and Portes (2011), showing that CDS spreads have superior price discovery for six European countries and that there is information flow from the derivative to the cash market. A different opinion is shared by Duffie (April 29 2010a) and Duffie (2010b), who believes that the ban will have the unintended consequences of increasing execution costs, lowering the quality of price information, and hence, market efficiency. Moreover, because of the empty creditor problem, a covered insurance holder may have reduced monitoring incentives, reducing the borrower’s efforts for efficient investments. Thus, these channels would...

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129 Even though the legislation became effective in November 2012, it was voted in October 2011, and a final draft of the law was published in March 2012. For further details, see Sambalaibat (2013) and http://ec.europa.eu/internal_market/securities/short_selling_en.html.
lead to higher, not lower, public borrowing costs.

Several researchers have studied the agency conflicts and incentives of governments in the presence of sovereign default insurance. While the agency conflicts are to a large extent similar in the sovereign and corporate context, we discuss below the literature that focuses on the sovereign aspect, and which was not discussed in section 5. Goderis and Wagner (2011) argue that the existence of insurance contracts will lower the ex-ante probability of default, because the insurance holder can credibly commit to reject a restructuring offer made by the borrower in bad states of the world. Thus, the borrower must internalize more of the default costs in bad states, which incentivizes him to invest more efficiently in the first place. On the other hand, the author also emphasizes that the probability of default can increase when multiple bond holders fail to coordinate and buy more insurance than what is socially optimal. Salomao (2013) introduces sovereign insurance contracts with uncertain payoffs into a dynamic model with endogenous sovereign default. She illustrates how the existence of the insurance contract can increase the lender’s bargaining power in the default states, incentivizing the borrower to default less often. This raises equilibrium debt levels and lowers borrowing costs in equilibrium. Sambalaibat (2011) focuses specifically on the effect of naked CDS on government bonds and finds that the ultimate outcome depends largely on the infrastructure of the insurance market. The parameterization of the model predicts that naked CDS buyer may induce either over- or underinvestment of the borrower, associated with, respectively, lower and higher borrowing costs.

While the theoretical evidence on the impact of sovereign CDS on public bonds is mixed, the current empirical evidence draws positive conclusions. For example, Ismailescu and Phillips (2011) picture sovereign CDS as efficient monitoring tools, which can reduce the adverse selection costs for informationally opaque countries, allowing for greater risk-sharing and encouraging greater market participation. Their conclusions are based on the findings that after the initiation date of sovereign CDS trading, public bonds become more informationally efficient, especially for high-yield countries, and bond spreads decrease on average by 60 bps, with stronger effects for less creditworthy governments. Sambalaibat (2013) studies how the CDS market affects the liquidity of the sovereign bond market in the context of a dynamic OTC search model with search frictions and endogenous entry of broker-dealers. Her model predicts that investors will migrate to the bond
market if they are temporarily shut out of the CDS market, but that they will leave altogether in case they are permanently restricted from trading in the CDS market. These predictions are empirically validated by showing that liquidity in the sovereign bond market improved following the temporary German naked CDS ban, while it reduced after the permanent ban of the EU. The temporary naked CDS ban by Germany on May 19, 2010 is also studied by Pu and Zhang (2012), who provide descriptive evidence that after the ban, sovereign CDS and bid-ask spreads of the GIIPS countries continued to rise. On the other hand, the authors find that sovereign CDS spread volatility declined.

To summarize, the mixed results from the existing theoretical and empirical literature make it difficult to draw the conclusion that speculators in the sovereign CDS market were responsible for causing a spike in public borrowing costs during the Euro-zone sovereign debt crisis. We do believe that sustaining such an argument using price information only is empirically challenging. Bolton and Oehmke (2013) do not concur with the allegation that hedge funds artificially drive up sovereign borrowing costs; they argue that this claim is hard to substantiate without a deeper analysis. We hope that future research will analyze this important policy issue from diverse angles, based on improved access to actual trading positions and public bond holdings, in order to provide clear policy guidance.

8 CDS Indices

Stock market indices were developed in the late nineteenth century in the United States as barometers of the performance of the stock market. Since that time, indices have been created for stock markets in other countries and a variety of markets for bonds, foreign exchange, commodities, and more recently, credit derivatives. Apart from providing benchmarks for measuring performance, they also serve to improve liquidity and transparency. In a similar manner, CDS markets have experienced the development of synthetic credit indices which fostered the aggregation of information and price discovery through product standardization.

Note that a key assumption for these results is endogenous entry. If the proportion of traders is held constant, these predictions are reversed. The predictions can be explained by the fact that, in the long run, CDS and bond markets are complementary. The ability to simultaneously search and trade with naked CDS and bonds lowers the opportunity cost in the bond market, and thus, naked CDS trading attracts traders into both bond and CDS markets.
There are now essentially two classes of credit derivative indices: those that are backed by single name bond or loan CDS, and synthetic structured indices that are backed by pools of residential or commercial mortgage-backed securities. Within the first class of standardized credit indices, there exist two main families. The iTraxx family covers reference entities in Europe and Asia (both corporate and sovereign), and the CDX family covers those in North America and in Emerging Markets. Both families are owned and administered by Markit Group Limited. In addition to standardized corporate and sovereign credit indices, there are also standardized credit indices for real estate securities. Probably the best known products for real estate are those backed by subprime home equity and commercial mortgage-backed securities (MBS), the ABX.HE and CMBX indices, respectively. The credit indices themselves are tradable products that can be tranched into risk categories of descending priority. Thus, investors have the opportunity to take an exposure to only part of the capital structure by investing in a tranche of the credit derivative index. These are the so-called second-generation indices (or derivatives on derivatives), typically tranche products that are backed by credit derivative indices.

Academic research has to a large extent focused on information embedded in credit indices backed by synthetic mortgage risk, in particular because of the toxic role of mortgages during the 2007 subprime crisis. However, the indices based on corporate and sovereign credit risk are of equal economic importance. In the following subsections, we first review the mechanism and the market development of credit derivative indices, and then discuss the early literature, which has mainly focused on their statistical properties. We then follow up with a more extensive discussion on the academic papers that analyze the information embedded in the second generation indices.

8.1 Market Overview

Similar to the market for single-name credit default swaps, the market for credit index products experienced spectacular growth in the period preceding the subprime financial crisis. Table 3, which is based on the semi-annual OTC derivatives statistics available on the website of the Bank of Canada, shows the rapid growth of the market for credit derivative indices.

The origin of synthetic credit indices goes back to 2001 with the launch of the JECI and Hydi indices by JP Morgan, and TRACERS by Morgan Stanley. Both firms decided to merge their activities in 2003 to create the Trac-x indices, but they faced renewed competition with the creation of the iBoxx indices in 2004. Later in the year, both Trac-x and iBoxx merged to form the iTraxx and CDX families, which were administered by Markit. Markit took over the management of the indices in November 2007, and is now the market leader in the administration and handling of synthetic credit indices. See Markit (2014).
for International Settlements, illustrates that the gross-notional amount outstanding in multi-name instruments grew from approximately $6.5 trillion at the beginning of 2006 to $24 trillion at the end of the first half of 2008. The market subsequently took a dive and has since fluctuated in the ballpark of $11 trillion in gross notional amount outstanding. Over time, this reflects a market share of the overall credit derivative market ranging between 30 and 46 per cent. The biggest fraction of the multi-name instruments is accounted for by A to BBB rated instruments, representing a market share of 52% in 2011, whereas subinvestment-grade products account for approximately 17% of the market. The remaining market share is associated with unrated products. Detailed statistics on index products are, unfortunately, only available since the beginning of 2011, but Table 3 shows that they make up most of the trading volume in multi-name products, with values ranging from $12.5 trillion in 2001 to $10.2 trillion in 2013. As the statistics further illustrate, about half of this market consists of reporting dealers, the other half being more or less equally shared between central counterparties, and banks and security firms. Hedge funds, on the other hand, represent only 3% of the entire gross notional amount outstanding in 2011, and 6% in 2013.

Table 4 provides an overview of the break-down in multi-name credit derivatives statistics based on maturity and sector. In contrast to single-name corporate CDS, where liquidity is largely concentrated in 5-year contracts, multi-name products are primarily traded in maturities of one year and less. As can be seen in Panel A, at the beginning of 2013, the fraction of very short-term instruments was 25% of the total gross notional volume in all OTC credit derivatives, and about 57% of all multi-name products. In the same year, maturities above five years account for $3.2 trillion, or 13.3% of all OTC credit derivatives, and maturities between one and five years represent, with $1.9 trillion, about 7.8% of the entire OTC credit derivative market, in terms of gross notional amount outstanding. Panel B reports the statistics by sector. The biggest fraction of trading volume is accounted for by securitized products and sector products, which have consistently represented 57% or more of the total multi-name market since 2011. The second biggest trading volume in multi-name products is concentrated in products written on financial institutions, representing between 20% and 29% of the market between 2011 and 2013. A similar magnitude of trading is reported for multi-name products on non-financial institutions, while the index market for sovereign CDS has remained fairly small, with a gross notional amount outstanding of $145 billion in 2013, or 1.3% of
8.2 Credit Indices - A Primer

The two main corporate credit derivative indices are the Markit iTraxx Europe Main (iTraxx Europe) and the Markit CDX North American Investment Grade (CDX.NA.IG). These two indices reference the top 125 European and American, investment grade reference entities, respectively, in terms of CDS volume traded. The indices are equally-weighted, so that each reference name has a weight of 0.8% in the index. Both indices are “rolled” over every six months on 20 March and 20 September when a new on-the-run series is created, which is quoted in parallel to the previous outstanding series of off-the-run indices. The traded maturities are 3, 5, 7 and 10 years for the iTraxx Europe; in addition, the CDX.NA.IG also trades in shorter maturities of one and two years. Payments are typically on a quarterly basis and accrue on a Actual/360 basis. The coupons are standardized, usually 100 or 500 basis points, the difference being settled as an upfront payment between the protection seller and the protection buyer.

In addition to the main indices, both families have several sector-specific sub-indices. For example, the iTraxx Financial covers senior, respectively subordinated debt of 25 underlying financial reference entities. The Non-financials index covers the auto sector, consumers, energy, industrial and TMT (technology, media and telecommunications) with 100 reference entities, while the iTraxx HiVol contains 30 single-name CDS with the largest spread reference entities from the iTraxx Europe Main. The iTraxx Crossover index comprises the 50 most liquid sub-investment grade names. Finally, the iTraxx Europe CEEMEA contains 25 corporate and quasi-sovereign entities from the CEEMEA countries. The iTraxx family also references Asian credit derivatives, the most common products being the iTraxx Asia Japan (50 corporate reference entities from Japan), the iTraxx Asia ex-Japan Investment Grade (50 names), the iTraxx Asia Australia (25 names) and the iTraxx Asia ex-Japan High Yield (20 names). Moreover, the iTraxx family comprises several sovereign credit derivative indices, namely the iTraxx Sovx Western Europe (top 15 sovereign entities by liquidity that trade on Western European documentation), the iTraxx SovX CEEMEA ex-EU (top 15 sovereign entities by liquidity that trade on Emerging Market documentation), the iTraxx SovX

132 Refer to Markit (2014) for further institutional details on credit derivative indices.
133 CEEMEA stands for Central and Eastern Europe, Middle-East and Africa.
Asia Pacific (top 10 sovereign entities by liquidity in the Asia and Oceania regions), the iTraxx SovX Global Liquid Investment Grade (between 11 and 27 most liquid high grade global sovereign entities), the iTraxx SovX G7 (up to 7 most liquid industrialised countries) and the iTraxx SovX BRIC (up to 4 most liquid BRIC countries). The last category of the iTraxx family is the iTraxx LevX, referencing the most liquid first lien syndicated loans.

The North-American counterparts to the European iTraxx indices are the CDX North America High Yield (100 single-name CDS), the CDX North America Investment Grade High Volatility (30 credits with largest spreads from CDX.NA.IG), the CDX North America Emerging Markets (14 sovereign names) and the CDX Latin America Corporates (20 Latin American corporate names). The counterpart to the iTraxx LevX is the Markit LCDX, which is a tradable index with 100 equally-weighted underlying single-name senior secured loan credit default swaps. Markit also administers a municipal index, referencing 50 CDS contracts on municipal reference entities.

The credit derivative market allows investors to synthetically invest or hedge different portions of the capital structure of a standardized credit portfolio. This is done by chopping the standardized indices into so-called tranches. The most common tranche products are those written on the iTraxx Europe and CDX.NA.IG, but similar products exist also for the other indices. A detailed explanation of the mechanism of tranche products can be found in Longstaff and Rajan (2008) or Coval et al. (2009), among many others, but we find it useful to provide a stylized example of tranches on the iTraxx Europe index in Figure 4. The riskiest part of the index capital structure is the equity tranche, which will absorb the first losses on the underlying portfolio. Thus, the equity tranche can be compared to the equity capital of a company’s balance sheet and the investor in the equity tranche is the residual claimant on the assets underlying the index. Each tranche is defined by an attachment and a detachment point. For the iTraxx Europe index, the detachment point of the equity tranche is at 3% of the capital structure. Thus, an investor taking credit exposure on the tranche directly superior to the equity tranche will only be affected if more than 3% of the companies (i.e. 4 reference entities) in the underlying basket default. Similarly, the tranche corresponding to the attachment and detachment points of respectively 6 and 9 per cent will only suffer losses if more than 6% of the underlying basket defaults, corresponding to at least 8 reference names. The safest tranche of the capital structure is typically called the super senior tranche, and
is exposed only when, in the case of the iTraxx Europe, at least 28 companies in the underlying basket default altogether. While the mechanism for tranches written on the CDX.NA.IG is similar, the attachment and detachment points differ.

8.3 Early Research on Credit Indices

One of the first researchers to investigate the statistical properties of credit derivative indices is Hans Byström, who reports that 8 sub-indices for the iTraxx Europe family are serially correlated and exhibit substantial skewness and excess kurtosis \(^{(Byström (2006))}\). Using the CreditGrades model, he relates model-implied and index spreads to show that the stock market has information that can predict contemporaneous and future empirically observed spreads. In related work, he uses the iTraxx Europe IG and HiVol indices to extract the market-implied term structure of aggregate risk-neutral default probabilities \(^{(Byström (2005))}\). Furthermore, he investigates the tail behavior of the 5-year iTraxx Europe CDS index and its sub-indices using Extreme Value Theory in Byström (2007). Related work is undertaken by Hung-Gay et al. (2008), who, in a VAR framework, investigate the lead-lag relationship in price levels and volatilities between the S&P500 and the CDX.NA.IG and HY indices, representing the aggregate stock and credit markets respectively. The authors conclude that the information flow between the stock and the credit market is more pronounced for the high credit risk category, that is the lead-lag relationship is dependent on the underlying credit quality. Alexander and Kaeck (2008) find some support for the hypothesis that theoretical determinants suggested by structural credit risk models partially explain the time series variation in the iTraxx Europe indices. Estimating a Markov switching model, they find support for regime-dependency in the influence of the theoretically suggested determinants.

8.4 Second Generation Indices

Much of the early research involving credit derivative indices focused primarily on their statistical properties. However, the subprime crisis motivated many researchers to study the pricing behavior

\(^{134}\)In his work, Byström (2007) also conjectures the creation of a hypothetical futures market on credit derivative indices and suggests that Extreme Value Theory, specifically the peaks-over-threshold method, should be the preferred method to determine futures margins in this hypothetical CDS index futures market. The empirical results indicate that the EVT-based margin levels in the CDS index market are much more accurate compared to those implied by the assumption of normally distributed price changes.
of the indices in more detail and to analyze what kind of information can be extracted, in particular from tranches backed by synthetic pools of subprime mortgage risk. One of the reasons is that tranche products contain information about joint default probabilities, which is difficult to obtain from marginal default probabilities only. One of the major challenges in pricing tranche products is the statistical modeling of default correlation risk. Covering this part of the literature in detail is out of the scope of this survey. Here we will focus on those studies that have proposed pricing models with a direct economic or financial application.

The importance of the creation of the ABX.HE subprime home equity loan price indices is emphasized by Gorton (2009), who explains how these indices allowed the market to aggregate and disseminate the information about the values of highly illiquid subprime mortgages once house prices started to fall. Importantly, the index enabled investors to express their negative views by shorting the market. While the aggregation of information enabled investors to gauge the quantity of risk in the market, Gorton conjectures that it did not allow them to determine the location of risk in the system, which is one of the reasons for the 2007 sub-prime crisis in the financial markets. In related work, Gorton (2009) studies the ABX BBB cash basis, i.e., the difference between the synthetic and cash BBB subprime bonds. He argues that the explosive widening of the basis arose because of excessive hedging demand of subprime mortgage risk. This argument is more thoroughly studied in Stanton and Wallace (2011), who study the pricing of AAA ABX.HE index credit default swaps on baskets of mortgage-backed securities and conclude that market prices during the crisis were inconsistent with any reasonable expectation of expected future credit losses. They further find that price changes of the AAA ABX.HE indices are only weakly correlated with the actual credit performance of the underlying loan pools, but highly correlated with short-sale imbalances in the stocks of the investment banks. Because the short-interest ratio is meant to capture

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135 The determinants of implied correlations from iTraxx tranches are studied by Heidorn and Kahlert (2010). These authors essentially show that realized correlations are significantly lower than implied correlations, and that the implied correlations are primarily correlated with gold prices and swap spreads.

136 For more references on the pricing of credit indices and their tranches, see among others, Hull and White (2004), Hull and White (2008), [Wang et al. 2009], Garcia and Goossens (2010), [Eckner 2010], [Cont and Kan 2011], Azizpour et al. (2011), and references therein.

137 The BBB ABX.HE index 2006-01 vintage is used for the synthetic index and the on-the-run subprime bonds are substitutes for the cash component as the BBB subprime bonds referenced by the index are not traded.

138 The authors document detailed information about the composition, quality and performance of the loan pools underlying the four vintages of the ABX.HE indices.

139 The short-interest ratio is calculated as the market value of shares sold short divided by the average daily trading volume, and is meant to be a measure of short-selling in the investment bank sector.
demand imbalances in the market for mortgage default insurance, the authors argue that capital constraints limited the supply of mortgage insurance, which kept the tranche prices artificially low. Their findings cast doubt on the use of these synthetic CDS indices as a valuation benchmark for marking-to-market loan portfolios. Concerns that the ABX prices are unrepresentative of prices for the entire MBS market are also raised by Fender and Hördahl (2008). Evidence of demand-based price pressure is provided more generally in a study of CDX.NA.IG index inclusions by Kitwiwattanachai and Pearson (2014), who suggest that temporary positive cumulative abnormal price changes in single name CDS included in the benchmark index are caused by dealers’ hedging demand trying to manage their inventory imbalances. Junge and Trolle (2013) average the wedge between CDS index prices and their theoretical fair values based on the index constituents across ten indices of the iTraxx and CDX families to compute a CDS market illiquidity measure. This illiquidity measure correlates with other commonly used measures of market illiquidity, such as, for example, the average bid-ask spread or the funding cost measure.

In contrast to Stanton and Wallace (2011), Fender and Scheicher (2009) find that changes in the credit performance of the underlying loans as well as macroeconomic and housing market variables do explain the observed price changes in the AAA ABX.HE index CDS. They find that the relationship of the index with housing price indices became in particular stronger during the financial crisis. The authors also find that risk aversion and decreasing market liquidity had an important influence on the evolution of the AA and AAA indices during the general deterioration of the financial market environment. Another author who disagrees with Stanton and Wallace (2011) by arguing that synthetic credit indices are useful indicators to reflect the fair value of loan exposures is Vyas (2011). The author studies the timeliness of the accounting write-downs of financial institutions during the subprime financial crisis by comparing the schedule of quarterly write-downs related to mortgage-backed securities, and structured credit exposures to the mark-to-market valuation implied by the synthetic credit indices backed by commercial and residential MBS. These results suggest that institutions that are better governed, that have been investigated

\footnote{This argument is also supported by Dhat et al. (2011), who find empirical evidence that the CDS price dynamics of the AAA ABX.HE 2006-1 index is positively associated with sales of non-agency mortgage backed securities by regulated U.S. financial institutions, and that this correlation dissipates once FASB eased the mark-to-market rules temporarily on April 2, 2009.}

\footnote{The authors study 23 index inclusions in total from January 2004 to May 2008.}
by regulators and that face litigation pressures are more timely in writing down their losses. On
the other hand, firms with higher financial leverage, tighter regulatory constraints, more complex
and less risky exposures are less timely in signaling their write-downs.

[Longstaff and Rajan (2008)] focus more directly on the pricing of tranches of the CDX investment
grade index and develop a three-factor CDO pricing model accounting for three independent sources
of risk: firm-specific risk, sector-wide risk and economy-wide risk.\footnote{Each source of risk is modeled as a separate Poisson process.} As previously discussed, CDOs provide useful information about the joint default probabilities, which cannot be inferred
from the marginal probabilities, individually. Hence the authors use the model to infer the market’s
expectations about default correlations. They estimated jump sizes of, respectively, 0.4%, 6% and
35%, corresponding roughly to situations in which, assuming a 50% recovery rate, either a single
firm defaults, 15 firms default or about 70% of all firms in the economy are wiped out.\footnote{Note that the CDX index is backed by 125 single name CDS. Thus one firm corresponds to 0.8% of the index. A single default multiplied by a 50% recovery rate yields 0.4%. A similar argument applies for the other categories.} Using
the intensity estimates, the authors decompose the level of the CDS index spread and find that,
on average, 64.4% of the total CDX index spread reflects firm-specific default risk, sector-specific
default risk represents 27.1% of the index, and economy-wide risk makes up for the remaining 8.3%.

[Bhansali et al. (2008)] apply a linearized version of the model in [Longstaff and Rajan (2008)] to
quantify the systemic risk component during the subprime financial crisis based on the information
embedded in CDX investment-grade and high-yield indices and their tranches. Two findings stand
out. First, the results seem to suggest that the increase in credit spreads during the 2007 subprime
crisis arose mainly because of a dramatic increase in economy-wide risk. This makes the subprime
crisis fundamentally different from the crisis in the automotive sector in May 2005, when economy-
wide risk was small in comparison to 2007, and sector-wide risk increased substantially. Second, the
equity tranche is mostly sensitive to firm-specific risk, while the senior and super-senior tranches
are more responsive to the economy-wide risk. In that sense, the super-senior tranches may be
interpreted as the market price for bearing economic catastrophe risk.

The argument that super-senior tranches in CDOs feature characteristics that resemble catast-
trophe bonds is articulated in [Coval et al. (2009)]. In other words, this means that the payoff
function of such senior tranche products is highly sensitive to the economic state in which default
occurs. Thus, investors ought to take into account not only state prices, but also the distribution of payoffs across economic states. In reality, however, it seems that the compensation offered from investing in super senior tranches reflected only expected payoffs, and they were, therefore, over-priced. This argument is not shared by Collin-Dufresne et al. (2012), who manage to reasonably fit tranche prices at all levels of subordination with an arbitrage free framework that allows for jump dynamics. The authors emphasize that using information from the entire term structure of CDS spreads is an important ingredient in the successful pricing of CDO tranches. While the previous studies have a primary interest in the super senior tranches, Longstaff and Myers (2014) focus on the equity tranche in the CDX.NA.IG and HY indices. The authors argue that CDOs may be viewed as synthetic versions of commercial banks by drawing analogies between the returns on the equity index tranche and returns of common banks, which share strong similarities. First, unconditional moments of equity tranche returns are more similar to those of equity than fixed income. Second, these similarities are particularly pronounced for stocks from the financial and bank sectors. Third, within banks, the relationship is more similar for banks with a larger balance sheet and a higher ratio of commercial loans. About two thirds of CDS equity returns can be explained by fundamental factors.

Berndt and Obreja (2010) empirically investigate the idea that super-senior tranches in synthetic credit indices reflect economic catastrophe risk in the context of European corporate CDS returns. They show that nearly half the variation in European corporate CDS returns can be explained by a factor that mimics economic catastrophe risk. The catastrophe factor is constructed as a portfolio of CDS returns maximally correlated with realized negative innovations in super senior tranche spreads of the iTraxx Europe index (12-22% cut-off). The factor construction is motivated by the fact that firm loadings on the first principal component of the correlation matrix of weekly CDS returns are high for firms with high credit quality and low equity volatility, but low for firms with low credit quality and high equity volatility. This is suggestive that the first principal component correlates substantially with firms whose payoff structure at default is closely tied to the economic state in which default occurs. In the cross-section, average portfolio returns line up with the loadings on the economic catastrophe factor, indicating that it is a priced factor in European credit markets.
Longstaff (2010) takes the price information in the ABX indices of subprime mortgage-backed securities at face value to study the underlying nature of contagion during the subprime financial crisis. He compares the lead-lag relationships in a VAR framework between returns on the ABX indices of subprime MBS and those in other markets during the pre-crisis period (2006), the subprime crisis period (2007) and the global financial crisis (2008). The conclusion is that contagion, defined as an increase in cross-market linkages, occurred through a liquidity channel, which spread from the less liquid subprime mortgage market to the more liquid Treasury market. Hypotheses of contagion through an information or risk aversion channel are ruled out.

Dieckmann and Plank (2011) are not interested in the housing market per se, but study the private-to-public risk transfer during the financial crisis. One of the hypotheses of the authors is that if governments explicitly or implicitly assumed financial sector liabilities during the crisis period, one might expect that a country’s CDS spread sensitivity toward the financial system is larger if domestic banks were heavily invested in the subprime sector. In order to capture a country’s exposure to the subprime sector, the authors use the ranked correlation in returns between the domestic financials and the ABX.HE index. However, countries’ exposure to the subprime mortgage sector does not appear to matter given the measurement based on the ABX.HE index. Finally Mizrach (2012) studies jumps in the prices of ABX.HE index tranches and finds that these discontinuous movements are significantly related to market news.

9 Summary and Future Research

We have provided a survey of the academic literature on credit default swaps (CDS) since their inception two decades ago. Although the history of the CDS market is relatively short, we have gained a reasonable understanding of the market, although several avenues for further research remain. For example, the conceptual foundations of pricing are well established but there are a number of issues relating to calibration of the models. In addition, the global financial crisis and the European sovereign debt crisis have highlighted several shortcomings of the CDS market and this awareness has stimulated a useful debate about the market structure, with many industry and regulatory changes to remedy some of these apparent shortcomings, both at the level of the
individual entity and the system as a whole.

The extant literature shows that corporate CDS do facilitate additional debt financing, given
the opportunity for lenders to hedge their credit risk. Consequently, corporate borrowers increase
their leverage and may be able to obtain looser loan covenants. However, this may also render
firms to be more prone to bankruptcy risk. Banks, on the other hand, tend to extend more loans
when they can access the CDS market. Much of this literature has been developed in the context
of the global financial crisis, during which the CDS market went through considerable stress.

The European debt crisis has sparked several research contributions that have improved our
understanding of the relationship between sovereign and bank risk. This stream of research has
been facilitated by the growth of the sovereign CDS market, and the sovereign default episodes
have uncovered regulatory uncertainties pertaining to the CDS market.

There remain however many unresolved, yet important, research questions that need to be
addressed in the future. The most pressing one relates to the aggregate welfare effect of the CDS
market. The current evidence seems to suggest that high-quality firms benefit from the presence
of the CDS market, in contrast to low-quality firms, which may be negatively affected. While
current research typically studies individual market participants, or a group, in isolation, it may be
beneficial to study all stakeholders jointly in a holistic framework, including CDS buyers and sellers
with the underlying borrower-lender relationship, regulators and other stakeholders.\footnote{See Anderson (2010) for such a discussion.}

Theoretical work on how CDS affect the debtor-creditor relationship (Bolton and Oehmke (2011)) and end-
users (Bolton and Oehmke (2014)) has stimulated research that seems to suggest that the existence
of CDS increases bankruptcy risk. This has obvious consequences for corporate policy that we need
to better understand, along the lines of, for example, Subrahmanyam et al. (2014a), who examine
how the existence of CDS trading affects corporate cash holdings.

While the U.S. and E.U. are putting in place stringent rules on CDS trading, China is embracing
the credit derivatives market with greater regulatory encouragement and spurring banks on to adopt
more sophistical financial innovations in credit risk management. However, it is interesting to note
that, even with strong government support, the CDS market initiative in China in 2010 has failed
to realize its potential, so far. In contrast, even under regulatory pressures, the credit derivatives
market continues to grow, particularly in the U.S., and to a lesser extent, even in Europe. New credit derivative products are constantly being introduced to the market. For instance, J.P. Morgan offered an exchange-traded fund (ETF) based on a basket of CDS in 2014. As documented by Ivanov et al. (2014), loan spreads are increasingly tied to CDS spreads since this practice was first introduced in late 2008. We anticipate that future studies will further our understanding about why the CDS market is so resilient in the U.S., but not so in other countries such as China.

Even though we do have a good understanding of CDS pricing, we continue to learn about market frictions that inhibit arbitrage between the CDS and the underlying bonds. In this context, the literature on liquidity and liquidity risk in CDS spreads has gained steam in recent years, and we expect this to continue. More transparency and the dissemination of CDS transactions data from the new Swap Data Repositories in the U.S. and elsewhere would help us better understand how frictions such as liquidity and counterparty risk play out in the data, just as the TRACE corporate bond data in the US significantly improved our knowledge about these frictions in the corporate bond market. Having detailed information jointly about the CDS and the related bond market would also allow us to study the important question of why both markets are not perfectly integrated.

Market segmentation across the loan, bond, and CDS markets, is another topic that deserves further attention. In particular, the loan CDS market is still in its infancy. It still requires more data to gain a good understanding of this market, including the pricing and implications of loan CDS. It would be premature to judge how the new trading conventions introduced in 2013, under the auspices of the Dodd-Frank act in the U.S. and the European Market Infrastructure Regulation will perform in the long run. Moreover, market participants are still anticipating greater regulatory uncertainties ahead given the ongoing anti-trust investigations in the U.S. and E.U. against major market players such as Markit.

The sovereign CDS literature highlights a strong co-movement of spreads across countries. While this co-movement appears to be linked to global risk factors originating in the US, we are still unclear about the micro-foundations that lead to this factor structure. The literature on the sovereign bank-nexus has further highlighted the dependence structure between sovereign and local financial risk. Thus, we need to deepen our views on the time-varying dynamics between global
and local risk factors for the determination of sovereign spreads. Using the information embedded in the term structure of spreads seems to be useful direction, as pointed out by Pan and Singleton (2008) and applied by Augustin (2013). Understanding the economics of sovereign CDS and their impact on the underlying cash market is particularly relevant in light of the current regulatory debate surrounding the use of sovereign CDS by speculators and the pros and cons of constraints on “naked CDS positions. Over time, we will gain more insight into the efficiency of the naked sovereign CDS ban in Europe. We look forward to future studies in this field that will allow us to deepen our understanding of the economics of this quickly developing and exciting market, based on new granular data on trading positions, and intra-day quotes and prices.

Another important debate surrounds the role of CDS for macro-prudential regulation. Hart and Zingales (Fall 2011) propose to regulate bank capital ratios by their CDS spreads, while Huang et al. (2009) propose to use the information from CDS to assess systemic risk of large financial institutions. Similarly, Flannery et al. (2010) argue that CDS spreads should replace credit ratings in financial regulations. Indeed, Chava et al. (2013) show that in the presence of CDS trading, credit rating downgrades have less impact on stock prices. Future studies can examine the real effect and implications of CDS-based regulations.

We conclude by emphasizing that we are hopeful that research on CDS will flourish in various directions. The complexities of the market provide for interesting debates to come. Our hopes are that this survey can serve as useful starting point for those unfamiliar with the literature, and as a comprehensive summary that nurtures reflections for those who are well acquainted with the diverse world of CDS.
References


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**URL**: http://dx.doi.org/10.1111/j.1755-053X.2012.01203.x


**URL**: [http://dx.doi.org/10.1111/0022-1082.285595](http://dx.doi.org/10.1111/0022-1082.285595)


Table 1: Sovereign Credit Default Swaps: Notional Amounts outstanding ('000,000,000)

Panel A of this table reports the total gross notional amount outstanding, in billion USD, of all OTC credit derivatives, of all credit derivatives (and their market share in % of all OTC derivatives) and sovereign credit derivatives (single-name and multi-name) with their respective market shares in % of all credit derivatives. Panel B shows the counterparties of sovereign single-name credit default swaps. Source: www.bis.org.

<table>
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<tr>
<th>Period</th>
<th>All OTC</th>
<th>All OTC Credit Derivatives (%)</th>
<th>Sov. All (%)</th>
<th>Sov. Single Name (%)</th>
<th>Sov. Multi-Name (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-H1</td>
<td>706,884</td>
<td>32,409 (4.58)</td>
<td>2,908 (8.97)</td>
<td>2,749 (8.48)</td>
<td>159 (0.49)</td>
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<tr>
<td>2011-H2</td>
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<td>28,626 (4.42)</td>
<td>3,039 (10.62)</td>
<td>2,928 (10.23)</td>
<td>111 (0.39)</td>
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<td>2012-H1</td>
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<td>26,931 (4.21)</td>
<td>2,986 (11.09)</td>
<td>2,846 (10.58)</td>
<td>138 (0.51)</td>
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<tr>
<td>2012-H2</td>
<td>632,579</td>
<td>25,069 (3.96)</td>
<td>2,941 (11.73)</td>
<td>2,799 (11.16)</td>
<td>145 (0.57)</td>
</tr>
<tr>
<td>2013-H1</td>
<td>692,908</td>
<td>24,549 (3.51)</td>
<td>3,243 (13.32)</td>
<td>3,098 (12.72)</td>
<td>145 (0.60)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Period</th>
<th>All Counterparties</th>
<th>Reporting Dealers</th>
<th>Other Financial Institutions</th>
<th>Central Counterparties</th>
<th>Banks and Security Firms</th>
<th>Insurance &amp; Fin. Guaranty Firms</th>
<th>SPVs</th>
<th>Hedge Funds</th>
<th>Other Financial Customers</th>
<th>Non-Financial Institutions</th>
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<td>828</td>
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<td>8</td>
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<td>2011-H1</td>
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<td>1,837</td>
<td>801</td>
<td>2</td>
<td>592</td>
<td>378</td>
<td>14</td>
<td>145</td>
<td>119</td>
<td>21</td>
</tr>
<tr>
<td>2012-H1</td>
<td>2,848</td>
<td>2,026</td>
<td>802</td>
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<td>378</td>
<td>14</td>
<td>145</td>
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<tr>
<td>2013-H1</td>
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<td>752</td>
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<td>378</td>
<td>14</td>
<td>145</td>
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</table>
Table 2: Trade Information Warehouse Data

This table is a replication of the statistics illustrated in [Augustin (2014)]. The table reports the average gross (Column 3) and net (Column 4) notional amount (in million USD) on CDS contracts outstanding in USD equivalents of the sovereign reference entities among the 1,000 mostly traded contracts over the time period 31 October 2008 through 12 April 2013. All numbers are reported in million USD. Column 5 indicates the average number of contracts live in the Depository Trust & Clearing Corporation’s (DTCC) Trade Information Warehouse (Warehouse) over the same time period. Column 6 reports the ratio of gross to net notional amount outstanding and column 7 is the average ratio of net notional amount outstanding to number of contracts outstanding. The notional values are represented as US dollar equivalents using the prevailing foreign exchange rates. Columns 8 and 9 report the gross amount of public debt in billion USD and the debt-to-DGP ratio as of 2012, taken from the World Economic Outlook database in Datastream Thomson Reuters. The final row labeled Total reports the sum over all rows for column 3, 4 and 5, and the average for columns 6 and 7. The values are reported in descending order according to the net notional amount outstanding. The countries are grouped in five regions: Americas, Asia ex-Japan, Australia and New Zealand, Europe/Middle East and Africa (EMEA) and Japan. Source: www.dtcc.com and Datastream/Thomson Reuters.

<table>
<thead>
<tr>
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<th>(4)</th>
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<tr>
<td>Country</td>
<td>DC Region</td>
<td>Gross Notional</td>
<td>Net Notional</td>
<td># Contracts</td>
<td>Gross/Net</td>
<td>Net/Contract</td>
<td>Debt</td>
<td>Debt/GDP</td>
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<tr>
<td>Italy</td>
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<td>22,513</td>
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<td>2,796</td>
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<tr>
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<td>10.56</td>
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<td>0.43</td>
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<tr>
<td>Greece</td>
<td>EMEA</td>
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<td>5,337</td>
<td>3,757</td>
<td>11.63</td>
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<td>Austria</td>
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<td>3.65</td>
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<tr>
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<td>4,216</td>
<td>6.49</td>
<td>2.12</td>
<td>1,517</td>
<td>2.37</td>
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<td>0.38</td>
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<tr>
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<td>Asia ex-Jp</td>
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<td>9.12</td>
<td>1.38</td>
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<tr>
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<td>Americas</td>
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<tr>
<td>Spain</td>
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<tr>
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<td>21,479</td>
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<td>4,216</td>
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<tr>
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<td>2.12</td>
<td>1,517</td>
<td>2.37</td>
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</tr>
</tbody>
</table>

Total/Average(*) 2,313,056 214,524 165,099 11.70 1.80 861 0.58

* Asterisks indicate significant differences.
Table 3: Multiname Derivatives by Rating: Notional Amount outstanding ('000,000)

This table reports the total notional amounts outstanding in million USD of over-the-counter derivatives and the market share (in %), broken down by risk category, counterparty and rating. Data on total notional amount outstanding are shown on a net basis, that is transactions between reporting dealers are reported only once. Source: BIS.

<table>
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<tbody>
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<td>42,580,546</td>
<td>57,402,759</td>
<td>36,098,169</td>
<td>30,260,923</td>
<td>32,409,444</td>
<td>26,930,572</td>
<td>24,349,452</td>
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<tr>
<td><strong>Single-name instruments</strong></td>
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<td>24,239,478</td>
<td>33,412,115</td>
<td>24,165,086</td>
<td>18,493,632</td>
<td>18,104,619</td>
<td>15,566,357</td>
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<td>(Fraction)</td>
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<td>58.21</td>
<td>66.94</td>
<td>61.11</td>
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<td>53.94</td>
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<tr>
<td>Multi-name instruments</td>
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<td>11,214,162</td>
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<td>44.14</td>
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<td>46.06</td>
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<td><strong>Multi-name Products by Rating</strong></td>
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<tr>
<td>AAA to AA</td>
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<tr>
<td>A to BBB</td>
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<td>BB and below</td>
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<td><strong>Multi-name Index Products by Counterparty</strong></td>
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<tr>
<td>SPVs, SPCs, or SPEs</td>
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</tr>
<tr>
<td>(Fraction)</td>
<td>18.58</td>
<td>18.58</td>
<td>18.58</td>
<td>18.58</td>
<td>18.58</td>
<td>18.58</td>
<td>18.58</td>
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<td>Hedge funds</td>
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<td>Other residual financial customers</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Non-financial institutions</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>(Fraction)</td>
<td>74,000</td>
<td>40,511</td>
<td>76,384</td>
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</table>
Table 4: Maturity Structure of Multi-Name Credit Default Swaps: Notional Amount Outstanding (’000,000)

Panel A of this table reports the total notional amount outstanding in million USD of multi-name credit default swaps by remaining maturity as well as their respective market shares (in %). Panel B reports the total notional amount outstanding in million USD of multi-name credit default swaps by sector as well as their growth and respective market shares (in %) as a fraction of total multi-name credit default swaps (in parentheses). *Sov* refers to Sovereigns, *Fin* to Financial Firms, *NonFin* to Non-Financial Firms and *Sec* to Securitised Products and Multiple Sectors. Data on total notional amount outstanding are shown on a net basis, that is transactions between reporting dealers are reported only once. The remaining contract maturity is determined by the difference between the reporting date and the expiry date of the contract and not by the date of execution of the deal. Source: BIS.

### Panel A: Multi-name Products by Maturity (’000,000)

<table>
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<tr>
<th>Year-Half</th>
<th>Total</th>
<th>MultiName</th>
<th>Fraction</th>
<th>1y or less</th>
<th>Fraction</th>
<th>Over 1y up to 5y</th>
<th>Fraction</th>
<th>Over 5 years</th>
<th>Fraction</th>
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<tr>
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<tr>
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<tr>
<td>2009-H2</td>
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</tr>
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<td>2,449,945</td>
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<td>3,706,826</td>
<td>11.44</td>
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<td>1,896,661</td>
<td>7.79</td>
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### Panel B: Multi-name Products by Sector (’000,000)

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<tr>
<th>Year-Half</th>
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<th>Multi Name Sov</th>
<th>Growth</th>
<th>Multi Name Fin</th>
<th>Growth</th>
<th>Multi Name NonFin</th>
<th>Growth</th>
<th>Multi Name Sec</th>
<th>Growth</th>
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<td>2005-H1</td>
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<td>2006-H2</td>
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<tr>
<td>2007-H1</td>
<td>18,341,068</td>
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<tr>
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<tr>
<td>2009-H1</td>
<td>11,933,083</td>
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<tr>
<td>2011-H1</td>
<td>14,304,825</td>
<td>158,516 (1.11)</td>
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<td>8,083,088 (20.53)</td>
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<tr>
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<td>111,272 (0.95)</td>
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<td>2,566,443 (21.82)</td>
<td>-11.97</td>
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<tr>
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<td>6,793,025 (14.33)</td>
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<tr>
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<td>6,404,402 (13.59)</td>
<td>-7.20</td>
<td>6,342,604 (56.56)</td>
<td>-1.03</td>
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</table>
Figure 1: Timeline for the CDS Market

This figure presents a time-line with major developments in the CDS market from 1994 to 2014.
Figure 2: Global Gross Notional Amount Outstanding in the CDS Market

This figure presents the global gross notional amount outstanding in the CDS market in billions of U.S. dollars. The data are from the Bank for International Settlements (www.bis.org). Panel A presents the gross notional amount outstanding for all CDS contracts. Panel B separates the gross notional amount outstanding of CDS for single-name and multi-name CDS. Panel C dissects the notional amount by credit ratings.

Panel A: All CDS
Panel B: Single-name and Multi-name CDS

Panel C: All CDS by Credit Ratings
Figure 3: CDS-BOND Basis

This figure provides an illustration of the CDS-Bond basis, i.e. the difference between a CDS spread and the credit spread on the same underlying bond, for a selected sample of 177 bonds. The red line relates to the credit spread, the green line to the CDS spread, and the blue line to the CDS-Bond basis. Source: Authors’ computation.

Figure 4: Standardized Credit Index Tranches: iTraxx

This figure provides an illustration of the attachment and detachment points of tranches written on the underlying iTraxx Europe Main Index.