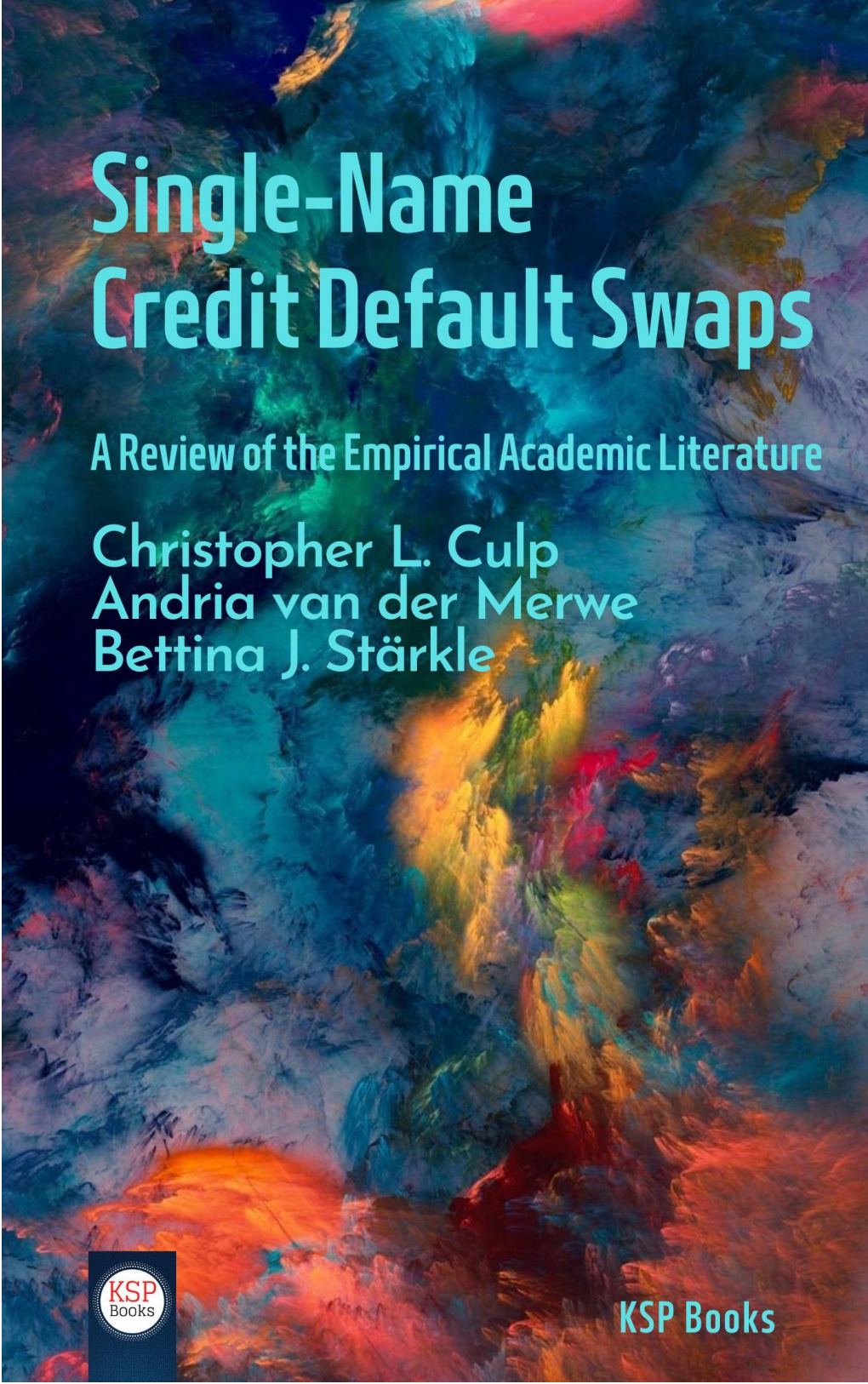
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ISBN: 978-625-8190-83-0 (e-Book)
KSP Books 2023

Single-Name Credit Default Swaps: A Review of the Empirical Academic Literature

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Abbreviations and Acronyms

ABCDS	CDS Based on an Asset-Backed Security
ABS	Asset-Backed Securities
APD	Arbitrage-Pricing Difference
BIS	Bank for International Settlements
bps	basis points
CAC	Collective Action Clauses
CBOT	Chicago Board of Trade
CCAR	Comprehensive Capital Analysis and Review
CCP	Central Counterparty
CDO	Collateralized Debt Obligation
CDS	Credit Default Swap
CLO	Collateralized Loan Obligation
CSA	Credit Support Annex
CTD	Cheapest-to-Deliver
DC	Determinations Committee
ECB	European Central Bank
EDF	Expected Default Frequency
EFSF	European Financial Stability Facility
EMEA	Europe, Middle East, and Africa
EMIR	European Market Infrastructure Regulation
FINRA	Financial Industry Regulatory Authority
FSB	Financial Stability Board
FSOC	Financial Stability Oversight Council

FV	Face Value
ICE	InterContinental Exchange
IMF	International Monetary Fund
IMM	Initial Market Midpoint
ISDA	International Swaps and Derivatives Association
LBO	Leveraged Buyout
LCDS	Loan CDS
LGD	Loss Given Default
LIBOR	London Interbank Offered Rate
M&M	Modigliani-Miller Proposition(s)
NRAM	Northern Rock Asset Management PLC
OECD	Organisation for Economic Co-operation and Development
PAUG	Pay As You Go
PSI	Private Sector Involvement (related to E.U. sovereign debt crisis)
PPDM	Primary Price Discovery Market
RFV	Recovery of Face Value
RMV	Recovery of Market Value
SOE	State-Owned Enterprise
SRO	Standard Reference Obligation
SSRN	Social Science Research Network
TBTS	Too Big to Save
TRACE	Trade Reporting and Compliance Engine

Foreword

Single-name credit default swaps ("CDSs") are derivatives based on the credit risk of a single borrower such as a corporation or sovereign. Although the single-name CDS market expanded rapidly during the period of loose monetary policy and expanding credit from 2002 through 2007, its growth began to slow after the global credit crisis and during the Eurozone sovereign debt crisis in 2010 and 2011, after which the single-name CDS market began to contract. In recent years and despite deliberate efforts by the International Swaps and Derivatives Association ("ISDA") and market participants on both the buy and sell sides, the single-name CDS market shifted from stagnating growth to an actual contraction and has shrunk substantially. At its high-water mark in June 2011, the total notional amount outstanding on single-name CDSs based on corporate and sovereign borrowers was $15.4 trillion. By June 2015, notional outstanding had collapsed to $6 trillion – i.e., a contraction of 61 percent over four years.

Several possible reasons may explain the recent decline in single-name CDS activity. One possibility is that the current environment of relatively low interest rates and default rates

has reduced the demand for hedging and synthetic bond investments (a.k.a. taking a position on the credit risk of a borrower) using CDSs. Another oft-cited potential explanation for the post- 2011 contraction in the single-name CDS market is the panoply of changes to the global financial regulatory framework, such as margin and capital requirements on cleared and non- cleared swaps and the ban in the E.U. on short selling using sovereign CDSs. Such regulatory changes have already reportedly raised costs and decreased demand for single-name CDSs (or for hedging entity-specific credit risk altogether) even though many regulatory initiatives have still not been implemented in final form.

Some skeptics of single-name CDSs believe that the products themselves may have been defective prior to some of the reforms undertaken following the credit crisis and Eurozone sovereign debt crisis. Indeed, despite any significant evidence, a few commentators maintain that CDSs were either a cause or significant source of amplification for the credit crisis that migrated from U.S. subprime and leveraged finance markets to the global credit system beginning in August 2007.

To provide a more widespread and better understanding of the benefits and costs of single-name CDSs, we were commissioned by ISDA to prepare a review of the empirical academic literature on these products. Specifically, we restricted our review to single-name CDSs based on corporate and sovereign borrowers and did not consider the research on multi- name and/or index CDSs, loan CDSs, or CDSs based on asset-backed securities. The scope of our review included empirical research published in peer-reviewed academic journals, quasi- academic/trade journals with largely academic editorial boards, and working papers distributed through the Social Science Research Network ("SSRN"), universities, and the research divisions of financial regulators (e.g., the Bank for International Settlements, European Central Bank, and Federal Reserve). Our review did not include a survey of industry research, articles in industry and trade magazines or journals, and mainstream media publications. Although we have made every effort to be

comprehensive and reviewed more than 260 empirical studies, comprehensive is not synonymous with exhaustive, and we offer our apologies for any research we might have missed.

To frame our literature review and analysis, we considered four major subject areas into which most single-name CDS research can be divided:

(a) The informational content and determinants of single-name CDS spreads;
(b) Implications of single-name CDS trading for lenders and reference entity borrowers;
(c) Relations between single-name CDS markets and related debt and equity markets; and
(d) Single-name CDSs, interconnectedness, and systemic risk.

In the four sections below, we summarize 15 conclusions that we reached from our review of the empirical literature in these four topic areas.

In the four sections below, we summarize 15 conclusions that we reached from our review of the empirical literature in these four topic areas.

A. Informational Content and Empirical Determinants of Single-Name CDS Spreads

1. Single-name CDS spreads contain valuable information about the probability and severity of adverse credit events that the underlying reference entity may experience during the life of the CDS.

Significant empirical evidence indicates that CDS spreads and/or changes in spreads contain information that can be used to estimate the probability of future adverse credit events at the underlying reference entity, as well as market participants' expectations about recovery rates and loss given default. We did not identify any evidence in our review that the connection between CDS spreads and the information they reflect about reference entities has become weaker during the recent years in which CDS activity has declined. The informational content of CDS spreads thus remains significant,

which is essential for single-name CDSs to be useful credit risk transfer mechanisms.

> *2. Single-name CDS spreads reflect a risk premium that protection sellers demand to compensate them for reference entity-specific and systematic risks (both credit-related and non-credit-related).*

One of the largest bodies of empirical academic research on single-name CDSs concerns the risk premium reflected in CDS spreads. Part of this risk premium is related to the credit risk of the reference entity. Specifically, CDS spreads reflect expected credit losses but also include a risk premium demanded by protection sellers to compensate for the risk of unexpected losses and changes in recovery rates.

The academic literature also identifies the following additional determinants of the risk premium reflected in single-name CDS spreads: volatility of the reference entity's equity price; leverage of the underlying reference entity; liquidity risk for the cash bonds of the reference entity and a market-wide liquidity risk factor; market-wide investor sentiment and risk aversion; and macroeconomic conditions. For CDSs with restructuring specified as a credit event, protection sellers demand additional compensation for bearing restructuring risk. For sovereign borrowers, moreover, both national and global macroeconomic conditions impact CDS spreads.

> *3. Single-name CDS spreads are anticipatory and contain information regarding future announcements about the credit risk and financial condition of the underlying reference entity.*

Using the time-honored and well-established "event study" methodology in financial economics, abnormal single-name CDS spreads (i.e., single-name spreads in excess of spreads on a relevant index or basket) are found to provide information about credit events before such events occur, as well as additional information subsequent to the event or announcement. In particular, significant evidence indicates that CDS spreads reflect negative actions by credit rating agencies, including downgrades, reviews for downgrades, and negative outlooks prior to the rating action. Interestingly, there

is little evidence to indicate that single-name CDS spreads anticipate positive actions by credit rating agencies.

CDS spreads also provide anticipatory information about events other than rating actions.

For example, studies have found that single-name CDS spreads anticipate both earnings and dividend announcements or surprises and can be used to analyze both the anticipation and impact of public policy announcements (e.g., government bailouts of banks and sovereign rescue packages).

B. Implications of Single-Name CDS Availability for Lenders and Reference Entity Borrowers

1. Single-name CDSs are used by financial institutions to achieve their desired risk/return profiles and commercial objectives. Little empirical evidence supports the often-voiced belief that banks' usage of single-name CDSs translates into more aggressive and riskier lending decisions.

Some have expressed concerns that the availability of single-name CDSs can give rise to moral hazard and incentivize banks to make riskier lending decisions. Single-name CDSs are not the sole means by which banks manage their credit exposures. In addition to purchasing credit protection through CDSs, lenders also have other choices such as syndicating loans in the primary market or selling loans or loan participations on the secondary market. Loan sales combined with securitizations can transfer all but the first-loss exposure of a loan portfolio to investors in other financial instruments like collateralized loan obligations.

The literature on how banks use single-name CDSs is somewhat ambiguous. Some research indicates that banks use CDSs primarily in their capacity as dealers and rely more heavily on loan syndications, sales, and securitization for credit risk management. Other studies indicate that single-name CDSs are an efficient means of hedging credit risk, especially for loans to high-quality borrowers for which monitoring costs are high. Yet, further research indicates that some banks and insurance companies are net sellers of credit protection and use CDSs primarily to generate income as

compensation for deliberately and selectively assuming credit risk. Lead arrangers in loan syndicates also tend to be net sellers of CDS protection to other syndicate members to mitigate concerns about moral hazard in the syndication process.

The main conclusion thus seems to be that banks use single-name CDSs to help achieve their desired risk/return profile and commercial objectives. Because of the bank-specific nature of risk, return, and commercial objectives, it is not entirely surprising that banks use single-name CDSs to help accomplish their goals as efficiently as possible, the implication of which varies from bank to bank given their different and sometimes disparate goals. This evidence supports other academic research showing that firms' uses of non-credit derivatives also depends on their specific risk management objectives and cannot easily be generalized across groups of firms (even within the same industry). (See, e.g., Tufano, 1998; and Stulz, 1996, 2015).

2. The empirical evidence is mixed regarding the impact of bank CDS usage on the ongoing monitoring of the credit risks of their borrowers.

Another potential concern with CDSs is that bank hedging with single-name CDSs could attenuate banks' incentives to engage in costly monitoring of borrower credit risks. As noted in the summary for Conclusion 4, there is some evidence that single-name CDS hedging is indeed more popular for loans to borrowers with high monitoring costs. Less monitoring for such borrowers, however, is not necessarily commensurate with higher risks. If high monitoring costs lead to less bank monitoring regardless of the availability of CDSs then public monitoring of borrowers through CDS spreads (which aggregate all market participants' expectations) could on net provide more discipline on borrowers. To the extent that borrowers with higher monitoring costs are also higher quality and lower risk, any increases in borrower risk that result from reduced monitoring may be insignificant at the margin.

The literature reveals different results for passive and active monitoring of bank borrowers. An example of passive

monitoring is the use of loan covenants – i.e., pre-emptive restrictions on borrowers that prevent them from undertaking certain activities that increase their credit risks – whereas examples of active monitoring include ongoing reviews of borrowers' financial statements, interviews with senior management, and the like. Some of the empirical research indicates that borrowers with traded CDSs engage in less conservative financial reporting and are subject to more restrictive covenants, or increased passive monitoring. The research also indicates that certain lenders – especially lead arrangers in bank loan syndicates – engage in more scrupulous active monitoring prior to the introduction of CDSs and engage in fewer CDS credit protection purchases (and perhaps even engage in CDS protection sales to other syndicate members on their reference entity borrowers) after the introduction of single- name CDSs.

On the whole, the empirical evidence indicates that the impact of single-name CDSs on banks' borrower credit monitoring depends on how banks use the CDSs. For protection buyers, there is some evidence of reduced monitoring of borrowers underlying the banks' CDS protection purchases. For CDS protection sellers, the evidence suggests – together with the regular pro rata allocation of syndicated loan facilities – that lead arrangers have adequate (and perhaps even stronger-than-usual) incentives to engage in diligent ongoing borrower monitoring.

> *3. Single-name CDSs positively impact the supply of credit to borrowers that are reference entities underlying traded CDSs.*

The impact of the availability of CDSs on the supply of credit to reference entities underlying those traded CDSs tends to be positive. Saretto & Tookes (2013) find that the introduction of single-name CDSs is associated with increased extensions of credit to reference entities. Shan, Tang, & Yan (2014) find that banks which report open CDS positions in their financial statements actively use single-name CDSs to extend more credit, make larger loans in general, and are more likely to extend larger loans to reference entities underlying traded single- name CDSs.

A slightly more ambiguous story is told by the data analyzed in Hirtle (2009), who finds that the impact of CDS trading on reference entity credit supply depends on the type of borrower and loan facility. Specifically, for relatively larger and lower-risk firms, CDS trading is associated with greater extensions of term-loan credit, whereas the introduction of single-name

CDSs appears to have little or no impact on loan commitments or bank lending through small term loans and to small borrowers. (Hirtle, 2009) Unlike some of the other studies, however, Hirtle (2009) only analyzes the impact of CDSs on bank loans, whereas studies such as Saretto & Tookes (2013) find that the introduction of CDSs primarily increases the availability of credit to reference entity borrowers through increased corporate bond issuance.

> *4. The impact of single-name CDSs on the cost of credit to borrowers that are reference entities underlying traded CDSs depends on the characteristics of the borrowers and whether or not the credit spread is fixed or indexed to CDS spreads.*

Several empirical studies have documented different impacts of the introduction of single-name CDSs on reference entities' borrowing costs. In general, the availability of single-name CDSs tends to lower borrowing costs for corporate and sovereign reference entities which are informationally transparent and relatively low-risk, whereas borrowing costs can rise after the introduction of single-name CDSs for relatively more opaque and higher-risk corporates and sovereigns. (Ashcraft & Santos, 2009; Ismailescu & Phillips, 2015) Norden, Buston, & Wagner (2014) find, moreover, that banks using single-name CDSs for hedging realize benefits and cost savings that they pass along to borrowers in the form of lower funding costs, and that banks using CDSs exhibited smaller losses and a more stable supply of loans during the credit crisis. For large corporate borrowers, the evidence indicates that, although the availability of credit and the size of loan facilities are higher after the introduction of CDSs, the increased credit supply is accompanied by higher borrowing

costs at banks that actively hedge using single-name CDSs. (Hirtle, 2009; Shan, Tang, & Yan, 2014).

The introduction of CDSs is also associated with an increase in the maturity of term loan facilities (Hirtle, 2009; Saretto & Tookes, 2013). Although maturity is a non-price term of bank credit facilities, borrowers often consider longer-term debt more desirable – especially for relatively more opaque firms that expect a deterioration in their credit rating. In this sense, the impact of listing CDSs on the maturity structure of borrowers' debt may also be beneficial for certain borrowers.

The impact of traded single-name CDSs on borrowing costs for reference entities underlying traded single-name CDSs is also affected by whether or not the loan facilities specify a credit spread (over a base floating rate like LIBOR) that is indexed to the borrower's CDS spread. CDS-indexed loans are known as market-based loans, and the empirical evidence indicates that the borrowing cost on market-based loans are lower than on similar loans priced with fixed credit spreads, both at origination and over the lives of the loans. (Ivanov, Santos, & Vo, 2016).

> 5. *The availability of traded single-name CDSs can influence the capital structure and corporate financing decisions of reference entity borrowers.*

Some research is available that examines the impact of single-name CDS trading on the capital structure and financing decisions of reference entities underlying traded CDSs. As noted in Conclusion 7, the introduction of CDSs enables at least some firms to have greater access to longer-dated term loans and longer-maturity bonds, thus indicating an impact of CDSs on the debt maturity structure of reference entity borrowers. Saretto & Tookes (2013) find that, even for firms with similar credit ratings, borrowers that are reference entities underlying traded CDSs have higher leverage ratios and longer debt maturities.

Danis & Gamba (2016) analyze how the onset of CDS trading affects a firm's trade-offs between investment, equity financing, and debt financing. The authors find that the initiation of CDS trading is associated with increases in the

reference entity's leverage and investment but has no appreciable impact on its borrowing costs.

> *6. The existence of creditors with hedged exposures to borrowers (so-called "empty creditors") and the amount of hedged credit have ambiguous implications for the bankruptcy decisions of single-name CDS reference entities.*

A frequent criticism of single-name CDSs is that lenders to a reference entity can use CDSs to eliminate their ongoing credit exposures to borrowers but retain their control rights in debt renegotiations, restructurings, and bankruptcy determinations. This "empty creditor hypothesis" holds that such hedged creditors have incentives to force reference entity borrowers into bankruptcy prematurely even when a restructuring or out-of-court debt renegotiation would better preserve the long-term value of the firm (Hu & Black, 2008a, 2008b).

Several studies report empirical results that support the negative implications of the empty creditor hypothesis for firms with traded single-name CDSs. Specifically, some empirical research indicates that reference entities exhibit higher probabilities of default and/or more frequent bankruptcy filings after the beginning of single-name CDS trading. (Peristiani & Savino, 2011; Subrahmanyam, Tang, & Wang, 2014) In addition, some research indicates that borrowers with significant amounts of hedged creditors may also face higher borrowing costs (Narayanan & Uzmanoglu, 2014).

Other research indicates that whether or not empty creditors lead to suboptimal bankruptcy filing decisions, the existence of hedged creditors can have an ex-ante beneficial impact on a reference entity's borrowing costs and debt capacity. Specifically, the presence of hedged creditors with relatively greater bargaining power in debt renegotiations can discourage borrowers from engaging in so-called strategic defaults (i.e., situations in which a firm has sufficient cash to service its debt but attempts to renegotiate the debt to divert cash to other uses). (See, e.g., Bolton & Oehmke, 2011 and Colonnello, Efing, & Zucchi, 2016). Shan, Tang, & Winton

(2014) find support for the hypothesis that CDS protection purchases mitigate incentives for borrowers to engage in strategic defaults. Their empirical analysis shows that lenders loosen loan covenants after the introduction of CDS trading and that (consistent with the related empirical literature) the relaxation of loan covenants is more pronounced for firms with relatively more transparent financial statements and relatively lower perceived default risks.

Altman & Karlin (2009), moreover, present information that is at odds with the predictions of the empty creditor hypothesis. Specifically, they find that the number of restructuring events (as a percentage of default events) between 1984 and 2009 increased significantly after 2003 when a ISDA made a major revision in its Credit Derivatives Definitions and when single-name CDS market activity was on the rise. The correlation between the frequency of adverse credit events and restructurings (as opposed to bankruptcy filings), moreover, is nine percent over the whole sample period but jumped to 90 percent after 2003.

Because the empty creditor hypothesis implies a larger number of bankruptcies and a lower correlation between adverse credit events and out-of-court restructurings following the introduction of single-name CDS trading, the evidence calls into question the negative implications of the empty creditor hypothesis. (Mengle, 2009) Nevertheless, the authors do not control for the various other potentially relevant events that may have occurred around 2003.

C. Relations between Single-name CDSs and Related Markets

> *7. Single-name CDSs are the primary markets for price discovery when compared to corporate bonds and often also lead equity markets in processing new information about underlying reference entities.*

Price discovery is the process by which trading incorporates new information and market participants' expectations into asset prices. The relatively low transaction costs and higher market liquidity of many derivatives markets relative to their corresponding underlying cash markets

generally result in new information about assets being reflected in derivatives prices first. Single-name CDSs are no exception, at least for CDSs with corporate reference entities.

The empirical evidence overwhelmingly supports the conclusion that single-name CDSs lead corporate bonds in price discovery, which is not surprising given the illiquidity in cash corporate bonds relative to single-name CDSs. The results are more ambiguous when CDSs are compared to equities, partly because the empirical evidence is more sample-specific. In particular, single-name CDSs and equities are at times both primary price discovery markets, with the informational dominance often switching depending on whether market conditions are stable or stressed (although the research is at odds as to which of the two markets dominate during stressed periods). The informational dominance of CDSs vs. equities also seems to vary between U.S. and European samples, which may indicate the different regulatory costs and levels of transparency in these jurisdictions.

The empirical results are also ambiguous concerning where price discovery happens for sovereign credit risk. Whether the sovereign debt or sovereign CDS market dominates depends on the country, the nature of the underlying information being processed, and in some cases the sample period.

> *8. The introduction of single-name CDS trading has adverse impacts on the liquidity of related debt and equity markets, at least initially.*

After the inception of single-name CDS trading, large institutional traders migrate from corporate bonds to single-name CDSs. As a result, corporate bond market trading volume declines and bid-ask spreads rise. The empirical research also suggests that equity markets become less liquid (in terms of reduced volume and higher spreads) and more volatile after the introduction of single-name CDS trading, especially for firms in distress.

Some evidence suggests, however, that the adverse impact on cash market volume and volatility is limited to the short term after the introduction of single-name CDSs. Given the valuable information conveyed by CDS spreads, the quality of

overall public information about the credit risk of the underlying reference entity is generally improved by the introduction of CDSs. Some of the trading volume that migrated from cash markets into CDSs markets may flow back into cash markets, moreover, as inter-market arbitrage between CDSs and cash bonds and capital structure arbitrage between CDSs and equities become more prevalent.

9. Differences in credit spreads for the same reference entity observed in single-name CDSs and corporate bonds (the "CDS-bond basis") are driven by differences in market liquidity, funding costs, counterparty risk, and the design of the financial products.

In theory, the CDS-bond basis should be zero for par bonds. In reality, various economic and institutional factors can lead to a non-zero CDS-bond basis. The empirical evidence indicates that a positive basis (i.e., CDS spreads exceed bond spreads) is caused by some mixture of the value of the cheapest-to-deliver option held by protection buyers in physically settled CDSs, the issuance of new bonds by the reference entity, and the degree of any "specialness" on a bond eligible for physical delivery in a CDS in the repo market (i.e., a repo rate that deviates from the general collateral rate as a result of excess demand for the specific bond). A negative CDS-bond basis can arise, by contrast, as a result of illiquidity in the corporate bond market, counterparty risk in the CDS market (especially following the Lehman Brothers failure), and variables that inhibit inter-market arbitrage (e.g., funding constraints, margin requirements, and economic or regulatory capital constraints). The empirical evidence regarding the often-significant and persistent negative CDS-bond basis that occurred during the credit crisis is consistent with the importance of these variables and was especially influenced by funding constraints, margin requirements, and capital constraints.

D. Single-Name CDSs, Interconnectedness, and Systemic Risk

10. Single-name CDSs on corporate and banking reference entities are a source of interconnectedness and contain

information that may be valuable to policy makers in measuring potential systemic risk. Yet, there is a dearth of empirical evidence to indicate that single-name CDSs are systemically de-stabilizing.

Following the credit crisis, the academic literature on the quantitative measurement of interconnectedness across financial institutions and systemic risk has burgeoned. A large number of studies include information from single-name CDS spreads as inputs for computing these risk measures. CDS spreads are valuable for such purposes both because they convey useful information about credit risk and are themselves a source of interconnectedness on inter-dealer CDS transactions.

Yet, no significant or persuasive empirical evidence in the academic literature supports the notion that single-name CDSs either caused the credit crisis or amplified shocks during the crisis, or are systemically de-stabilizing. Especially in light of the credit risk transfer benefits of single-name CDSs documented elsewhere in this review and the literature, a more realistic interpretation of the empirical evidence as a whole is that single-name CDSs help diversify default risk (especially for holders of corporate bonds), although it is unclear whether or not the parties to which default risk is being transferred are relatively more informed or financially stronger than the originators of such credit risks.

11. Sovereign CDSs are significant transmission mechanisms for economic shocks but not a cause of those shocks.

A significant amount of empirical literature analyzes the role played by sovereign CDSs in the transmission of both financial and macroeconomic shocks, and the academic research is consistent in finding that sovereign CDSs do give rise to linkages across sovereign credits. Yet, the exact nature of these linkages is sample-specific (e.g., some evidence indicates that shocks originating in peripheral or smaller countries are transmitted to large, core countries, whereas other evidence suggests the opposite or a bilaterally integrated feedback loop).

The literature on sovereign CDSs and interconnectedness also investigates whether the shocks transmitted across sovereign credits during the Eurozone sovereign debt crisis were primarily based on macroeconomic shocks in individual countries or a global common risk factor. Although not unambiguous, most empirical evidence suggests that the Eurozone crisis was driven both by changes in individual countries' macroeconomic and fiscal fundamentals and at least one common global factor that explains some of the co-movements in sovereign CDS spreads.

> *12. A well-documented "sovereign-bank" loop exists in which the financial condition of the banking sector and sovereign credit risk are interconnected. Single-name CDS spreads for banks and sovereigns provide strong information that government bailout programs of banks significantly intensify this feedback loop. Although single-name CDSs do not appear to play a causal role in this feedback loop, sovereign CDS spreads can provide policy makers with valuable information about the characteristics of this feedback loop.*

When the financial condition of a national banking system deteriorates, government bailout programs and other public sector support can place fiscal strains on the sovereign's credit and lead to heightened sovereign risk. Increased sovereign credit risk, in turn, reduces the value of sovereign debt (often held by local banks), calls into question the value of future government guarantees, and can jeopardize the sovereign's credit rating, all of which place further downward pressure on the financial condition of the banking system. Empirical analyses of this sovereign- bank loop often relies on the information contained in bank and sovereign single-name CDS spreads, and the evidence strongly supports that such a loop exists and is intensified in countries that adopt large-scaled bank bailout programs.

1 Introduction

Background and Motivation

Single-name credit default swaps ("CDSs") are derivatives based on the credit risk of a borrower such as a corporation or sovereign. During the period of loose monetary policy and expanding credit from 2002 through 2007, single-name CDSs were actively traded and notional amounts outstanding grew at an unprecedented pace. The substantial growth of the single-name CDS market in this period reflected the popularity of market participants using CDSs to manage credit risk and/or take positions on the credit of borrowers during a period in which leverage was expanding dramatically. After the global credit crisis that erupted in August 2007 and expanded throughout 2008 (hereinafter, the "credit crisis"),[1] followed by the Eurozone

[1] U.S. subprime mortgage lending markets were under pressure from at least 2005 onwards, and related subprime ABS markets were affected significantly beginning in February 2006. August 2007, however, is generally regarded as the time at which the mortgage crisis burgeoned into a more widespread credit crisis. See, e.g., Borio (2008), Greenlaw, Hatzius, Kashyap, & Shin (2008), Mishkin, (2011), and Gorton & Metrick (2012).

sovereign debt crisis from 2010-2012, single-name CDS market activity began to wane.[2] In 2011, at the high water market for the single-name CDS market, the average weekly volume of single-name CDSs traded was $140 billion, as compared to an average weekly trading volume of $57 billion in 2016 (i.e., a 60 percent contraction over the last five years) (Rennison & Childs, 2016).

A February 4, 2016, story in the Financial Times stated that single-name CDSs "are experiencing renewed growth after a long period of decline" (Stafford & Rennison, 2016). Yet, an article in the Financial Times just four months later stated that "[i]nvestors...have all but lost the ability to buy a...single-name credit default swap" (Rennison & Childs, 2016). Such cognitive dissonance makes it difficult to assess the state of the single-name CDS market based solely on popular media accounts, and, indeed, the data indicates that neither of those two extremes is entirely accurate.

Despite the recent portrayal by some of the single-name CDS market's demise, there is little doubt that the market has shrunk appreciably and been plagued with its fair share of problems and controversy. Amongst the most frequently cited reasons for the decline in single- name CDS activity since 2011 is the series of sweeping changes to the global financial regulatory framework that have been (and continue to be) implemented following the crisis.

Three of the most significant changes that have impacted CDSs include the revised Basel Accord (i.e., Basel III), which significantly increases the capital costs of trading certain single-name CDSs, as well as the ban in the E.U. on short selling using CDSs (i.e., buying CDSs without owning an obligation of the reference entity), and the mandated clearing of some CDSs by central counterparties ("CCPs") under the Dodd-Frank Wall Street Reform and Consumer Protection Act ("Dodd-Frank") in the U.S. and the European Market Infrastructure Regulation ("EMIR") in the E.U. The first two regulatory reforms have had a decidedly chilling impact on

[2] We discuss some of the reasons for the recent decline in single-name CDS activity in more detail below.

single-name CDS trading. In addition to regulatory changes, the relatively low default rate on corporate debt has also suppressed the demand for hedging credit risk.

The third regulatory reform (i.e., mandated clearing) thus far only has applied to multi- name CDS index products and has not had a direct impact on single-name CDSs as of the date of this publication. Nevertheless, the significant expansion of CCP capabilities and services to clear interest rate derivatives and CDSs subject to mandated clearing requirements under Dodd-Frank and EMIR has had an indirect benefit for single-name CDSs – i.e., significantly expanded opportunities for market participants to engage in the voluntary clearing of single-name CDSs.

For example, a group of 25 major buy-side investment management firms committed in December 2015 to begin clearing their single-name CDS transactions through CCPs such as the InterContinental Exchange ("ICE").[3] In addition to the December 2015 buy-side initiative, the International Swaps and Derivatives Association ("ISDA") has also undertaken various efforts to revitalize the single-name CDS market (Rennison, 2015).

Another possible explanation for the decline in single-name CDS volume and notional amounts outstanding, of course, is that in their original form (i.e. before the implementation of new market practices), single-name CDSs might have been inherently defective (Brown & Hao, 2012). Some contend (despite a lack of any significant empirical evidence) that single-name CDSs "caused" the credit and Eurozone sovereign debt crises. As we discuss in Section II of this paper, some legitimate deficiencies in certain CDS documentation and market practices have been identified and addressed over time, but many of the more sweeping and often hyperbolic criticisms of single- name CDSs are not supported by the empirical evidence.

Although some of the issues and controversy surrounding single-name CDSs are subjective and qualitative, the majority

[3] Certain CDS index products are subject to mandatory clearing requirements, whereas single-name CDSs are not.

of such issues are empirical and testable. Examples of empirical questions that can help explain the value (or lack there of) of single-name CDSs include the following:

- What information is contained in CDS spreads about the credit risk of the underlying borrowers? In particular, do single-name CDSs convey valuable information about the likelihood and severity of a borrower credit event in the future?
- Do single-name CDSs enable banks to manage their credit risk more efficiently, or do they incentivize and facilitate additional bank risk-taking?
- Does the availability of single-name CDSs to banks result in attenuated monitoring of the credit risks of their borrowers?
- Do single-name CDSs impact the supply and cost of credit to borrowers on which CDSs are traded (or other borrowers in general), and, if so, what is the impact?
- Does the ability for a lender to a reference entity to hedge its exposure with single-name CDSs give rise to "empty creditors" (i.e., creditors that eliminate their credit exposure to borrowers but retain their control rights), and, if so, do those empty creditors prematurely and inefficiently force ailing firms into bankruptcy instead of negotiating restructurings that would allow the reference entity to remain in operation?
- Do single-name CDS spreads lead or lag corresponding debt, equity, and options markets in processing and reflecting new information?
- How has the introduction of single-name CDS trading impacted the volatility, liquidity, and informational efficiency of related equity, debt, and options markets?
- What economic factors drive the difference between credit spreads for a reference entity as reflected in single-name CDSs compared to credit spreads implied by the entity's cash bonds?
- Are single-name CDSs a source of heightened interconnectedness and potential systemic risk in the banking and financial systems?

- Do single-name CDS contain information that can be used by policy makers to improve their quantitative measurements of systemic interconnectedness?

Since the advent of single-name CDS trading in the 1990s, a large academic literature has evolved that examines all of the above questions/issues and more. The purpose of this paper is to provide a survey of that literature and summarize the empirical evidence on single-name CDSs and the impact of single-name CDS trading on related markets in order to try and elucidate the true economic benefits and costs of these products. In addition, we review the mechanics of corporate and sovereign single-name CDSs, provide an overview of the markets in which they trade, and discuss the documentation and market practices governing the trading of these products.

Interested readers are also directed to the CDS literature surveys by Augustin, Subrahmanyam, Tang, & Wang (2014, 2016) (for CDSs in general) and Augustin (2014) (for sovereign CDSs).[4] Although our paper has some obvious overlaps with these other surveys, we view our study as complementary to theirs and not as a substitute.

Scope of Review

Selection Criteria

We attempt in this paper to be comprehensive and include all of the significant academic research on single-name CDSs. Comprehensive, however, is not synonymous with exhaustive. Given the substantial volume of research on single-name CDSs, we restricted our literature review along certain dimensions.

First, we limited our survey of the literature to single-name CDSs based on corporate and sovereign borrowers. We therefore do not review any academic research on multi-name

[4] For more targeted surveys, see Das & Hanouna (2006) (emphasizing the literature on the difference between CDS spreads and credit spreads on bonds) and Griffin (2014) (emphasizing the relation between CDS spreads and accounting information).

CDSs and/or index products,[5] loan CDSs ("LCDSs"), or CDSs based on asset-backed securities ("ABCDSs").

Second, we only surveyed academic and research-oriented articles and papers. Our review covers articles published in peer-reviewed academic journals, quasi-academic/trade journals with largely academic editorial boards (e.g., the Journal of Fixed Income), and working papers distributed through the Social Science Research Network ("SSRN"), universities, and the research divisions of financial regulators (*e.g.,* the Bank for International Settlements ("BIS"), the European Central Bank ("ECB"), and the Federal Reserve). Our review did not include a survey of industry research (*e.g.,* bank research publications), articles in industry and trade magazines or journals, and mainstream media publications.[6]

Third, our literature review is focused on *empirical* research involving single-name CDSs. The theoretical academic literature comprises an important part of CDS research as well, and a large such body of research exists and presents a range of theoretical models of various issues involving single-name CDSs. That literature, however, is beyond the scope of this review (except in a few specific instances in which theoretical papers played an important role in guiding empirical research).

Given the extensive amount of academic research on single-name CDSs, it is likely that we have missed some working papers or publications that fall within the criteria defined above. If so, we offer our apologies to those authors in advance. In no case did we exclude any article based on its conclusions.

[5] There are a handful of exceptions in which index data was included with single-name data and the results were not disaggregated. We only include such studies to the extent that the index CDSs are a small part of the overall sample.

[6] Research produced by industry and distributed by financial institutions – as well as other trade literature – is often very high quality and informative. We excluded such publications purely for reasons of tractability and limitations of scope.

Citation Style and Underlying Data Sources

Throughout most of this review, we adopt a parenthetical citation style for the academic studies we reference. In other words, we cite the research we review using a reference style such as Smith (2012), which corresponds to a citation in the References section in Appendix A to a publication by Smith dated 2012. When one or more of the same authors have multiple publications in the same year, we note the references using lower-case letters (*e.g.*, Smith, 2012a, 2012b). In certain situations throughout this review, we also cite non-academic publications and books (both by trade and academic publishers) for background purposes. In those cases, we provide a full citation to the article or book in footnotes but do not include them in the References appearing as Appendix A.

All empirical studies involving single-name CDSs, moreover, are summarized in Table 7, which appears in Appendix C. Table 7 summarizes the nature of the underlying data samples on which authors relied to draw their conclusions. The information presented in Table 7 for all of the empirical studies we reference includes the sample period (*i.e.*, dates over which the analysis was performed), the type of reference entity and sample size, the region(s) in which reference entities included by authors are located, the single-name CDS tenors reviewed in the studies, and the authors' CDS-related data sources.

Structure of the book

Following this introduction, Section II of this review provides some institutional background on single-name CDSs as well as an overview of market activity in the single-name CDS space and a discussion of the primary, significant contract terms and trading conventions for single-name CDS products. Absent from Section II is any discussion of the academic literature on single-name CDSs with the single exception of a review of the literature on the performance of CDS auctions in Section II.B.5.(b). Readers already familiar with single-name CDS products, documentation, and market

practices may wish to skip Section II. For other readers, Section II is provided to give a comprehensive and self-contained introduction to single-name CDS products and markets.

In Section III, we review the potential economic benefits and costs of single-name CDSs.

No empirical evidence is reviewed in this section, but our discussion sets the stage for the empirical issues we review throughout the remainder of the paper. In particular, the benefits and costs discussed in Section III are essentially the issues on which we concentrate in our review of the empirical literature in Sections IV through VII.

Section IV reviews the academic literature on the informational content of CDS spreads.

Specifically, we review the literature on the information contained in CDS spreads regarding default probabilities and loss-given-default ("LGD") rates for the underlying reference entities. We also discuss how the literature decomposes CDS spreads into expected credit loss and risk premium components, where the latter is demanded by protection sellers to bear both unexpected credit risk and non-credit risks such as market liquidity risk. Finally in Section IV, we review how single-name CDS spreads and/or changes in those spreads can provide useful information regarding certain events and announcements related to underlying reference entities (*e.g.,* ratings actions, earnings announcements, and public policy actions such as bail-out and bail-in initiatives).

Section V summarizes the existing academic research on how the availability of single- name CDSs impacts both lenders to reference entities underlying traded CDSs and the reference entities themselves. We specifically evaluate the literature on the influence of single-name CDSs on the availability and supply of credit to reference entities, reference entity borrowing costs, and the credit and credit risk management decisions of lenders.

In Section VI of the paper, we review the academic literature on the relations between single-name CDSs and other related securities, including the bonds and equities issued by reference entities underlying single-name CDSs. In

particular, we consider which market is the primary source of price discovery for the revelation of new information about the reference entities underlying single-name CDSs, the implications of the introduction of CDS trading on the liquidity and volatility of related bond and stock markets, and the difference between the credit spreads on a reference entity as reflected in single-name CDSs versus cash bonds issued by the same reference entities (*i.e.*, the "CDS-bond basis").

Section VII reviews the academic literature on the systemic risk aspect of single-name CDSs. We specifically review the literature on single-name CDS cross-market correlations, how CDSs can give rise to interconnectedness across financial institutions, and how CDS spreads can be used to measure systemic interconnectedness, spillover effects, and relations between sovereign CDS spreads and the financial condition of local banking systems.

We provide a brief summary and conclusion in Section VIII.

This review includes three appendices. Appendix A contains the references to the academic literature cited within the body of the review. Our brief biographies as authors of this review are presented in Appendix B. Appendix C presents two additional tables that are too lengthy to insert in the text. (The numbering of these tables, however, is consistent with the order in which they are referenced in the text.) In particular, Table 3 in Appendix C presents a list of all single-name CDS auctions held from 2005 through May 2016. Table 7 in Appendix C summarizes the details regarding the data samples underlying all of the empirical studies we surveyed. As is the case with any empirical research in financial economics, the inferences and conclusions drawn by the authors of the cited studies often depend on characteristics regarding the underlying data, including the sample period, product and geographical universe, and sample selection criteria, all of which define the data on which the various empirical studies and inferences are based. Reporting all of these details in the body of our text is both intractable and distracting. Accordingly, these details appear in Table 7 in Appendix C.

Sponsorship of the Review and Disclaimers

We were commissioned to prepare this review by ISDA. Since 1985, ISDA has engaged in various initiatives intended to ensure the safety and efficiency of global derivatives activities. ISDA's significant accomplishments have included the following: developing the ISDA Master Agreements and other documentation materials; helping to ensure the enforceability of the netting and collateral provisions of the master agreements in multiple international jurisdictions (thereby significantly attenuating counterparty and legal risks); promoting industry-wide safe and sound risk management practices; engaging in an ongoing dialogue with various international and national legislators, regulators, and policymakers to promote the understanding of derivatives products and markets and to facilitate an appropriate and efficient regulatory framework for derivatives; increasing transparency for privately negotiated derivatives; and enhancing the industry's operational infrastructure. At present, ISDA has over 850 member institutions from 67 countries that include banks (both regional and international), corporations, energy and commodities firms, government and supra-national entities, insurance companies, investment and asset managers, as well as organized financial exchanges, CCPs, repositories, law firms, accounting firms, and other service providers.

ISDA provided us with an honorarium for our preparation of this review. In aggregate, however, our total research expenditures (*e.g.*, purchases of articles and new subscriptions) exceeded our honorarium, and we collectively received no net compensation for preparing thisreview.

Although this paper was commissioned, sponsored, and primarily distributed by ISDA, we prepared this study entirely independently, and none of our conclusions or interpretations of the literature we reviewed were influenced by ISDA directly or indirectly. The opinions expressed herein (along with any remaining errors) are ours alone and do not necessarily reflect the views of ISDA or any other organizations with which any

of the authors of this review are affiliated (or their clients and customers).

2 Backgraund on Single-Name CDSs

In a typical CDS, a credit protection purchaser makes a series of fixed payments over the life of the contract (known as the coupon, spread, or premium) to the credit protection seller (i.e., the counterparty to the transaction) in exchange for a commitment by the protection seller to make a payment to the protection buyer following a specified adverse credit or triggering event. CDSs include single-name, portfolio, and index products.

In a single-name CDS, the cash flows and value of the CDS is based on the credit risk of a single legal entity, such as a corporation, sovereign, or municipality.[1] The legal entity on which a single-name CDS is based is known as the "reference name" or "reference entity." Portfolio and index CDSs, by contrast, have multiple underlying reference entities and thus are known as "multi-name" CDSs. The most important

[1] Other economic variables (e.g., liquidity and counterparty risk) may also impact the value of the cash flows on single-name CDSs, but the product is designed primarily to reflect changes in the credit quality of the underlying reference entity.

features of single-name CDSs are discussed in the sections below as background for the remainder of this review. Although this paper is exclusively focused on single-name CDSs, some of the background discussion below includes data on multi-name CDSs, LCDSs, and ABCDSs for comparison purposes.

The Composition of the CDS Market

Aggregate CDS Market Activity

Exhibit 1 shows semi-annual notional amounts of all types of CDSs outstanding with reporting dealers from 2010 through a bit more than the first half of 2015 ("2015H1") by type – i.e., single- versus multi-name and, for multi-name CDSs, non-index versus index products.

Exhibit 1 further indicates the percentage of single-name CDSs based on total CDS notional amounts outstanding. As is evident, the total notional amount of CDSs outstanding began to decline in 2011 and continued to contract through 2015H1. (Not shown on Exhibit 1 is that single-name CDS volumes have started rising since 2015H1.[2]) As Exhibit 1 also indicates, multi-name CDSs have experienced a relatively larger decline in notional amounts outstanding than single-name CDSs.

[2] The official data indicating the apparent trend reversal had not yet been published at the time of this writing.

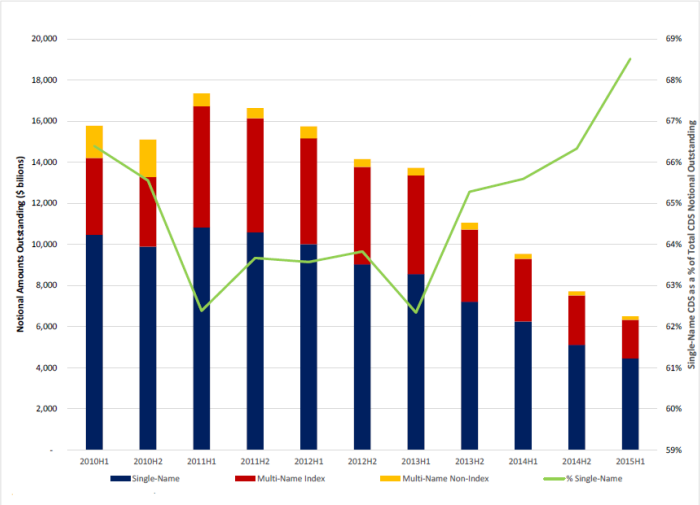

Exhibit 1. *Notional Amounts Outstanding of CDS by Type, 2010-2015H1*
Source: BIS
Note: Data reflects notional amounts outstanding with reporting dealers.

Exhibit 1 and any other exhibits that show notional amounts of CDSs outstanding, however, must be interpreted with caution. Over the last decade, swap market participants have been increasingly reliant on portfolio compression services to eliminate redundant positions and reduce unnecessary credit exposures. In a typical portfolio compression service, participants submit trades to a compression service provider (e.g., Markit/Creditex or TriOptima), which then evaluates and compares potentially offsetting trades. Any identified offsetting trades are then terminated legally and voluntarily (assuming all involved counterparties agree) and replaced with economically equivalent bilateral trades. The net cash flows and risk exposures on the compressed bilateral trades are identical to the original portfolio, but the gross notional amounts and numbers of trades can be reduced significantly through this compression process.[3]

[3] See generally, ISDA, "Interest Rate Derivatives: A Progress Report on Clearing and Compression," ISDA Research Note (February 2014).

The increased usage of portfolio compression services creates the false impression that the CDS market has contracted by more than the underlying data indicates. Especially for multi-name CDS index products for which portfolio compression has been the most popular, some of the shrinkage in notional amounts in recent years (i.e., the red columns on Exhibit 1) is attributable to compression. Although the reductions in notional amounts outstanding for single-name CDSs have been less significant than for CDS index products, such reductions have hardly been inconsequential. The compression service for single-name CDSs offered jointly by Markit and Creditex, for example, reports a cumulative reduction in gross notional amounts of single-name CDSs outstanding of $8.6 trillion as of February 2016 [Retrieved from].

Unfortunately, disentangling actual declines in market activity from the impact of portfolio compression on notional amounts outstanding is not easily accomplished given the proprietary nature of compression data at providers such as Markit/Creditex and TriOptima.[4] ISDA conducted a study in 2013, however, that sheds light on CDS compression activity in the 2005-2012 period. The data compiled by ISDA from Markit/Creditex and TriOptima for that period is shown in Exhibit 2 along with total notional amounts of CDSs outstanding as reported by the BIS. The blue portions of the columns in Exhibit 2 reflect BIS reported totals, and the green portions reflect compressed trading volumes. Total reported notional amounts are also provided for 2013-2015 for comparison purposes.[5]

[4] We attempted to obtain compression statistics from the two leading CDS compression providers – TriOptima and Markit (now IHS Markit) – but were unable to do so.

[5] Care must be taken not to infer that the sum of the blue and green columns in Figure 2 represents what notional amounts would have been outstanding in the absence of compression. The green bars in Figure 2 show the amount compressed in each year, but, depending on the maturities of the compressed trades, compression in one year could impact total notional amounts outstanding in subsequent years.

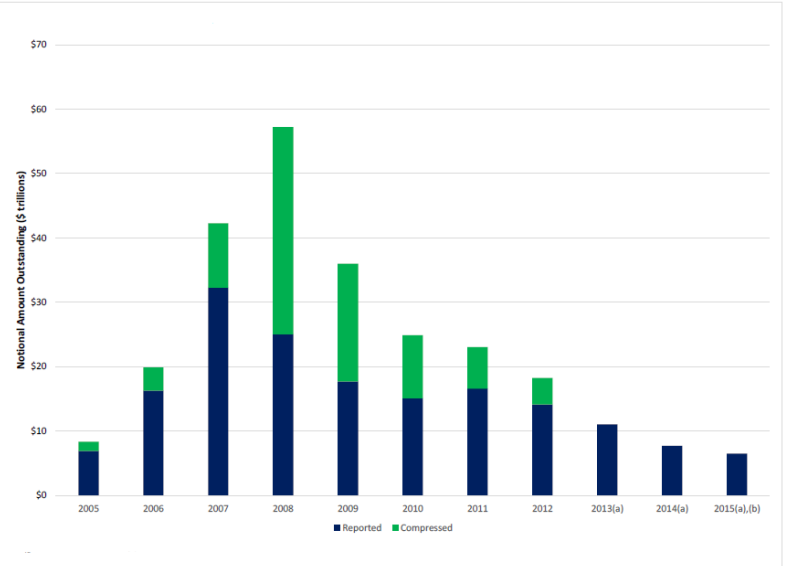

Exhibit 2. *CDS Notional Amounts Outstanding and Compressed*
Source: BIS & ISDA
Notes: (a): Compression data was not available for 2013, 2014, and 2015 (b): 2015 notional amount is as of June; all other years reflect end-of-year notional amounts

Single-Name CDSs by Type of Underlying

Single-name CDSs can be based on specific reference entities (e.g., corporates and sovereigns), as well as specific assets. In particular, CDSs based on asset-backed securities ("ABSs"), including commercial and residential mortgage-backed securities, are known as ABCDSs or structured finance CDSs.[6] Similarly, single-name CDSs based on the syndicated loans of a single reference entity are known as LCDSs, as noted earlier.

Exhibit 3 shows the weekly gross notional amounts outstanding in single-name corporate and sovereign CDSs as compared to single-name ABCDSs and single-name LCDSs from October 2008 through October 2015. As Exhibit 3 demonstrates, the market for single-name CDSs is orders of

[6] The "reference name" for an ABCDS is not a well-defined concept because the ABSs on which the CDSs are based are issued by special purpose entities whose sole function is to issue those securities.

magnitude larger than the markets for ABCDSs and LCDSs. For the week ending October 9, 2009, when the ABCDS market was at its high water mark level, the gross notional amount of ABCDSs outstanding was still only one percent of the gross notional amount of single-name CDSs outstanding.

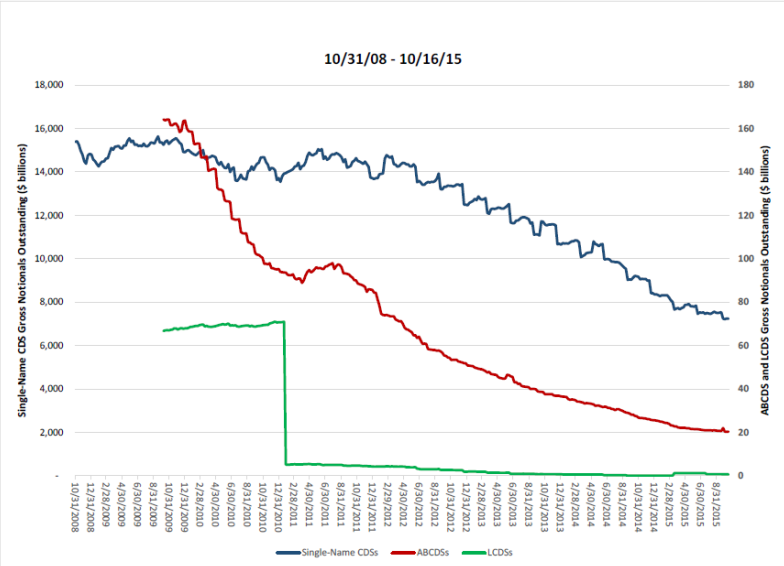

Exhibit 3. *Weekly Gross Notional Amounts of Single-Name CDSs Outstanding by Collateral Type 10/31/08 - 10/16/15*
Source: ISDA

Like Exhibits 1 and 2, Exhibit 3 shows a significant decline in gross notional amounts of all three types of CDSs in the period from October 2008 through October 2015. Single-name CDSs are still relatively significant (i.e., roughly $7.2 trillion in gross notional outstanding for the week ending October 16, 2015) despite the pronounced decline from earlier periods, whereas the ABCDS and LCDS markets have significantly contracted or virtually disappeared (respectively) as of the publication of this review.

Significant Contract Terms and Trading Convertions

The terms of a single-name CDS transaction are set forth in a pro forma master agreement together with any supporting

credit supplement and the confirmations of individual transactions executed pursuant to a governing master agreement and credit supplement. The ISDA master agreements and ISDA credit support annex ("CSA") are the most common documentation for CDSs.

The significant economic terms of a single-name CDS contract specified in the underlying documentation include the following: (1) identity of the underlying reference entity; (2) contract's maturity and time to maturity (a.k.a. "tenor"); (3) required payments (amounts and dates) by the protection buyer to the protection seller; (4) credit events that give rise to an obligation from the protection seller to the protection buyer; (5) method of settlement for any obligation arising following the occurrence of a credit event; and (6) conditions that securities must satisfy to be deliverable under physically settled CDSs after a credit event.

Beginning around 2004, market participants had already started to consider the practicability and desirability of clearing certain CDSs through CCPs in an effort to reduce counterparty-specific, bilateral credit and settlement risks (Tett, 2009).To accommodate potential CCP clearing of CDSs, market participants began an effort to standardize certain significant economic terms of CDS contracts. The ultimate result was a series of changes implemented by ISDA and major CDS market participants beginning in 2009, which resulted in a more homogenous and standardized CDS product. Those initiatives involved changes in CDS contracts, trading conventions, and clearing, and are henceforth collectively referred to as the "2009 Standardization Initiatives."

The significant contract terms and trading conventions for single-name CDSs and the most significant standardizations in those terms and conventions following the 2009 Standardization Initiatives are discussed in Sections II.B.1 through II.B.6 below.

Reference Entity

An important differentiating factor in the market activity for single-name CDSs is the type of reference entity underlying CDS contracts. A related and yet distinct way to view single-name CDS market activity is to summarize outstanding notional amounts based not on the type of entity but rather on the risk of the underlying reference entity. The next two subsections summarize recent single-name CDS activity along those two related but distinct dimensions.

a) *Type of Reference Entity*

As noted earlier, single-name CDSs can be based on the credit risk of securities issued by corporations, as well as national, state, and local securities issuers and state-owned enterprises ("SOEs"). Exhibit 4 shows gross notional amounts outstanding of single-name CDSs from end- August 2004 through end-August 2015 by type of reference entity as reported by the BIS. Specifically, the dark-blue bars show notional amounts outstanding of single-name CDSs based on non-financial corporate reference names, whereas the light-blue bars reflect notional amounts outstanding for financial corporate issuers. The green bars reflect notional amounts outstanding of CDSs based on sovereign debt. The solid red line indicates the proportion of all single-name CDSs outstanding based on corporate reference entities over the time period.

As Exhibit 4 demonstrates, single-name CDSs based on corporate debt accounted for 70 to just over 90 percent of the total notional amount of single-name CDSs outstanding over the period (with the sole exception of 2005H2). CDSs based on non-financial corporate debt experienced a significant spike in activity in 2011H1, which is consistent with increased hedging activity in response to the significant uptick in corporate defaults at the time. Since then, although sovereign debt remains a smaller segment of the single-name CDS market, sovereign CDSs have accounted for an increasing proportion of single-name CDS notional amounts outstanding.

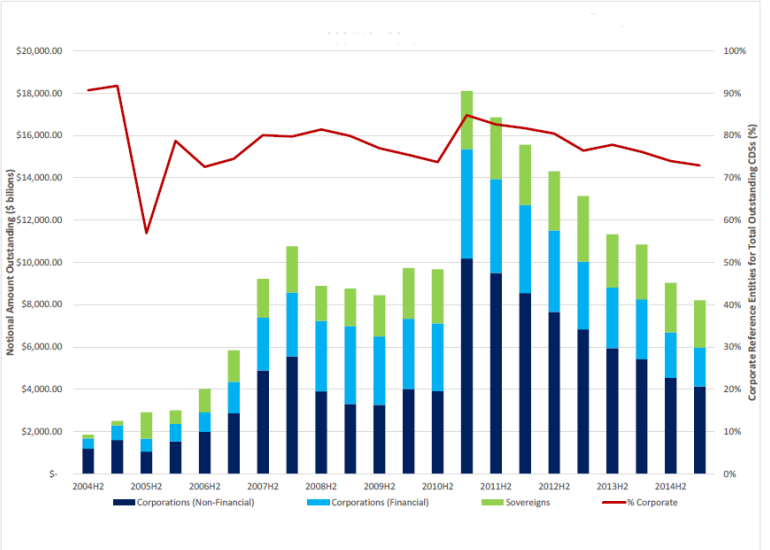

Exhibit 4. *Notional Amounts Outstanding of Single-Name CDSs by Reference Entity Type, 2004H2 - 2015H1*
Source: BIS

In this book, our focus is on corporate and sovereign single-name CDSs. We did not review the literature on ABCDSs and LCDSs for two reasons. First, the markets for those products have shrunk to negligible amounts outstanding, as previously mentioned. Second, for ABCDSs in particular, the underlying economic issues and product designs are very different from single-name CDSs based on corporate or sovereign reference entities.[7] We also do not

[7] In particular, ABCDSs are documented using the pay as you go ("PAUG") template, which allows for bidirectional periodic payments between a protection buyer and seller. For example, a CDS based on a mortgage-backed security typically requires the protection seller to pay the buyer for any writedowns in principal but also requires the protection buyer to pay the seller if those writedowns are subsequently reversed. In a single-name CDS, by contrast, payments always flow in one direction – i.e., spread payments from buyer to seller before the occurrence of a credit event, and the final settlement payment from seller to buyer following a credit event. Although single-name CDSs are distinct from insurance contracts, in this specific sense they are similar to insurance – i.e., policy holders are never required to pay insurance companies anything in excess of the contractually required premium.

specifically discuss single-name CDSs based on municipal, state, or SOE reference names because of their limited activity.

Exhibit 5 shows gross notional amounts outstanding of single-name CDSs based on the two types of reference entities on which we focus in this paper. The data in Exhibit 5 shows weekly notional amounts outstanding from July 2010 through October 2015 based on data compiled by ISDA. Unlike the generally systematic decline in single-name CDSs based on corporate reference entities over this period, notional amounts of single-name CDSs referencing sovereigns grew steadily from 2010 through 2013, stabilized around a roughly flat trend briefly, and then began gradually to contract in June 2014.

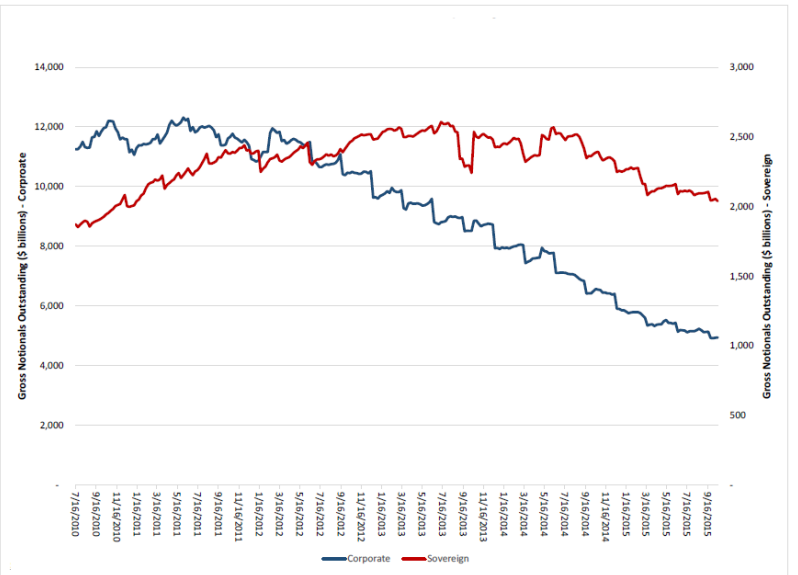

Exhibit 5. *Weekly Gross Notional Amounts of Single-Name CDS Outstanding by Reference Entity Type, 7/16/10 - 10/16/15*
Source: ISDA

For the period from July 2010 and July 2012, Berg & Streiz (2016) analyzed trading volume for sovereign CDSs on a weekly basis across 57 sovereigns. They determined that the five largest CDS markets during that period (measured based

on net notional amounts reported to the Depository Trust Clearing Corp.'s Swap Data Repository) were Italy, France, Germany, Brazil, and Spain.

Table 1 offers a slightly different perspective on single-name CDS market activity from 2010 through 2015. Specifically, Table 1 summarizes the trading volume (as opposed to notional amounts outstanding) in single-name CDSs during this period. As Table 1 indicates, single-name CDS trading fluctuated significantly from 2010 through 2014, and, in 2015, experienced a significant contraction in trading volume. Average weekly total gross notional amounts traded, average weekly per-contract sizes, and average weekly numbers of contracts traded all declined dramatically in 2015 vis-à-vis earlier years. Perhaps even more noticeably, the average number of reference entities for which single-name CDSs were traded in 2015 (through October)

Table 1. *Single-Name CDS Weekly Trading Volume, 2010 – 2015*

	Average Weekly GrossNotional Amounts Traded	*Average Weekly GrossNotional Amounts Traded per Contract*	*Average Number of Contracts Traded perWeek*	*Average Number ofReference Names Traded per Week*
2010[a]	$163,730,798,396	$6,969,026	24,557	916
2011	$140,736,862,010	$6,838,293	20,739	891
2012	$119,469,924,526	$6,077,910	19,753	837
2013	$130,771,184,639	$5,968,713	21,944	832
2014	$140,771,099,264	$6,033,745	22,492	808
2015[b]	$71,116,517,756	$5,116,167	13,652	684

b) *Credit Risk of Reference Entity*

We can also analyze the composition of the single-name CDS market based on the relative risk of the underlying reference entity. To that end, Exhibit 6 summarizes the credit ratings of reference entities on which single-name CDSs were based for the semi-annual periods from end-December 2004 through end-August 2015.

From 2004H2 through 2006H2, the proportion of single-name CDSs based on investment-grade borrowers (i.e.,

reference entities rated BBB-/Baa3[8] or above) declined significantly, even though actual notional amounts of CDSs on such entities rose from 2005 through 2006H2. The reason was the explosive growth in single-name CDSs based on speculative-grade (i.e., BB+/Ba1 and below) and unrated borrowers through 2007. As Culp (2013) and Culp & Forrester (2013, 2015) explain, the increased demand for CDSs based on speculative-grade and unrated borrowers during this period was not indicative of increases in underlying default rates in speculative-grade firms borrowing in leveraged finance markets, but rather was largely driven by the demand from collateralized loan obligation ("CLO") managers and high-yield bond funds to sell credit protection on leveraged debt during a period of low interest rates and credit spreads, which had fueled a significant leveraged buy-out boom at the time.[9]

[8] The rating before the slash indicates the rating frameworks of Standard and Poor's and Fitch, for which BBB- is the lowest investment-grade rating. The rating after the slash uses the lexicon from Moody's Investors Service, for which Baa3 denotes the lowest investment-grade rating.

[9] A CLO is a structure in which a special-purpose entity issues tranched debt instruments to finance either the purchase of loans or the collateralized sale of credit protection on loans using CDSs. For a general discussion, see Culp, (2006).

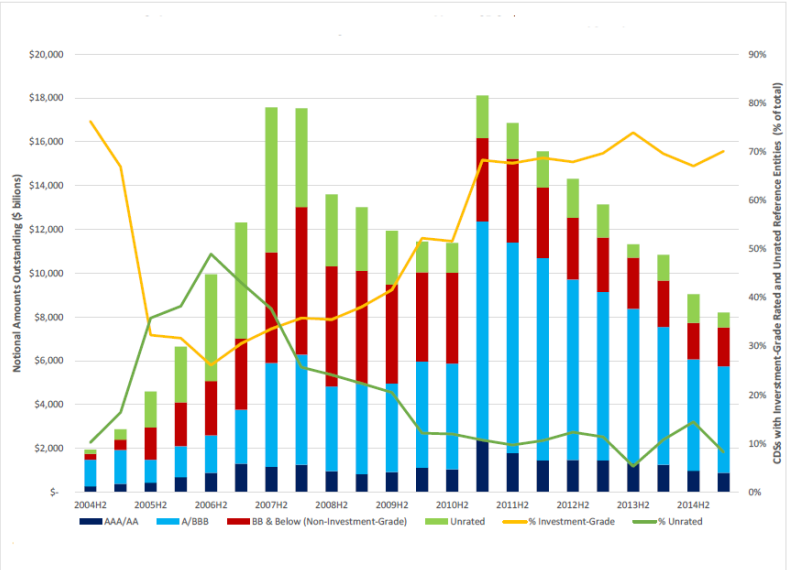

Exhibit 6. *Notional Amounts Outstanding of Single-Name CDSs by Reference Entity Rating, 2004H2 - 2015H1*

In 2007H1 when instability in U.S. subprime mortgage markets first began to impact subprime mortgage-backed securities, total notional amounts of CDS protection sold on investment-grade entities began to rise, whereas total protection sold on unrated entities began to decline. As the mortgage crisis spilled over first into U.S. leveraged finance markets (as discussed in Culp, 2013) and, in August 2007, to broader global credit markets, total notional amounts of credit protection sold on unrated entities contracted dramatically and continued a slow and steady decline through the end of 2011. As of 2015H1, less than 10 percent of the single-name CDS notional amount outstanding was accounted for by unrated reference entities.

Maturity/Tenor

The maturity date of a CDS contract reflects the last date on which credit protection is in force for the counterparties. In other words, the maturity date of a CDS is the date on which the credit protection expires. The maturity of a CDS does not necessarily depend on the maturity of the securities

issued by the reference entity, as discussed further in Section II.B.6 below.

The tenor of a CDS contract is its time-to-maturity as of the initial trade date. Even before the 2009 Standardization Initiatives, most single-name CDS tenors were annual with the most popular tenor being five years. The calendar dates of CDS contract maturities were not formally standardized until the 2009 Standardization Initiatives, by which time the market standard had coalesced around CDS maturity dates of March 20th, June 20th, September 20th, and December 20th (known collectively as standard maturity dates). For example, a one-year single- name CDS on reference entity XYZ Corp. with a trade date of February 17, 2016, would have a maturity date of March 20, 2017, under the 2009 Standardization Initiatives.

Five years remains the most popular tenor for new CDS transactions. Exhibit 7 shows total gross notional amounts of CDS protection bought as of end-August and end-December from August 2004 through August 2015. The solid and dashed lines represent single- and multi- name CDSs, respectively. The green, red, and blue lines represent times to maturity for the CDSs – i.e., one year or less, over one and up to five years, and greater than five years, respectively.

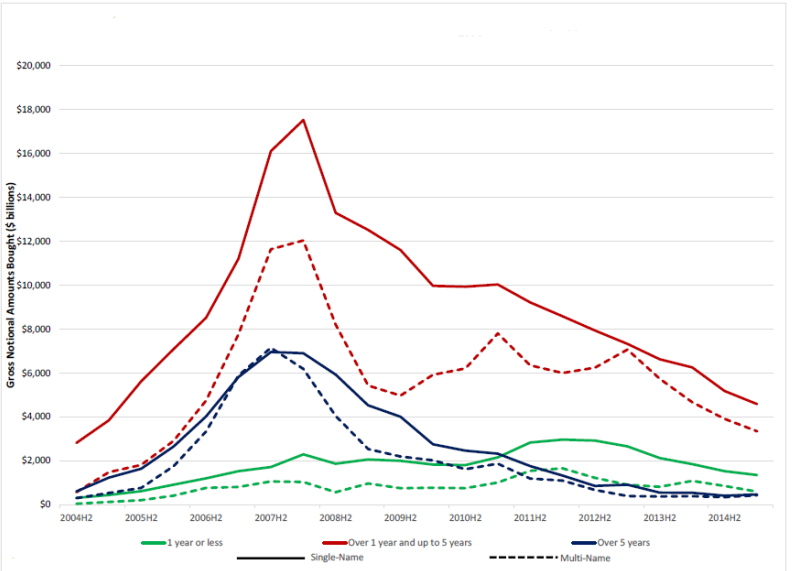

Exhibit 7. *Gross Notional Amounts of CDS Protection Purchased by Type and Time to Maturity, 2004H1 - 2015H1*
Source: BIS

As Exhibit 7 shows, CDSs with one to five years remaining to maturity have regularly accounted for the largest proportion of both single- and multi-name CDSs outstanding. CDSs of all types and tenors experienced declines in gross notional protection purchases beginning in 2007H2 or 2008H1 (i.e., the outbreak of the credit crisis). During August 2011, gross notional amounts outstanding of short-term CDSs (with maturities of one year or less) began to exceed notional amounts outstanding for CDSs with more than five years to maturity, with the trend being more pronounced for single-name CDSs than for multi-name CDSs. Purchases of CDS protection for more than five years experienced the largest relative contraction in market activity.

Exhibit 7 also demonstrates that from 2009H2 through 2013H1, the markets for multi- name and single-name CDSs with times to maturity of over one year and up to five years (i.e., the medium-term tenor bucket) behaved rather differently. During that period, gross notional amounts outstanding of single-name CDS purchases in that tenor

bucket declined steadily, whereas comparable multi-name CDSs experienced a brief recovery. As of end-August 2013, the gross notional amount of medium-term tenor single-name CDSs was only about four percent larger than protection purchased with multi-name CDSs in the same maturity bucket. From end- August 2013 through end-August 2015, however, gross notional amounts of multi-name CDSs declined at a more rapid rate than gross notional amounts of single-name CDSs in the medium- term tenor bucket. A similar phenomenon occurred from 2007H2 through 2009H2, when both single- and multi-name medium-term CDS notional amounts outstanding shrunk but with the latter contracting at a more rapid pace.

Coupon/Spread

In a single-name CDS, the credit protection purchaser must pay a contractually specified and fixed coupon (also known as a spread[10]) periodically over the life of the contract to the protection seller. In a fully customized market, the CDS coupon will be the spread over the London Interbank Offered Rate ("LIBOR") that equates the discounted present value of coupon payments to the discounted expected payments from the protection seller following the occurrence of a credit event.

The CDS coupon is fixed on the trade date and does not change over the life of the CDS contract. If the perceived credit risk of the reference entity changes over the life of the CDS contract – as it surely will, at least to some degree – then the value of that CDS and the mark-to- market credit spread will fluctuate accordingly. For example, suppose a single-name CDS based on reference entity XYZ Corp. has a one-year tenor and a contractual coupon rate of 100 basis points ("bps"), which was at-market on the trade date.[11] If XYZ Corp.

[10] The term "spread" is used because the CDS spread is analogous to the spread over LIBOR on a floating-rate bond issued by the reference entity underlying the CDS.

[11] A basis point is equal to 1/100th of a percentage point. For example, 100bps is equivalent to one percentage point.

is downgraded shortly into the life of the CDS, investors in a new CDS following the downgrade with a maturity date identical to the original CDS would require a higher coupon to compensate for the heightened perceived credit risk of XYZ Corp. –say, e.g., 125bps. With a then below-market contractual coupon rate of 100bps, the original CDS will trade below its par value.

For standardized CDSs, coupon payments are made by protection buyers to sellers quarterly on March, June, September, and December 20th.[12] CDS coupons are quoted on an annualized basis, and the actual payment amount is computed using the notional amount of the CDS contract and an Actual/360 day-count convention. The actual payment, moreover, is based on an accrual period that begins with the previous standardized coupon payment date and ends with the current coupon payment date minus one day (except for the last coupon payment which is based on an accrual through the final maturity date). If a credit protection buyer purchases CDS protection in the middle of a quarter, the first coupon payment is in arrears and based on an accrual period from the last standard coupon payment date (i.e., not the actual trade date). In other words, the protection buyer must pay for coverage from the previous standard coupon date even when the trade date occurs later.

Consider, for example, the aforementioned one-year single-name CDS on XYZ Corp., and suppose that the counterparties agree on a February 17, 2016, trade date to a 100bp annualized coupon. The first coupon payment date is due on March 21, 2016 (i.e., the Monday following Sunday, March 20, 2016), and is based on an accrual period from Monday, December 21, 2015 (*i.e.,* the coupon payment date for the standard 2015Q4 coupon payment), through March 20, 2016 (*i.e.,* the day before the 2016Q1 standard coupon payment date). The standard coupon dates and corresponding amounts payable by the protection buyer to the protection seller in this

[12] Unless otherwise specified in the transaction documentation, if the 20th falls on a weekend or holiday, the payment is due on the first business day following the 20th.

exemplar transaction (with an assumed notional amount of $25 million) are shown in Table 2.

Table 2. *Coupon Payments for a One-Year CDS on XYZ Corp. with a 100bp Coupon and $25mn Notional Amount*

	Accrual Period Begins	Accrual Period Ends	Coupon Pymt Date	Actual Days	Coupon Pymt Amount
1st Coupon	12/21/2015	3/20/2016	3/21/2016	90	$62,500
2nd Coupon	3/21/2016	6/19/2016	6/20/2016	90	$62,500
3rd Coupon	6/20/2016	9/19/2016	9/20/2016	91	$63,194
4th Coupon	9/19/2016	12/19/2016	12/20/2016	91	$63,194
5th Coupon	12/20/2016	3/20/2017	3/20/2017	90	$62,500

Part of the 2009 Standardization Initiatives was an effort to shift CDSs toward standard coupon rates in order to promote the ease with which CDSs could be cleared by CCPs. These standard coupons vary by geographical region. For example, single-name CDSs based on North American corporate and sovereign reference entities generally have standard coupon rates of either 100bps or 500bps per annum for investment-grade and high-yield reference names, respectively.

In practice, very few CDSs have at-market coupon rates of either exactly 100bps or 500bps on their trade dates. As a result, credit protection buyers usually make upfront payments to protection sellers (or vice versa depending on whether the market credit spread is above or below the standard coupon rate) that reflect the difference in the discounted present values of cash flows on the CDS valued using the standard coupon rate and the current market-based rate,as well as any accrued coupons.[13]

[13] Market participants can also still negotiate a specific coupon rate by entering into two CDSs with different notional amounts that result in the desired blended coupon rate. For example, if a firm wishes to buy credit protection on XYZ Corp. at a 75bp coupon rate for one year, the firm can buy protection on a $15.9375 million notional amount at the standardized 100bp spread and simultaneously sell protection on a $937,500 notional amount at the standardized 500bp coupon, which results in a net exposure of $15 million notion protection purchased at the effective cost of 75bps.

Credit Events

The basic concept of a credit event – *i.e.*, an adverse development to a reference entity's financial condition that exposes its lenders to heightened credit risk – has not changed since single-name CDSs first began trading. The specific definitions of different scenarios that give rise to credit events (and the process by which determinations are made as to when credit events occur) are articulated in ISDA's *Credit Derivatives Definitions* ("Definitions"). In response to various issues concerning the credit events experienced by specific reference entities and in the aftermath of the credit crisis, ISDA (in coordination with market participants) has made several significant revisions to its *Credit Derivatives Definitions*. We review the most important of these revisions in the sections below.

a) *The 1999 and 2003 Definitions*

The original 1999 ISDA *Credit Derivatives Definitions* specified six types of creditevents for single-name CDSs:

- *Bankruptcy:* the reference entity becomes insolvent or admits in a regulatory, judicial, or administrative proceeding to its insolvency;
- *Obligation Acceleration:* one or more obligations of the reference entity (with an aggregate amount in excess of a specified "Default Requirement" threshold) are due and payable before their scheduled payment date as a result of an event of default or default-like condition (excluding "Failure to Pay" events);
- *Obligation Default:* one or more obligations of the reference entity (with an aggregate amount in excess of the Default Requirement) are *capable of being declared* due and payable before their scheduled payment date(s) as a result of an event of default or default-like condition;
- *Failure to Pay:* the reference entity fails to make a required payment when and where it is due on one or more of its obligations (following the expiration of a contractually specified grace period);
- *Repudiation/Moratorium:* the reference entity (or a

governmental authority) disaffirms, rejects, disclaims, repudiates, or challenges the validity of one or more obligations (in excess of the Default Requirement) or imposes a moratorium on the payment of one or more obligations (in excess of the Default Requirement), provided that the reference entity has experienced a failure-to-pay or restructuring event (without regard to the Default Requirement) on or prior to the repudiation./moratorium "evaluation date"; or

- *Restructuring:* the reference entity restructures one or more obligations (including through an "Obligation Exchange" –*i.e.,* a mandatory transfer of securities, obligations, or assets) in excess of the Default Requirement as a result of any of the following and provided that the following were the direct or indirect result of a deterioration in the reference entity's credit quality: (i) reductions in accrued or payable interest; (ii) reductions in principal payable or premiums payable on redemption dates; (iii) deferrals of interest or principal repayment dates; (iv) changes in the priority/subordination of an obligation; or (v) changes in the currency denomination of interest and/or principal payments to an impermissible currency.

In 2003, ISDA released a revised version of its *Credit Derivatives Definitions*. Among the changes to the 1999 credit events reflected in the 2003 revision were refinements to the bankruptcy, repudiation/moratorium, and restructuring credit event definitions.

For single-name CDSs, restructuring events have presented market participants with some significant challenges over the years, both for corporate and sovereign reference entities. These challenges have involved both the definition of a restructuring credit event (mainly an issue for sovereign reference entities) and the obligations deliverable under physically settled CDSs following a restructuring event (primarily an issue for corporate reference entities). The issue of deliverable obligations is discussed later in Sections II.B.5 and II.B.6.

For sovereign CDSs, the three primary triggering events are failure-to-pay, repudiation/moratorium, and restructuring (ISDA, 2012). Historically, the most prevalent credit event triggering sovereign CDSs is the restructuring event (Pan & Singleton, 2008; Longstaff, Pan, Pedersen, & Singleton, 2011; Das, Papaioannou & Trebesch, 2012). The definition of a sovereign restructuring event, however, has evolved in the underlying ISDA documentation over time as specific sovereign defaults have highlighted issues about which market participants desired clarification. In particular, the restructurings of Argentine sovereign debt in 2001 and Greek sovereign debt in 2012 both resulted in disputes over the meaning of the definition of the restructuring event, and both events precipitated revisions in ISDA's 2003 *Credit Derivatives Definitions*.

One change in the 2003 definitions occurred following the announcement in November 2001 by the Argentine Republic ("Argentina") of its plan to "voluntarily restructure" $95 million of its $132 billion in outstanding debt by exchanging the $95 billion in 15 percent bonds for bonds with interest rates capped at seven percent (BBC News, 2001). Argentina claimed that because the bond exchange was voluntary that it did not constitute a restructuring event and that dedicated tax revenues had been earmarked to cover the interest payment obligations on the new bonds. Rating agencies and analysts disagreed, however, and contended that Argentina's declining tax revenues were insufficient to support the old bonds and, hence, that any investor not swapping old bonds for news ones would be subject to an even greater risk. As such, the rating agencies and many analysts claimed that the proposed debt swap was *de facto* involuntary (Pollack, 2003).

Based on two sovereign CDS transactions outstanding with JPMorgan as its counterparty, HBK Master Fund LP ("HBK") provided JPMorgan in December 2001 written notice that it believed a restructuring event had occurred on Argentine sovereign debt underlying its CDSs in which HBK was the credit protection purchaser. Under the 1999 Definitions, the definition of a restructuring depended heavily on the definition of an "Obligation Exchange," defined as "the

mandatory transfer (other than in accordance with the terms in effect as of the later of the Trade Date or date of issuance of the relevant Obligation) of any securities, obligations or assets to holders of Obligations in exchange for such Obligations." JPMorgan responded to HBK that a restructuring event had *not* occurred because the Argentine restructuring was a voluntary one and, as such, no Obligation Exchange had occurred. HBK responded that, regardless of whether any *actual* Obligation Exchange had occurred, the exchange constituted a restructuring event because it triggered a reduction of principal and interest and a deferral of the maturity dates on the Argentine sovereign debt (Collins & Sackmann, 2003; Pollack, 2003). Eternity Global Master Fund Limited ("Eternity") filed a similar lawsuit against JPMorgan.

Both the HBK and Eternity lawsuits resulted in drawn-out litigation and generated significant controversy amongst market participants about the term Obligation Exchange in the definition of a restructuring event in the Definitions. As a result, the 2003 ISDA *Credit Derivatives Definitions* eliminated the term Obligation Exchange from the definition of a restructuring event. Under the 2003 Definitions, a restructuring credit event was defined solely based on the occurrence of any of the five events defined in the 1999 definitions as long as such events bind all holders of any obligations to the restructuring.

b) *The 2009 "Big Bang Protocol" and Supplement to the 2003 Definitions*

As part of the 2009 Standardization Initiatives, ISDA redefined the means by which a credit event is determined. Prior to the 2009 Initiatives, a protection purchaser typically notified its counterparty when it believed a credit event had occurred. In the event of a dispute between counterparties (such as those that occurred in the HKB and Eternity disputes with JPMorgan), the documentation of the transaction and the facts of the circumstances were subject to the determination of a court.

In consultation with market participants and various regulatory agencies, ISDA implemented the 2009

Standardization Initiatives by promulgating the *2009 ISDA Credit Determinations Committees, Auction Settlement, and Restructuring Supplement* to the 2003 ISDA *Credit Derivatives Definitions*, more commonly known as the "Big Bang Protocol." Specifically, the Big Bang Protocol resulted in three significant changes to CDS contract terms:

(i) the creation of "determinations committees" ("DCs") for each major geographical region together with the definition of the roles and responsibilities of DCs and corresponding changes in CDS documentation; (ii) the incorporation of common "look-back" provisions for credit and succession events; and (iii) the introduction of "Auction Settlement" as a default method settling single-name CDSs. Components (i) and (ii) of the Big Bang Protocol are discussed below, and the third component is discussed in Section II.A.5.(c). As of its April 8, 2009, effective date, over 2,000 market participants opted to adhere to the Big Bang Protocol (ISDA, 2009).

In the first prong of the Big Bang Protocol, adherents to the protocol agree that instead of counterparties to a CDS making determinations about the occurrence of a credit event, the relevant geographical DC will make such determinations. DCs may accept requests from eligible market participants (including non-members of ISDA) to consider whether or not a credit event has occurred at a particular reference entity. The ISDA DCs consist of up to 10 voting dealer members, five voting non-dealer members, and up to three consultative non-voting members (two dealers and one non-dealer). Dealer members are selected annually based on their firms' CDS trading volumes from the previous year, and non-dealer members are selected at random from a pool of buy-side firms with CDS activity in excess of specified minimum size thresholds.

If an eligible market participant petitions the DC under its own name and asks the DC to determine whether or not a credit event has occurred, at least one member of a DC must accept the question before the issue is put to a vote before the whole DC. "General interest" questions can also be submitted to a DC in which the submitter does not disclose its name, and such questions must be accepted by at least two members

of the DC before the whole committee considers whether or not a credit event has occurred.

Apart from their responsibilities for determining the occurrence of credit events, the responsibilities of DCs also include deciding whether or not an auction will be held to determine final CDS settlement values and selecting the deliverable obligations eligible for submission in the auction (as discussed in Sections II.B.5 and II.B.6, respectively).

The second component of the Big Bang Protocol – *i.e.*, the creation of a common look- back provision – was intended to deal with the basis risk to which traders were previously exposed (*see* Sections III.A.1.(a) and V.A.4) in the event that they purchased and sold credit protection on the same reference entity on different dates. Prior to the Big Bang Protocol, credit protection began for the purchaser one day after the trade date *T*. For example, a CDS on XYZ Corp. purchased on April 26, 2016, would go into effect on April 27, 2016. If the protection purchaser subsequently decided to reverse out its protection purchase – say, on May 1, 2016 – the protection sale went into effect on May 2, 2016. If a credit event occurred anytime from April 27th through May 2nd, the protection purchase was in force but the protection sale was not. As such, seemingly offsetting exposures did not actually offset and gave rise to basis risk for would-be hedgers.

To address this concern, the Big Bang Protocol specifies that CDS protection is in force at *T-60* for credit events.[14] This modification of CDS documentation was intended to help promote fungibility across individual CDSs transactions by eliminating the basis risk arising from any "stub period" occurring between the initial protection purchase (sale) in-force date and the in-force date for a subsequent protection sale (purchase) hedge or reversal of the original protection

[14] The Protocol further indicates that CDS protection is in-force at T-90 for succession events, which are defined in the 2003 Definitions with respect to non-Sovereign reference entities as "an event such as a merger, consolidation, amalgamation, transfer of assets or liabilities, demerger, spin-off or other similar event in which one entity succeeds to the obligations of another entity, whether by operation of law or pursuant to any agreement."

purchase (sale). Market participants refer to the rolling 60-day look-back period for credit events as their "statute of limitations" (Markit, 2009).

c) *Example of the Determinations Process: The Hellenic Republic Credit Event*

The determination process and revised restructuring event guidelines were both tested during the European sovereign debt crisis – specifically with respect to the debt obligations of the Hellenic Republic (*i.e.*, Greece). Public recognition of Greece's financial difficulties moved under the microscope in October 2009, when the newly elected federal government announced that previous statistics had badly understated the actual amounts of Greek sovereign debt and the sovereign's deficit. Following several months of continuing bad news from Greece regarding its economic condition and public sector spending, several of the rating agencies downgraded Greek sovereign debt. By April 2010, spreads on Greek sovereign debt had risen to as much as nine percent higher than otherwise-similar German sovereign bonds (Zettelmeyer, Trebesch & Gulati, 2013).

In May 2010, E.U. country leaders agreed to a comprehensive "bailout" package that involved increased lending to Greece (conditional on certain fiscal reforms), the creation of a European Financial Stability Facility ("EFSF") to provide up to €440 billion in loans to troubled E.U. sovereigns, and the authorization of the ECB to engage in secondary purchases of troubled E.U. sovereign debt to help reduce yields and stabilize the markets. The May 2010 intervention by Eurozone leaders did indeed stabilize the market, but only briefly. By mid-2011 the situation in Greece (as well as several other E.U. countries) had deteriorated even further. By the summer of 2011, many market participants anticipated that the Hellenic Republic's sovereign debt was rapidly becoming (or had already become) unsustainable unless substantial additional public sector assistance was provided (IMF, 2011).

On July 21, 2011, leaders of the Eurozone countries convened and agreed on another set of reforms and rescue

measures designed to provide an additional estimated €109 billion to the Hellenic Republic. This time, the rescue package called for a combination of public sector loans from the EFSF and International Monetary Fund ("IMF") together with contributions from the private sector. Of the total €109 billion in additional planned bailout funds, €37 billion was expected to come from *voluntary* private sector involvement ("PSI") – specifically, through voluntary agreements by Greek creditors to exchange their existing debt for new debt issued on terms more favorable to Greece (Council of the EU, 2011).

By October 2011, many market participants, politicians, and commentators believed that the reforms proposed in the July 2011 summit would be insufficient to ensure the sustainability of Greek sovereign debt without significant additional reforms, including substantial PSI (Zettelmeyer, Trebesch & Gulati, 2013). The official statement following the E.U. summit on October 26, 2011, thus included the following "invitation": "We invite Greece, private investors and all parties concerned to develop a voluntary bond exchange with a nominal discount of 50% on notional Greek debt held by private investors" (Council of the EU, 2011). Although large investors in Greek debt (*e.g.*, German banks) were subject to pressure from their local regulators (known as "moral suasion") to accept this invitation from the E.U., non-E.U. investors in Greek debt (*e.g.*, U.S. banks and asset managers) were skeptical of the proposal (Whittall, 2011).

Leading up to and immediately following the October 2011 E.U. summit, numerous market participants had already informally questioned whether the latest proposed reforms would constitute a restructuring event under the ISDA *Credit Derivatives Definitions* and determinations process. Such concerns and questions had become so frequent leading up to the *July* 2011 summit that ISDA published a "Greek Sovereign Debt Q&A" on July 8, 2011. On October 27, 2011, ISDA updated its Q&A and stated the following:

> The determination of whether the Eurozone deal with regard to Greece is a credit event under CDS documentation will be made by ISDA's [Europe, Middle East, and Africa ("EMEA")] Determinations

> Committee when the proposal is formally signed, and if a market participant requests a ruling from the DC. Based on what we know it appears from preliminary news reports that the bond restructuring is voluntary and not binding on all bondholders. As such, it does not appear to be likely that the restructuring will trigger payments under existing CDS contracts. In addition, it is important to note that the restructuring proposal is not yet at the stage at which the ISDA Determinations Committee would be likely to accept a request to determine whether a credit event has occurred (ISDA, 2011).

On February 21, 2012, the ministers of finance for the Eurozone countries issued a statement indicating that an agreement had been reached with Greece that, consistent with the broad goals of the October 2011 E.U. summit, would involve an exchange of existing debt for new debt with a face value of about 53.5 percent of the nominal amount of the original debt (Bloomberg, 2012). On February 23, 2012, the Greek Parliament enacted the "Greek Bondholder Act" to provide for the voluntary redemption of bonds on those terms. On February 24, 2012, the Greek Ministry of Finance issued a statement indicating that it had approved the terms of invitations for such debt exchanges to private-sector investors outside the United States and issued a statement in which it said:

> Under the collective action procedures introduced by the Greek Bondholder Act, the proposed amendments will become binding on the holders of all the Republic's Greek-law governed bonds issued prior to 31 December 2011 identified in the act of the Ministerial Council approving the PSI invitations, if at least two thirds by face amount of a quorum of these bonds, voting collectively without distinction by series, approve the proposed amendments (Hellenic Republic, 2012).

On the same day as the Greek Ministry of Finance's statement, the ISDA DC responsible for deciding whether a restructuring event had occurred for Greece – *i.e.,* the EMEA

(Europe) DC[15] – received its first question, which was submitted by HBK Capital Management (*i.e.,* the same fund manager that sued JPMorgan regarding the Argentine restructuring event). The DC agreed to accept the question on February 28, 2012, [Retrieved from] and to resolve the question by February 29, 2012 (ISDA, 2012). The question posed by HBK to the EMEA DC was as follows:

> Does the announcement of the passage by the Greek parliament of legislation that approves the implementation of an exchange offer and vote providing for collective action clauses ("CACs") that impose a "haircut amounting to 53.5%"...constitute a Restructuring Credit Event in accordance with Section 4.7 of the [ISDA *2003 Credit Derivatives Definitions* as amended in 2009] because (i) the [ECB] and National Central Banks benefitted from "a change in the ranking in priority of payment" as a result of the Hellenic Republic exclusively offering them the ability to exchange out of their "eligible instruments" prior to the exchange and implementation of the CACs, thereby effectively "causing the Subordination" of all remaining holders of eligible instruments, and (ii) this announcement results directly or indirectly from a deterioration in the creditworthiness or financial condition of the Hellenic Republic? [Retrieved from].

Before the DC issued its answer to the first question, it received a second question on February 29, 2012 [Retrieved from]. This question, submitted by Bracebridge Capital LLC, raised related concerns:

> Does (i) the agreement that has been reached between the Hellenic Republic and a number of private sector holders of Greek debt...exchange the Designated Securities for new securities...; (ii) the enactment of [the Greek Bondholder Act] and (iii) the statement by

[15] The voting members of the EMEA DC at the time were as follows: Bank of America Merrill Lynch, Barclays, BlueMountain Capital, BNP Paribas, Citadel Investment Group, Credit Suisse, D.E. Shaw Group, Deutsche Bank, Elliott Management Corporation, Goldman Sachs, JPMorgan Chase Bank, Morgan Stanley, PIMCO, Societe Generale, and UBS. See ISDA, EMEA Determinations Committee Decision (March 1, 2012) (hereinafter "Greece DC Decision").

> the Ministry of Finance of the Hellenic Republic on 21 [sic.] February 2012...constitute a Restructuring Credit Event in accordance with Section 4.7 of the [ISDA *2003 Credit Derivatives Definitions* as amended in 2009] because (i) a reduction in the amount of principal or premium payable at maturity or at scheduled redemption dates of the Designated Securities has been agreed between the Hellenic Republic and *a sufficient number of holders of the Designated Securities to bind all holders of the Designated Securities* and (ii) this agreement results directly or indirectly from a deterioration in the creditworthiness or financial condition of the Hellenic Republic? [emphasis added], [Retrieved from].

On March 1, 2012, the EMEA DC issued a statement that "it had not received any evidence of an agreement which meets the requirements of Section 4.7(a) of the [ISDA *2003 Credit Derivatives Definitions* as amended in 2009] and therefore based on the facts available to it, the EMEA DC unanimously determined that a Restructuring Credit Event has not occurred...." (Greece, 2015) For the first question, all 15 of the DC's voting members agreed that "the specific fact pattern...does not satisfy...the definition of Subordination as set out in the [ISDA *2003 Credit Derivatives Definitions* as amended in 2009] and therefore a Restructuring Credit Event has not occurred...." (Greece, 2015) For the second question, the DC provided no additional details.

On March 6, 2012, however, the Greek Public Debt Management Agency announced thatif the Republic...

> receives sufficient consents to the proposed amendments of the Greek law governed bonds identified in the [February 24, 2012] invitations for the amendments to become effective, it intends...to declare the proposed amendments effective and binding on *all* holders of these bonds. Consequently, all obligations of the Republic to pay holders of those bonds any amount on account of principal will be amended to permit the Republic to discharge these obligations in full by delivering to the holders of the amended bonds on the settlement date the consideration described in the

invitations. [emphasis added], (Hellenic Republic, 2012).

In other words, if enough market participants accepted the voluntary request from the Hellenic Republic to exchange their existing debt for new debt at lower face values and/or on less favorable terms, Greece intended to impose those new terms on *all* bond holders – even those which did *not* consent to the proposed exchange.

On March 9, 2012, the Greek Ministry of Finance announced that of the roughly €177 billion in outstanding sovereign Greek debt governed by Greek law and eligible for voluntary exchange under the Greek government's invitations, investors in approximately €152 billion (face value) in Greek debt had consented to and tendered for the proposed debt exchange.

Accordingly, the Hellenic Republic advised that it intended "to accept the consents received and amend the terms of *all* of its Greek law governed bonds, including those not tendered for exchange pursuant to the invitations, in accordance with the terms of the Greek Bondholder Act. [emphasis added]" (Hellenic Republic, 2012). In other words, on March 9, 2012, the Hellenic Republic declared its intention to impose reductions of principal on *all* holders of enumerated Greek sovereign debt instruments, even if investors did not consent, thus rendering the restructuring involuntary.

On March 9, 2012 (*i.e.,* the same date as the announcement by the Greek Ministry of Finance), UBS submitted a question to the EMEA DC asking whether or not a restructuring credit event had occurred in the Hellenic Republic as a result of the latest statements by the Greek government. The DC accepted the question the same day and also reached a determination that same day (by unanimous consent of all 15 members) that Greece's latest actions did constitute a restructuring credit event as defined in the 2003 ISDA *Credit Derivatives Definitions*as amended in 2009 (ISDA, 2012).

d) *The 2014 Definitions*

On February 21, 2014, ISDA published a new and substantively revised version of its *Credit Derivatives*

Definitions (the "2014 Definitions"). The new definitions reflected a number of substantive changes to the 2003 Definitions (as amended in 2009). The most significant changes are discussed below.

First, the 2014 Definitions added "governmental intervention" as a credit event. Such a triggering event occurs when an announcement or action by a governmental authority results in any of the following for obligations in excess of the Default Requirement threshold:

- Changes in creditors' rights so as to cause:
  - Reductions in interest payable or accrued;
  - Reductions in principal or premiums payable upon redemption;
  - Postponements or deferrals of interest payable or accrued and/or principal/premium payable beyond the originally scheduled dates;
  - Changes in the priority (seniority) of an obligation that results in an increased depth ofsubordination;
- Expropriation (*i.e.,* any event that mandatorily changes the beneficial holder of anobligation);
- Mandatory cancellation, conversion, or exchange of an obligation; or
- Any other event that has an analogous effect to the other above events.

The governmental intervention trigger was added to the ISDA *Credit Derivatives Definitions* to address forced "bail-ins" of creditors –*i.e.,* situations in which governmental authorities force creditors to participate in a bail-out of a distressed firm. For example, the Dutch Ministry of Finance nationalized SNS Reaal bank on February 1, 2013, (Ministerie van Financiën, 2013) which resulted in the expropriation of the bank's subordinated debt. Under the 2003 Definitions (as amended in 2009), significant uncertainty existed as to whether a mandated debtor bail-in qualified as a restructuring event (Linklaters, 2014). The new triggering event eliminates any such ambiguities and explicitly defines governmentally mandated creditor bail-ins as a credit event that will trigger corresponding single-name CDSs.

Second, the 2014 Definitions allow counterparties in a single-name CDS to elect "Financial Reference Entity Terms" in a confirmation, which separates credit event determinations for governmental intervention and restructuring events that impact CDSs based on senior and subordinated obligations of the reference entity differently. In the case of SNS Reaal, the expropriation of subordinated debt resulted in all CDSs on SNS Reaal being triggered under the restructuring event even though the senior debt holders of SNS Reaal were unaffected by the intervention (Linklaters, 2014). Under the 2014 Definitions, if counterparties opt for Financial Reference Entity Terms, a governmental intervention or restructuring event that affects subordinated debt but *not* senior debt will not trigger protection payments on corresponding senior single-name CDSs.

Third, the credit events experienced by both SNS Reaal and Greece highlighted issues associated with mandatory exchanges of debt that persisted even with the elimination of the term "Obligation Exchange" in 2003. Following the determination that SNS Reaal had experienced a credit event following the expropriation of its subordinated debt holders, *all* of the single-name CDSs on SNS Reaal obligations were triggered. The DC determined that the final value of CDSs referencing SNS Reaal would be determined by auction settlement (*see* Section II.B.5) at a final auction price that included *only* senior obligations (because the subordinated debt had been expropriated) despite that senior obligations were unaffected by the mandatory expropriation of subordinated debt. As a result, CDSs referencing the SNS Reaal entity were settled at prices that were too high relative to the actual expected recovery rates on the expropriated subordinated debt.

To address the various problems associated with mandatory debt exchanges, the 2014 Definitions introduced the concepts of an "Asset Package Delivery" and an "Asset Package Credit Event." For Financial Reference Entities, these provisions allow credit protection buyers in physically settled single-name CDSs to deliver a portfolio of assets resulting

from the exchange of "Prior Deliverable Obligations" or "Package Observable Bonds."

Finally, the 2014 Definitions introduce the concept of a "Standard Reference Obligation," which we discuss in more detail in Section II.B.6.

Settlement Methods

Credit protection purchasers in single-name CDSs are compensated following the occurrence of a credit event in one of three ways: cash settlement; physical settlement; and auction settlement. We discuss the three settlement methods below.

a. Physical Settlement

Historically, the most prevalent CDS settlement method is physical. In a physically settled CDS, the protection buyer must deliver any eligible deliverable obligation (*see* Section II.B.6) to the protection seller in return for a cash payment equal to the notional amount of the swap. In that situation, a protection buyer that initially owns the underlying XYZ Corp. obligation receives the par amount of that obligation (assuming it matches the notional amount of the CDS) and neither benefits from any subsequent improvements in the recovery rate expected by market participants at the time nor suffers any losses arising from later declines in the recovery rate. Instead, the protection *seller* in the CDS now bears this risk and return potential. If the protection seller holds the bond until the bankruptcy trustee makes a final distribution of assets (which is not usually the case) and the final recovery rate exceeds the expected recovery rate reflected in the market price of the bond at the time of the CDS settlement, the protection seller will be better-off *ex post* than if it had entered into an otherwise identical cash-settled CDS. But if the final recovery rate is below the expected recovery rate reflected in bond prices at the time of the CDS settlement, the protection seller will be worse-off *ex post* for electing physical rather than cash settlement.

Beginning in 2005, market participants began to express concerns with the physical CDS settlement process. As long as the total amount of CDS credit protection sold is less than the amount of underlying deliverable obligations corresponding to that CDS – as is generally the case for sovereign CDSs – physical and cash settlement should not generate significantly different payments by credit protection sellers to buyers. As discussed in more detail in Section III.B.2, however, a credit protection purchaser in a CDS need not own any obligation of the reference entity underlying the CDS and may instead be using the position to take a short position on the credit risk of the reference entity. When the notional amount of credit protection sold for a given reference entity significantly exceeds the amount of actual debt issued by that reference entity and deliverable into single-name CDSs based on that entity, problems can arise.

A classic "short squeeze" occurs when market participants establish a short position using a physically settled derivatives contract based on an asset that participants do not own at the time in order to try and benefit from subsequent price declines in the underlying asset. In order to realize any economic benefits from such price declines, however, the trader must eventually acquire the asset in order to deliver it to its counterparty. When the underlying supply of the asset is less than the amount of derivatives based on that asset, traders that have open positions when the derivatives contract matures are forced to buy the asset in the spot market. Knowing that such "naked shorts" cannot realize the benefits of their derivatives transactions unless they acquire the underlying asset, the actual holders of the asset may "squeeze" those shorts and sell the underlying asset for more than what it is actually worth.

For example, suppose XYZ Corp. experiences a credit event at a time when it has a total amount of debt equal to $100 million that could be eligible for delivery into physically settled CDSs but that a total of $500 million notional in physically settled CDSs is outstanding. To take the most extreme case, suppose the holders of XYZ Corp.'s $100 million debt have not purchased CDS protection, so that the

purchasers of all $500 million in notional CDS protection have "naked" short positions – *i.e.*, they do not own an XYZ Corp. debt instrument at the time they purchase credit protection and thus cannot receive a protection payment from their CDS counterparties without acquiring XYZ Corp. debt in the secondary bond market. For the protection purchaser in a naked physically settled short CDS position, the delivery of an eligible XYZ Corp. bond will result in a payment of 100 percent of the par value of an eligible XYZ Corp. obligation. Such a credit protection purchaser thus would potentially be willing to pay up to 99.99 percent of the par value of such securities in the secondary market. Yet, if protection purchasers do indeed bid up the price of the underlying $100 million in available securities, the result will be that the price of the XYZ Corp. obligations may be well above the actual expected recovery rate on XYZ Corp. The artificially higher prices on XYZ Corp. bonds driven by the demand from naked short CDS purchasers for deliverable securities thus may impose losses onhedgers that have purchased cash-settled CDS protection.

In 2005, market participants expressed concern that short squeezes could create basis risk for counterparties using CDSs to hedge their actual credit exposures to underlying reference entities. For example, when Delphi Corp. ("Delphi") declared bankruptcy in 2005, the firm had about $5.2 billion in par value of bonds and loans outstanding but had an estimated $28 billion of single-name CDSs outstanding. From one week prior to Delphi's bankruptcy filing to one week after, weekly trading volume increased from about $1.5 billion to more than $3 billion. As a percentage of the total par amount of Delphi obligations outstanding, weekly trading volume grew from roughly 75 percent to over 150 percent between the week prior to and after Delphi's bankruptcy filing. The secondary market price of Delphi's bonds following its bankruptcy filing, moreover, reached a peak in the low 70s, despite that Delphi bonds traded below that level for about three months prior to the bankruptcy (Batterman & Rosenthal, 2005).

b. Auction Settlement

To address potential problems arising from short squeezes in bonds deliverable into physically settled CDSs, ISDA introduced a third CDS settlement method in 2005 called auction settlement. The auction settlement essentially converts physically settled CDSs into cash-settled CDSs *and* defines the price at which cash settlement occurs through a rule-bound auction mechanism for the bonds underlying the defaulting reference entity. Specifically, following the occurrence of a credit event, buyers and sellers of single-name CDS protection could choose to agree to a protocol provided by ISDA that entitled those counterparties to convert physically settled CDSs to auction-settled contracts for which the final settlement payment from the protection seller to the buyer was equal to the notional amount of the CDS less the final auction price of the reference entity's deliverable obligation.

The final auction price is determined based on a two-stage process. In stage one, the main participants are dealers that have committed to place minimum bids or offers along with any bids/offers for physical settlement at the final price. Those stage one bids and offers establish an initial market midpoint ("IMM") price, which is a constraint on the final auction price. In stage two, limit orders from customers of dealers are added to the original stage one limit orders to arrive at a stage two auction price that clears the total net open interest. If the stage two auction price falls within a specified range (known as the "cap") of the IMM, the stage two auction price is the final auction price. If the stage two auction price is greater than the IMM plus the cap (for auctions in which the first-stage net open interest for physical settlement at the final auction price is for a purchase of the bonds), the final auction price is set to the IMM plus the cap. Conversely, if the net first-stage open interest is for a sale of the bonds, the final auction price is limited by the IMM minus the cap. The IMM and cap are intended to prevent large off-market limit orders from being submitted in an effort to manipulate the price. Manipulation is also discouraged by the imposition of a penalty for off-market submissions in stage one.

In 2009, the Big Bang Protocol (*see* Section II.B.4) "hardwired" CDS documentation to specify auction settlement as the default settlement method, provided that the relevant DC (*see* Section II.B.4.(b)) determines that there is a sufficient amount of CDSs outstanding to justify an auction. For reference entities with either a small amount of total outstanding debt or with total face values of debt well above the DC's estimate of total CDS protection bought and sold, the DC may choose not to hold an auction, in which case the settlement method chosen by counterparties in the master agreement and trade confirmations will remain in force. Another common occurrence when a reference entity has a significant quantity of senior debt but only a small amount of subordinated debt is for a DC to hold a senior CDS auction but not a subordinated CDS auction, in which case the subordinated CDSs revert to settlement through their fallback mechanism (*i.e.,* almost always physical). Table 3 in Appendix C indicates a number of situations in which separate auctions were held for the senior and subordinated obligations of a reference entity.

A list of all single-name CDS auctions held from 2005 through May 2016 is shown in Table 3 in Appendix C. Sovereign reference entities are shown in italics. There were four sovereign default events during the period – *i.e.,* the Republic of Ecuador in 2009, the Hellenic Republic in 2012, the Argentine Republic in 2014, and the Republic of Ukraine in 2015. Another 122 auction events shown in Table 3 involved single-name CDSs with corporate or SOE reference entities.

Helwege, Maurer, Sarkar, & Wang (2009) analyzed the results of 43 CDS auctions from 2005 through 2009 in order to evaluate how well final auction prices approximate expected recovery rates implied by cash bond market transactions. They find that final auction prices are generally very close to cash bond prices on the day before and the day of a CDS auction. The authors also report that the cash price of the bond on the date of the occurrence of the credit event is a good predictor of the final auction price (with the exceptions of Lehman Brothers and Washington Mutual) and thus conclude that the bond market was generally effective in

providing price discovery prior to the CDS auction. Notably, the authors do not explicitly consider whether or not CDS auctions play price discovery roles for post-auction cash bond trading.

Coudert & Gex (2010c) reviewed the results of 27 senior CDS auctions from 2005 through 2009. They find that the difference between the secondary market price of a defaulted bond and the final CDS auction price declines from the date of the credit event through the date of the auction. Examining secondary market bond prices on the date the CDS auction is *settled* (which is several days after the CDS final auction price is determined), the authors find significant differences between secondary market prices on the settlement date and final auction prices. In most cases, secondary market prices rose (in some cases significantly) from the auction date to the settlement date. Similar results of under-valuations of bond prices in the CDS auction are documented in many of the other studies reviewed below.

Chernov, Gorbenko, & Makarov (2013) examine 26 CDS auctions involving U.S. corporate reference entities between 2005 and December 2011. The authors compare the final auction prices to market prices of the bonds traded in the secondary market and reported through the Trade Reporting and Compliance Engine ("TRACE") maintained by the Financial Industry Regulatory Authority ("FINRA"). Their evidence indicates that the bonds analyzed were undervalued in the CDS auctions by six percent on average on the dates of the auctions, and that the amount of undervaluation is directly related to the total amount of bonds exchanged in stage two of the auctions – *i.e.,* the larger the net open interest, the greater the underpricing of the bonds in the auction on average.

Lieu (2011) also compares CDS auction prices to cash bond prices obtained from TRACE for 23 auctions involving U.S. corporate in 2008 and 2009. Unlike Chernov, Gorbenko, & Makarov (2013), Lieu (2011) does not analyze mispricings on the auction date but rather examines the price discovery role of the auction and its impact on secondary market trading in the five days subsequent to the auction. His results suggest

that CDS auctions play an important role in price discovery and that auction prices are generally fair despite a slight increase in bond prices on average following the auction date. (The latter result is consistent with Chernov, Gorbenko, & Makarov (2013), whereas the former is not.) At odds with the price-discovery role Lieu (2011) finds being played by the CDS auction, however, he also documents a significant increase in bond price volatility after an auction than in the pre-auction five-day window. His finding that post-auction trading volume is significantly higher than pre-auction volume suggests that the higher post-auction volatility may be the result of new market participants trading the bonds after the direct and indirect offers from auction participants have been satisfied.

Gupta and Sundaram have written two studies of CDS auction performance. In Gupta & Sundaram (2015a), the authors analyzed 22 CDS auctions from 2008 through 2010. Like Lieu (2011), the authors focus on the price discovery auction and confirm the results in Lieu (2011) that CDS auctions play a critical role in providing information to market participants for post- auction price formation in the cash market. In fact, the authors find that when the final auction price is taken into consideration, no pre-auction price or volume information at all helps explain post-auction secondary market prices – *i.e.*, all of the information on which post-auction trading is based is driven by the auction process. Gupta & Sundaram (2015a) also report that final auction prices are biased despite being informative. They attribute the pricing bias primarily to a combination of "winner's curse" issues influencing order placement, strategic bidding related to the size of bidders' net CDS positions, and illiquidity in the secondary bond market.

In Gupta & Sundaram (2015b), the authors evaluate 30 CDS auctions from November 2006 through December 2013 to examine the extent of any mispricings between the CDS auction final price and the pre- and post-auction cash market prices of the bonds. They report a systematic underpricing of bonds in CDS auctions where the net open interest is on the sell side and a systematic overpricing of bonds in auctions

dominated by buy orders. Although they estimate that an arbitrageur could earn as much as 15 percent by exploiting these mispricing patterns, they also attribute that return to a liquidity risk premium compensating arbitrageurs for illiquidity in the underlying bond market.

Most of the studies of CDS auctions have two major common conclusions – *i.e.,* CDS final auction prices tend to be biased (often on the side of undervaluing the underlying bonds), but the auction process is a critical component in the price discovery process for post-auction cash bond trading. Many of the studies, moreover, attribute pricing differences around auctions to illiquidity in the underlying bond market. We discuss the empirical relations between CDS spreads and cash bond credit spreads in more detail in Section VI.D.

c. Cash Settlement

Although rarely used historically and virtually non-existent in recent years, a third CDS settlement mechanism is cash settlement, which involves a single payment by the protection seller to the protection buyer equivalent to the notional amount of the CDS less the expected recovery value. The expected recovery amount reflects the ability of the CDS protection purchaser to receive subsequent payments on the underlying reference entity's debt from its bankruptcy trustee (or the equivalent). The actual recovery of a bondholder is, of course, determined well after (sometimes many years later than) the occurrence of the credit event on which the corresponding CDS is based. As such, cash-settled CDSs generally rely on the market price of a bond at the time of CDS settlement (which should, in principle, equal the market-based expected recovery value) or a pre-specified recovery rate as fraction of par value based on the credit rating of the reference entity and/or historical recovery data.

For example, suppose a credit protection purchaser that owns a $1 million face value bond issued by XYZ Corp. enters into a $1 million notional CDS on XYZ Corp. in which the protection payment from the seller to the buyer is based on the market-determined expected recovery rate (*i.e.,* the price of an obligation of XYZ Corp.) on the final settlement date of

the CDS. Suppose that the market price of a representative XYZ Corp. bond on the CDS settlement date is 40 (implying a 40 percent expected recovery rate). In that case, the protection seller must make a payment of $600,000 to the protection purchaser (*i.e.,* the par value of $1 million less expected recovery of $400,000). In such a cash-settled CDS, the protection purchaser locks in the market-based expected recovery rate (*i.e.,* 40 percent) as of the CDS settlement date.

If in this example the bankruptcy court eventually distributes more than 40 percent to XYZ Corp. bond holders – say, *e.g.,* 50 percent – then the CDS protection purchaser that also owns the bond will actually experience a net gain – *i.e.,* $600,000 received from its CDS protection seller counterparty plus $500,000 received upon surrender of the actual bond to the bankruptcy trustee, resulting in a total received of $1.1 million on a $1 million hedged bond investment. Conversely, a determination by the bankruptcy trustee that the recovery rate is less than 40 percent – say, *e.g.,* 30 percent – then the CDS protection buyer that owns the bond will be under-compensated for its actual losses. It will receive $600,000 from its CDS counterparty but will only receive $300,000 from the bankruptcy trustee, resulting in a net loss of $100,000 *vis-à-vis* the $1 million par value of the XYZ Corp. bond it owned.

Deliverable Obligations

Prior to the 2009 Standardization Initiatives, the debt obligations issued by a reference entity that were deliverable in a physically settled CDS were specified in the original transaction documentation. After the implementation of the 2009 Standardization Initiatives, the applicable DC applies the conditions contained in market-standard documentation to the available bonds in order to determine which bonds qualify for physical delivery and trading in the CDS auction.

Eligible market participants are entitled to submit proposed obligations for the DC to consider, and such market participants may also submit objections to the DC regarding the inclusion of certain obligations on the deliverable obligations list.

For most reference entities, any plain vanilla debt can be delivered in the CDS auction or by the protection purchaser in a physically settled CDS, usually subject to a maximum maturity of 30 years and to the constraint that subordinated debt cannot be delivered to satisfy the requirements of a senior CDS. As such, the CDS protection purchaser holds a cheapest-to-deliver ("CTD") option that drives the pricing of the corresponding CDS contract. In other words, the market-based spread on a single-name CDS is based not only on the credit risk of the underlying reference entity, but also on the probability that the protection seller will receive the lowest-possible valued deliverable obligation (*e.g.,* long-dated, high-duration, subordinated bonds) in lieu of less risky deliverable securities (*e.g.,* short-term, low-duration, senior debt).

For CDS auctions involving restructuring credit events, moreover, the deliverable obligations are often constrained by the contractual maturities of the underlying bonds and CDSs. This can give rise to auctions for different "buckets" of obligations issued by the reference entity as defined by the insolvency proceedings. For example, in the auction for Northern Rock (Asset Management) PLC ("NRAM") held on February 2, 2012, the EMEA DC elected to hold two auctions. In making this determination, the DC classified NRAM's senior and subordinated obligations into four maturity buckets, in which the obligations in buckets one, two, three, and four had approximately 2.5, five, 7.5, and 10 years to maturity, respectively. The DC decided to hold auctions for Buckets 1 and 2, in which senior and subordinated obligations within the covered maturities were deliverable. The DC opted not to hold auctions for the longer- dated maturity buckets, presumably because of the low number of deliverable obligations – *viz.,* Buckets 1 and 2 included 355 transactions, whereas Buckets 3 and 4 only included 22 transactions [Retrieved from].

In the 2014 Definitions, ISDA also introduced the concept of a standard reference obligation ("SRO"). Although deliverable obligations under single-name CDSs are not limited exclusively to SROs, the SROs for a reference entity (published by ISDA periodically for frequently traded CDSs)

are a minimum subset of deliverable obligations. In any physically settled CDSs, the protection buyer is contractually obligated to deliver the SRO to the protection seller before the latter makes a payment to the former. SRO designations are intended to further reduce the basis risk associated with the CTD option and to promote consistent pricing across CDS contracts.

3 Potential Benefits and Costs of Single-Name CDSs

In this section we provide a brief introduction to the main potential benefits and costs of CDSs. Prior to the credit crisis, the emphasis in the literature was tilted toward the benefits of CDSs (primarily as credit risk-transfer mechanisms). Since the crisis, relatively more discussion in the academic literature has centered on the potential costs of CDSs. We briefly discuss these primary benefits and costs (as a matter of theory) in this section, leaving the detailed literature survey and review of the empirical evidence to the rest of the paper.

Potential Benefits of Single-Name CDSs

There are four frequently noted potential benefits of single-name CDSs to their users and, in some cases, to other market participants: facilitating credit risk transfer, increasing the supply of loanable funds, providing opportunities for relatively lower-cost synthetic bond investments, and promoting price discovery and information aggregation. We

discuss each of these potential benefits in the sections that follow.

Credit Risk Transfer

The classic rationale for CDSs (as with most other derivatives) is to provide a risk- management solution for lenders to manage their credit exposures to borrowers. Prior to the advent of credit derivatives, there were mechanisms for firms to manage their corporate and sovereign credit exposures, but those credit risk transfer mechanisms were often inefficient, costly, and/or inaccessible to certain market participants. For example, bank lenders primarily managed and laid off their credit exposures to corporate borrowers through the loan syndication market and through the sale of loan participations on loan trading desks.[1] Until the mid-1990s, however, the syndicated loan market was largely non-standardized and not easy for non-financial institutions to access except through loan or prime funds and early CLOs.

Asset managers and other investors in corporate and sovereign debt were limited to hedging in the cash bond markets, where a bond investor concerned about the credit risk of the bond issuer could either sell the bond or utilize repurchase agreements (repos) and reverse repos to construct synthetic bond forward contracts. The former option deprived the bond investor of any ongoing exposure to the issuer, and the latter alternatives were often prohibitively expensive and gave rise to significant basis risks.

The introduction of single-name CDSs fundamentally altered the availability of risk- sharing mechanisms by creating a new, more efficient product that enabled market participants to customize their credit risk profile. Instead of being forced to sell a bond or loan investment or rebalance a whole portfolio, single-name CDSs presented a more surgical and precise risk management tool. (Duffee & Zhou, 2001) In addition to facilitating more tailored credit risk transfer solutions, single-name CDSs are also more liquid and

[1] For a discussion of the evolution of the loan market and loan trading, see, e.g., Taylor & Sansone, (2007), Miller, (2013), and Culp (2013).

accessible to would-be hedgers than cash bond and loan markets.

The risk management applications of single-name CDSs can be classified into two distinct categories: (i) firms that purchase credit protection to cover future potential losses that would be realized following a credit event; and (ii) firms that acquire credit event protection using CDSs to hedge the risk of periodic changes in the market values of a reference entity's obligations resulting from changes in market participants' expectations of future potential adverse credit event-related losses and other market factors.

a) Managing Realized Default Risk

The first category of hedgers relies on single-name CDSs for credit protection to cover realized losses following the occurrence of a credit event. These participants are generally unconcerned about interim changes in market expectations of the probability of default and/or expected recovery rates on the underlying reference entity. Although these hedgers must be attentive to funding liquidity risks arising from initial and variation margin, their main risk management objective is to protect themselves against an actual credit event, which could giverise to realized economic losses if unhedged.

For example, consider an asset manager that has invested in a large amount of bonds issued by XYZ Corp. If the asset manager believes that the market price of XYZ Corp. bonds and CDSs referencing XYZ Corp. reflect an excessively optimistic view of the true default risk on XYZ Corp. obligations, the asset manager may keep its bond holdings and purchase what it perceives as relatively cheap protection against the risk of default-related losses on XYZ Corp. bonds. Changes in market perceptions of XYZ Corp.'s default risk can result in potentially significant volatility in the prices of the asset manager's holdings in actual XYZ bonds and CDSs and may present potentially significant funding requirements should the prices of XYZ Corp. bonds decline. Although the asset manager will have achieved its risk management objective of locking in the final value of its hedged bond position, it must pay close attention to the impacts of mark-

to-market spread changes on its interim cash flows and funding liquidity.

Although often compared to bond insurance, CDSs differ from bond insurance in several important ways that are particularly relevant for hedgers. A typical indemnity credit insurance contract (*e.g.,* bond or loan insurance that reimburses lenders for losses arising from a borrower default) provides a lender with a reimbursement of *actual losses* sustained following a default by the borrower (subject to a first-loss retention (a.k.a. deductible) and a policy limit). Because CDSs are based on a reference *entity* and not a specific individual security, there is some basis risk for a hedger that wishes to manage its credit exposure to a given firm using single-name CDSs. For example, suppose an investor purchases a short-term, senior bond issued by Firm ABC and also purchases an auction-settled CDS on reference entity ABC. The CDS spread will reflect the CTD option and, to the extent that Firm ABC also has significant amounts of longer- term and subordinated debt outstanding, the investor will pay a higher CDS coupon than suggested by the risk of the actual short-term senior obligation it holds. The final price in the CDS auction, moreover, will reflect the valuations of *all* of Firm ABC's outstanding deliverable debt, which could also result in Firm ABC receiving a lower payment from its protection seller counterparty than what the bond it holds is worth. The contract is thus not equivalent to an indemnity contract that reimburses actual losses and is not considered insurance.

b) Managing Interim Mark-to-Market Risk

The second category of hedgers use single-name CDSs to manage their risk of actual economic losses or mark-to-market accounting losses (generating lower-quality and noisier earnings estimates) arising from interim changes in market expectations about the reference entity's probability of experiencing a credit event and or changes in the expected recovery rate following a credit event prior to the maturity of the CDS contract. Consistent with their risk management objectives, such CDS users can manage their risks by adopting

appropriate "hedge ratios" (*i.e.*, the proportions of CDS hedge positions *vis-à-vis* actual exposures to the reference entity). A typical hedge ratio will roughly match changes in mark-to-market values of CDS spreads (with opposite market directional exposure) to changes in the firm's corresponding riskexposure (see, Fage and Liu, 2002).

Increased Supply of Loanable Funds

Financial institutions, including bank lenders to CDS reference entities, are major participants in the CDS market. If creditors selectively trade single-name CDSs linked to their borrowers, CDS positions can change the creditor-borrower relationship and play an important role in determining the borrower credit risk that defines the value of the CDSs and the likelihood of the borrowers experiencing a credit event that will trigger the CDSs. Because single-name CDSs enable creditors to hedge their credit exposures, moreover, CDSs (prior to Basel III) freed up economic and/or regulatory capital that enabled some lenders to increase the supply of credit either to the same underlying firm or more generally. Improved access to capital for borrowers, in turn, can increase their financial flexibility and resilience to financial distress. Cebenoyan and Strahan (2004) confirm that banks engaging in loan sales and other credit risk transfer mechanisms hold less capital, extend larger amounts of credit to relatively high-risk borrowers, and have lower overall risks and larger profits than other banks.

This gives rise to several empirical questions that we will examine in Section V.A: To what extent do banks actually use single-name CDSs to hedge the credit risk of their borrowers? Does the use of CDSs by banks result in an increased supply of loanable funds to either the reference entities underlying the CDSs on which the bank has purchased protection or to other borrowers? Does the use of CDSs by banks lead to increased risk-taking by banks?

Synthetic Bond Investments

Unlike insurance, single-name CDSs do not oblige protection purchasers to own any of the underlying bonds issued by the reference entity. As such, single-name CDSs can be used by firms to take a position on the credit risk of the underlying reference entity either to add to or reduce/neutralize the same side of an existing bond position or to create a new credit exposure. Because single-name CDSs facilitate the standardized trading of underlying credit exposures, investors can usually make their desired economic trade in the underlying bond using CDSs as opposed to trading in fragmented, commoditized bond issues. The ability of investors to use CDSs as synthetic bond investments, moreover, indirectly benefits hedgers (all else equal) by bringing additional liquidity to the CDS market.

Price Discovery and Information Aggregation

Yet a fourth manner by which single-name CDSs provide a benefit to market participants is through their role in information aggregation. Like other derivatives contracts, single-name CDS market prices (*i.e.,* spreads) reveal market participants' expectations of the probability that the underlying reference entity will experience a credit event before the CDS contract matures and/or that the market-implied recovery rate and LGD will change. Even for firms that are not actively engaged in credit protection purchases or sales, market-determined CDS spreads still contain information that is potentially useful regarding market participants' expectations about the credit risk of reference entities underlying single-name CDS contracts with various maturities.

Potential Costs of Single-Name CDSs

Single-name CDSs also have potential costs that are subject to empirical examination. The major potential costs that have been discussed in the literature are summarized below. Note that several of these potential costs have been analyzed

extensively in the theoretical financial literature but have not been subject to significant empirical analysis.

Increased Risk-Taking and Diminished Monitoring by Banks

The widespread availability of single-name CDSs as credit risk transfer instruments can potentially give banks an incentive to take on greater risks. According to some, the easier it is for banks to protect themselves from the risk of borrower defaults, the more banks will have an incentive to originate larger and riskier loans. In other words, readily available credit risk transfer solutions can give rise to moral hazard and induce banks to make riskier lending decisions. (*See, e.g.,* Hakenes & Schnabel, 2010). Similar criticisms have been levelled at mortgage lending as well as leveraged finance markets. In both of these markets, the originate-to-distribute model of lending dominates the traditional originate-to-hold model.

A related concern is that banks that hedge their credit risk exposures to borrowers will engage in insufficient monitoring of borrower credit risks – *i.e.,* another form of moral hazard. (*See, e.g.,* Pennacchi, 1988). Generally and Morrison (2005) for a CDS-specific discussion.) Monitoring involves screening borrowers *ex ante* in order to identify good credits and measure their risk and then following borrowers over the course of their loans in order to both prevent them from engaging in opportunistic and excessively risky behavior and to penalize them when they fail to meet contractual obligations. To the extent that bank lenders can hedge their borrower credit exposures on a relatively low-cost basis, single-name CDSs could attenuate banks' incentives to monitor the credit quality of borrowers and shift monitoring responsibilities to credit protection sellers with relatively less skill and expertise than lenders have. The counter- argument, however, is that, to the extent the information about the credit risk of the reference entity reflected in CDS spreads is reliable, it may actually be a better source of information (even for the original bank lenders themselves) about the

credit quality of borrowers than passive or even active borrower-specific credit risk monitoring.

Yet another similar concern is that CDSs can make it "too easy" for investors and banks to increase their credit risk exposures. The mere fact that the uses of single-name CDSs can sometimes lead to increased risk is not, however, an indictment of CDSs if the firms' managers and shareholders have a preference for greater risk-taking and the corresponding potential for higher returns. On the contrary, given that single-name CDSs enable firms to achieve their desired risk/return targets is an indication that single-name CDSs are effective in facilitating firms' specific risk management and investment objectives.

Empty Creditors and Negative Economic Interests

Concerns have been expressed that when debt holders in a company purchase too much credit protection through single-name CDSs but retain their voting rights, those "emptycreditors" may no longer have an incentive to renegotiate their debt or make concessions even when it is efficient for them to do so, thereby forcing the debtor into inefficient bankruptcy or liquidation. (Hu & Black, 2008a, 2008b; Bolton & Oehmke, 2011).

A more extreme version of this theory known as the "negative economic interest" problem is that hedged creditors may have an incentive to buy up a significant amount of a firm's debt, purchase protection in a much larger notional amount, and try and drive the firm into bankruptcy to make a net profit on its CDS protection purchases. (Hu & Black, 2008b). *The Economist* characterized this potential concern as follows: "By purchasing a material amount of a firm's debt in conjunction with a disproportionately large number of CDS contracts, rapacious lenders (mostly hedge funds) can render bankruptcy more attractive than solvency" (The Economicst, 2009).

We discuss the empty creditor and negative economic interest concerns in more detail and survey the related empirical evidence in Section V.B.3.

"Excessive" Volatility Arising from Speculation

The use of CDSs to replicate bond positions synthetically has been an important source of demand for single-name CDSs in the past, but has also been a significant source of controversy. As noted in the previous section, single-name CDS contracts are (by design) derivatives and not insurance contracts. As a result, the insurable interest doctrine does not apply to protection buyers and, as such, they are not obliged to own an underlying bond issued by the CDS reference entity. This investment activity thus is often described in the popular press as "speculation" or "uncovered selling" or "naked shorting."

A potential benefit of synthetic bond investors and speculators is, of course, the potential for added liquidity in the CDS marketplace. Greater liquidity benefits hedgers by reducing market liquidity risks. The presence of speculators also helps ensure that the information reflected in market prices is not biased toward either primarily optimistic or pessimistic investors.

Dating back to the earliest days of U.S. futures regulation, however, many have held the belief that speculators can be a de-stabilizing influence and can cause an increase in market volatility not just in the derivatives product but in the cash market underlying the derivatives product. For example, in 1947 President Harry S. Truman said:

> Another factor that contributes to high prices of food is gambling in grain. Grain prices naturally respond to the laws of supply and demand, but they should not be subject to the greed of speculators who gamble on what may lie ahead in our commodity markets.... I say this because the cost of living in this country must not be a football to be kicked about by gamblers in grain (Bakken, 1953).

Such beliefs persist today. For example, during the European sovereign debt crisis, numerous media, public policy, and political commentators blamed naked shorting in sovereign CDS markets for the seemingly excessive volatility on the prices and rates of European sovereign debt and for the decline in sovereign debt prices in the cash market. The European regulators' concerns escalated to a ban on naked shorting of sovereign debt through sovereign CDSs

effective as of November 1, 2012. Excluded from the ban are protection purchasers that own the underlying bonds, have borrowed or arranged to borrow the underlying bonds, or had an arrangement with a third party confirming the source from which the deliverable bonds would be obtained.

The empirical evidence does not provide support for regulators' concerns. For example, Duffie (2010) shows that the growth in the *net* open interest of CDSs on Eurozone countries that were perceived as potential default risks in 2010 was not particularly volatile, which indicates that most CDS protection purchases were buy-and-hold hedges and not short-term speculative attempts to "take a view" on those countries. Duffie (2010), moreover, finds no statistically significant relation between net changes in open sovereign CDS positions and weekly changes in the CDS coupon rates for Greece, Ireland, Italy, Portugal, or Spain. In fact, the empirical evidence indicates that the E.U. ban on the naked shorting of sovereign debt using sovereign CDSs adversely impacted the market by reducing liquidity (Duffie, 2010; Pu & Zhang, 2012b; Silva, Vieira, & Vieira, 2016) and interfering with price discovery (Ni & Pan, 2011; Silva, Vieira, & Vieira, 2016).

Related to concerns that single-name CDSs provide relatively low-cost and liquid instruments for speculators to take a view or make a synthetic investment in the underlying reference entity is the concern expressed by some that single-name CDSs may provide market participants with a mechanism to manipulate CDS prices in order to generate profits in related financial instruments (*e.g.,* the reference entity' stocks or bonds). This concern is usually based on a perceived opacity in single-named CDS trading – *i.e.,* a perceived lack of transparency in single-name CDSs makes cross-market manipulations harder for other market participants to detect and prevent. (*See, e.g.,* Anderson, 2010; and Brown, 2010).

Systemic Risk

Although there is very little empirical evidence that single-name CDSs were either the proximate cause of the credit and Eurozone sovereign debt crises or that single-name CDS

markets stopped functioning during the crises (unlike other markets, such as collateralized debt obligations ("CDOs") backed by subprime mortgage-backed securities), many still contend that single-name CDSs are a source of potential interconnectedness and systemic risk across financial institutions that could serve as a transmission mechanism for contagion in the event of a systemic financial disruption.[2] This concern has been the focus of both academic researchers and government regulators, such as the Financial Stability Oversight Council ("FSOC").

[2] Even before the outbreak of the crisis, some academic cautioned about the heightened interconnectedness to which single-name CDSs gave rise. See, e.g., Rajan (2005a, b).

4 The Informational Content of CDS Spreads

One of the most important and well-recognized aspects of the market-based price system is the informational role of prices (Hayek, 1945). Prices that reflect all available information are essential in guiding and promoting efficient resource allocation across time and space. Financial asset prices, in particular, aggregate the information and expectations of a wide variety and number of market participants. (*See, e.g.,* Fama, 1970, 1991).

Prices of derivatives contracts reflect market participants' information and expectations about the asset or reference rate underlying the derivatives contract. For example, the current price of a forward or futures contract on a commodity to be delivered in three months can be interpreted as the current expected value of the spot price of wheat three months from now.[1] Furthermore, prices can contain information about

[1] Most of the empirical evidence indicates that futures prices are unbiased expectations of future spot prices. See, e.g., Working (1934, 1949, 1962), Telser (1958), Gray (1961), Dusak (1973), Fama & French (1987, 1988), and Ng & Pirrong (1994).

other exogenous market determinants. For example, Roll (1984) documented that, as a result of the strong relation between orange juice production and weather, orange juice futures prices provide better information about weather forecasts than weather forecasts themselves.

CDS spreads are a type of market-determined price and, like other asset prices, contain potentially valuable information. In this section, we review the academic literature on the informational content of CDS spreads along three dimensions: (i) the information contained in CDS spreads about the credit risk of the underlying reference entity; (ii) the other economic variables that influence and are reflected in CDS spreads; and (iii) the use of CDS spreads to estimate the significance of firm-specific information releases (*e.g.,* credit rating actions) and general market news announcements. The empirical research on these three issues can help us gain a better understanding of how well connected single-name CDS spreads are to the credit risk of their underlying reference entities and other economically relevant variables and, hence, how well single-name CDSs can function as credit risk transfer and synthetic investment mechanisms.

Reference Entity Credit Risk

Single-name CDS spreads reflect important information about market participants' expectations concerning the future probability of default and the recovery rate (and, hence, LGD) for underlying reference entities. Before reviewing the empirical evidence in Section IV.B, a brief review of two anecdotal examples will help motivate the subsequent discussion.

CDS Spreads and the Greek Restructuring Event

Exhibit 8 shows single-name CDS spreads with one-, five-, and 10-year tenors on the Hellenic Republic from 2009 through March 9, 2012 (*i.e.,* the date on which the EMEA DC declared that a restructuring event had occurred, as discussed in Section II.B.4). For scaling purposes, the data is presented

in two sub-exhibits: Exhibit 8(a) presents Greek CDS spreads from 2009 through September 30, 2011, and Exhibit 8(b) shows spreads from October 3, 2011, through March 9, 2012.

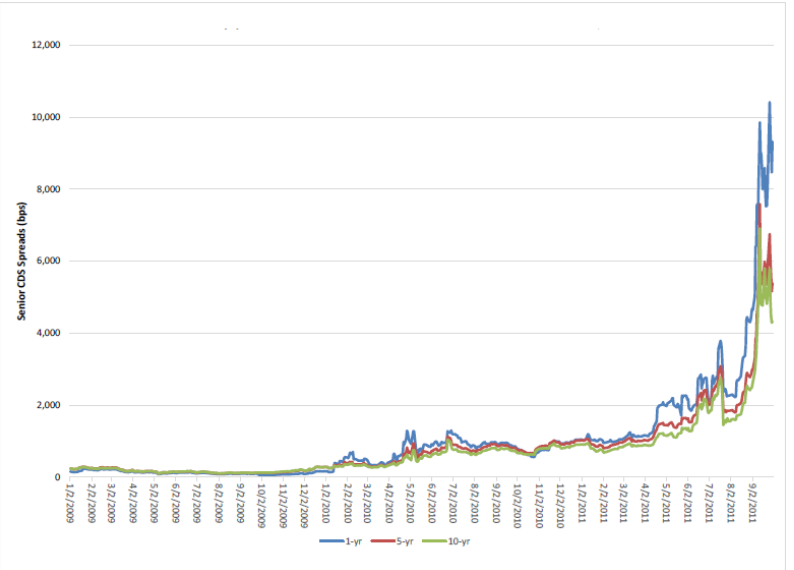

Exhibit 8(a). *CDS Spreads for the Hellenic Republic, 1/2/09 - 9/30/11*
Source: Capital IQ and CMA Subscribed Data NOTE: Spreads shown are the bid/ask midpoint for CDSs on senior Greek debt.

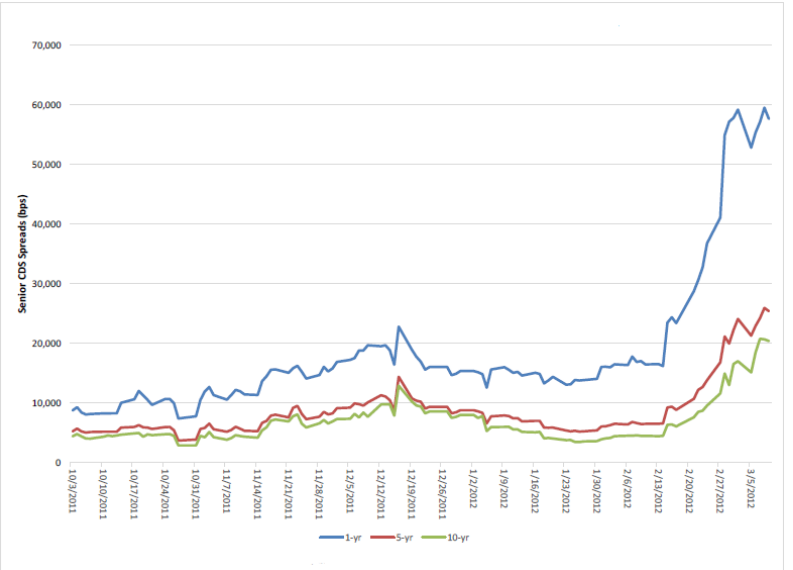

Exhibit 8(b). CDS Spreads for the Hellenic Republic, 10/3/11 - 3/9/12
Source: Capital IQ and CMA Subscribed Data NOTE: Spreads shown are the bid/ask midpoint for CDSs on senior Greek debt.

The Greek CDS spreads shown in Exhibit 8 unsurprisingly and consistently track the major news events surrounding the Hellenic Republic's mounting fiscal crisis. Tran (2013) confirms that sovereign CDS spreads on Greek debt provided a significant early warning to debt holders as much as three to six months in advance of the actual credit event determination. In Exhibit 8(a), for example, the increase in CDS spreads is pronounced prior to the May 2010 E.U. bailout announcement, as is the subsequent retrenchment of spreads after the creation of the EFSF was announced (*see* Section II.B.4). The significant increase in the volatility of credit spreads around the July 2011 E.U. summit is also apparent.

In Exhibit 8(b), we can see that following the October 26, 2011, invitation by the Greek government for investors to engage in a voluntary debt exchange, credit spreads fell, albeit only briefly and from already exorbitant levels. As Exhibit 8(b) further shows, moreover, spreads generally then rose through mid-December, with one-year spreads exceeding 20,000bps per annum. A purchase of €1 million in notional credit

protection on senior Greek debt in mid- December 2011 thus would have cost over €500,000 *per day*.

Also noteworthy from Exhibit 8 is the relation between CDS spreads of different maturities, more generally known as the term structure of CDS spreads.[2] Beginning in mid- January 2010, one-year spreads rose above five-year spreads, and five-year spreads began to exceed 10-year spreads. That remained true more often than not through 2010 and was consistently true in 2011 and 2012. In other words, the cost of purchasing credit protection on Greek debt (on an annualized basis) was higher for a one-year tenor than for a five- or 10-year tenor. Indeed, the cheapest credit protection on Greek debt (on an annualized basis) was for the purchase of 10-year default protection. Such inversions in the term structure of credit spreads (known in futures parlance as "backwardation"[3]) are common for reference entities experiencing financial distress. In essence, market participants generally expect the firm or the sovereign either to fail in the short run or, if it survives, to experience a subsequent improvement in its financial condition and credit quality, which leads to lower conditional default probabilities and CDS spreads for more deferred maturities. We discuss the term structure of CDS spreads in more detail in Section IV.B.2.

CDS Spreads and the Lehman Credit Event

The one-, five-, and 10-year spreads on senior CDSs referencing Lehman Brothers presented in Exhibit 9 tell a similar story for Lehman to that shown in Exhibit 8 for Greece. The cost of purchasing credit protection on Lehman senior debt began to increase noticeably in August 2007, when what had previously been limited to a U.S. subprime mortgage

[2] A true term structure of CDS spreads would typically include all available maturities and not just the three shown in Exhibit 8.

[3] Backwardation is a term used to describe futures markets for which prices of contracts for near-term expiration exceed prices of longer-dated contracts. (See, e.g., Culp, 2004). In the context of CDSs, this concept implies that coupon payments for the purchase of one-year credit protection on a reference entity exceed the cost of credit protection for longerdated tenors.

and leveraged loan crisis suddenly erupted into a broader global credit crisis. Spreads then became relatively more volatile and increased through the March 14, 2008, announcement by the Federal Reserve Bank of New York that it would provide temporary liquidity to facilitate the sale of ailing investment bank Bear Stearns.

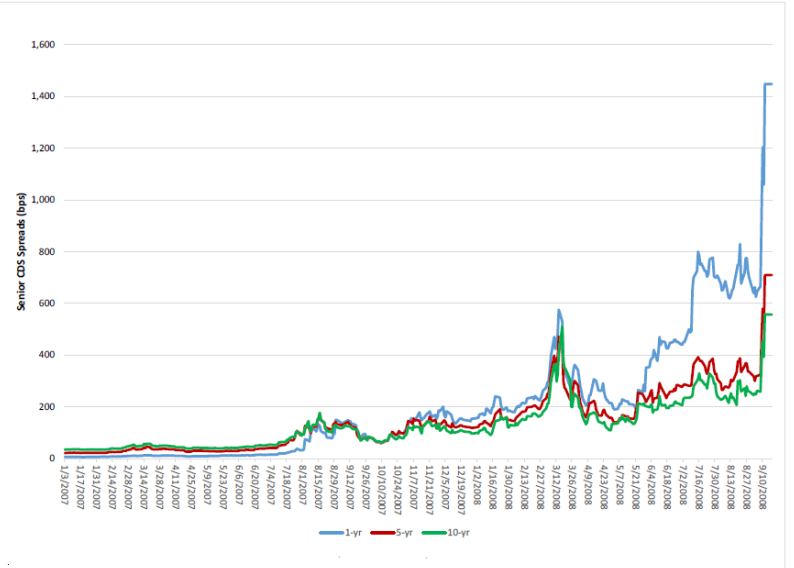

Exhibit 9. *CDS Spreads for Lehman Brothers, 1/3/07 - 9/15/08*
Source: Capital IQ and CMA Subscribed Data
Note: Spreads shown are the bid/ask midpoint for CDSs on senior Lehman debt.

Beginning late May of 2008, as Exhibit 9 indicates, the one-year CDS spread began to increase significantly. Five- and 10-year spreads also rose, but not by nearly as much as the one-year spread. Although the slope of the term structure of Lehman CDS spreads had been mostly negative since late 2007, the degree of backwardation increased sharply in Lehman's final months. On July 15, 2008, for example, the cost of purchasing credit protection on Lehman's senior debt for one year was eight percent per annum as compared to 3.93 and 3.10 percent per annum for the cost of five- and 10-year protection, respectively.

Determinants of CDS Spreads

Although the CDS spreads and slopes of the CDS term structures on Greek and Lehman debt leading up to the two entities' credit events tell a plausible story that single-name CDSs reflect market participants' expectations of future credit events, the mere graphical depictions of spreads does not empirically substantiate that numerical default probabilities and recovery rates can be extracted with confidence from observed CDS spreads. To accomplish that, more rigorous econometric analyses are required. Such analyses are also required to determine which other economic variables may influence and be reflected in single-name CDS spreads.

Significant attention has been paid in the academic literature to the empirical determinants of CDS spreads. In other words, what actually determines the price that protection purchasers must pay to transfer their credit risk or initiate a new synthetic bond position on reference entities underlying and utilizing single-name CDSs?

At a broad level, the market-determined spread on a single-name CDS is comprised of two components. The first component is the expected credit loss associated with the underlying reference entity – *i.e.,* the probability that the reference entity experiences a credit event over the life of the CDS contract, and the LGD if a credit event occurs (*i.e.,* the expected loss less expected recoveries). Protection sellers demand a CDS coupon rate that compensates them for these expected credit-related losses. We review the empirical research on expected credit loss information reflected in CDS spreads in Sections IV.B.1 and IV.B.2.

In addition to the expected credit loss component of CDS spreads, protection sellers also demand a risk premium from protection buyers to compensate for the risk that actual payouts on the single-name CDS protection sales they write may exceed expected credit losses (Pan & Singleton, 2008). As we discuss in Section IV.B.3, the risk premium reflected in CDS spreads is not limited to a credit risk premium; protection sellers in single-name CDS appear also to require compensation for non-credit risks.

Many of the economic variables discussed in the sections below have their theoretical roots in the classic characterization of corporate debt as a put option on the assets of a firm plus a risk-free loan originally pioneered by Merton (1974).[4] A large literature has evolved that expands on and modifies the original lognormal Merton model, tests the original version of the model and many of its successors, and empirically examines the related issue of the "credit spread puzzle" (*i.e.*, actual credit spreads are often much higher than those implied by the Merton model). Those theoretical and empirical studies are beyond the scope of this paper, but interested readers are directed to the useful surveys by Jarrow (2009) and Sundaresan (2013).

CDS Spreads and Expected Credit Losses

A significant amount of research has investigated the forecasting power of CDS spreads with respect to the credit risk of underlying reference entities. The evidence indicates that CDS spreads (both spreads and changes in spreads) contain information that can be used to estimate the probability of future adverse credit events. Hull, Predescu, & White (2004), Finnerty, Miller, and Chen (2013), and others confirm this hypothesis where negative rating events (primarily reviews for downgrade) are the adverse credit events. Berndt, *et al.*, (2005), moreover, find that over 70 percent of the variation (across different reference entities) in five-year single-name corporate CDS spreads is explained by corresponding expected default frequencies ("EDFs") measured using the Moody's KMV model.[5] Other studies of CDS spreads have confirmed that a reference entity's credit risk (measured by credit rating or market-based measures like

[4] The Merton (1974) insight can be used as a non-parametric empirical benchmark for credit risk analyses, as discussed in Culp, Nozawa, and Veronesi (2015).

[5] Moody's KMV model is based on the Merton (1974) structural model of credit spreads. EDFs are estimates of default probabilities specifically obtained from the Moody's KMV model, and subsequent uses of the EDF acronym in this review refer to probabilities of default obtained or estimated by authors from Moody's KMV.

EDFs) is a primary determinant of credit spreads during normal market conditions – *see, e.g.,* Aunon-Nerin, Cossin, Hricko, & Huang (2002), Abid & Naifar (2006), Fabozzi, Cheng, and Chen (2007), Jakovlev (2007), Chen, Cheng, & Liu (2008), Annaert *et al.,* (2013), and Kolokolova, Lin, & Poon (2015).

Some papers have focused specifically on the informational content of CDS spreads for banks or other financial institutions. Chiaramonte & Casu (2010) find that single-name CDS spreads on senior U.S. bank debt reflect the same information as bank balance sheet ratios and are a good proxy for bank credit risks. The authors also deduced that the relationship between CDS spreads and balance sheet ratios grew even stronger during the credit crisis. Norden & Weber (2012) find a similar result for CDSs on the senior debt of European banks and further document that CDSs on subordinated bank debt provide an early indication of bank default risk (which they measure using credit ratings and financial statement information). Not surprisingly, they show that CDSs on subordinated bank debt are more risk-sensitive than CDSs on senior debt.

Avino, Conlon, & Cotter (2016) examine the senior and subordinated CDS spreads of 60 European and U.S. banks and confirmed the results in the earlier two studies that changes in CDS spreads provide strong information about forthcoming financial distress at banks. They authors estimate that a one standard deviation increase in CDS spreads is associated with as much as a 15 percent increase in the probability of the reference bank's failure.

Single-name CDS spreads not only reflect the probability that the underlying reference entity will experience an event of default,[6] but also market participants' expectations about

[6] The probabilities of default extracted from the CDS term structure are known as "risk-neutral" probabilities – i.e., probabilities that a risk-neutral agent would perceive. Risk-neutral probabilities can be converted into "true" default probabilities by making some additional assumptions about investor risk aversion and systematic risk. See, e.g., Cochrane, (2001).

the recovery rate and LGD of the reference entity.[7] In a classic paper, Pan & Singleton (2008) estimate the nature of default arrivals and recovery rates implied by the term structure of sovereign CDS spreads using data from Mexico, Turkey, and Korea from 2001 to 2006. They show that the probability of default and LGD can be separately estimated from the term structure of sovereign CDS spreads. Christensen (2007), Schneider, Sögner, & Veža (2010), Elkamhi, Jacobs, & Pan (2014), and Schläfer & Uhrig-Homburg (2014) also find that separate estimates of default probabilities and expected recovery rates or LGDs can be extracted from observed CDS spreads and that the risk of changes in expected recovery rates gives rise to a risk premium for which protection purchasers demand to be compensated.

The Term Structure of CDS Spreads

The term structure of CDS spreads is normally upward-sloping. At least two different explanations have been posited for this phenomenon. The first and most obvious explanation for a positively sloped CDS term structure is that investors may perceive the firm's credit quality to be declining over time, resulting in rising costs of default protection and CDS spreads.

Sometimes known as the expectations hypothesis, this explanation essentially adopts the view that current CDS spreads are good forecasts of future default probabilities and recovery rates.

A significant amount of theoretical research has been conducted to try and connect the slope of the term structure of CDS spreads to underlying theories of credit risk. The idea is that the term structure of single-name CDS spreads should be upward-sloping for relatively high- quality, low-risk reference entities because of the direct link between CDS spreads and conditional default probabilities. To put it simply,

[7] CDS spread valuation models often assume a fixed recovery rate. To the extent that recovery rates are not fixed, however, spreads estimated in fixed-recovery models may understate true CDS spreads. See, e.g., Singh & Spackman (2009).

the probability of a firm defaulting over the course of one year starting at time t – conditional on the firm having survived up to time t – is higher for larger values of t because expected future credit quality is perceived as lower than current credit quality. For example, the conditional probability of default from year five to year six for a firm that has survived to year 5 is lower than the conditional probability of default from year nine to year 10 for a firm that has survived to year nine, thus implying a higher one-year CDS spread at year nine than the one-year CDS spread at year five.

For relatively riskier, lower-quality firms – especially those experiencing financial distress – the opposite is true, and the term structure of CDS spreads is generally downward-sloping, as shown in Exhibits 8 and 9 for CDS spreads on Greece and Lehman Brothers, respectively. For such firms, the one-year conditional probability of default at time t is decreasing in t – *i.e.,* a firm that survives the short run is expected to have subsequent improvements in its credit quality, thus leading to lower conditional default probabilities and CDS spreads.

An alternative to the expectations hypothesis is that CDS spreads for different maturities reflect not only expected future credit losses but also a risk premium that investors require as compensation to bear the risk that future losses are unexpectedly higher than the reference entity's expected credit loss and for other non-credit risks to which protection sellers (and buyers) may be exposed. This explanation is known as the risk premium hypothesis. Like the expectations hypothesis, the risk premium hypothesis also implies a positively sloped term structure of CDS spreads on average for relatively low-risk firms – *i.e.,* potential unexpected losses in excess of expected losses are perceived to be greater for dates further off in the future and lower for near-term risk horizons.

Both the expectations and risk premium theories of the CDS term structure have a common testable implication – *i.e.,* the CDS term structure is upward-sloping for high-quality issuers and downward-sloping for the riskiest issuers. Using pre-crisis single-name CDS data from July 1999 through December 2003, Lando & Mortensen (2005) find that the data is consistent with the theoretical prediction. For example,

reference entities whose 5-year CDS spreads exceeded 1,200bps had downward-sloping term structures from the 1-year tenor through the longest-dated tenor. The term structures of CDS spreads for issuers in the middle ground from a risk perspective tend to be hump-shaped. For example, reference entities whose 5-year CDS spreads are above 600bps had downward-sloping CDS term structures beginning with the 3-year tenor and thereafter. (Lando & Mortensen, 2005) The impact of accounting information

and associated uncertainties about reference entity credit risks on the CDS term structure has also been investigated by Duffie & Lando (2001), Das, Hanouna, & Sarin (2009), Griffin (2014), and Trujillo-Ponce, Samaniengo-Medina, & Cardone-Riportella (2014).

Han & Zhou (2011) analyze the relation between the slope of the CDS term structure (measured as five-year minus one-year single-name CDS spreads) and the expected returns on the stocks of those firms. Using North American corporate reference entities from 2002 through 2009, Han and Zhou find a negative relation between the slope of the CDS term structure and stock returns. Specifically, reference entities whose CDS term structures are steeply upward- sloping have negative abnormal stock returns on average, and firms with a mildly upward- sloping CDS term structures have positive abnormal returns. The abnormal returns, moreover, seem to persist for up to six months.

Calice, Mio, Štěrba, & Vašíček (2015) analyze the CDS term structure (measured as the difference between 10-year and five-year spreads) using sovereign CDSs on five European sovereign reference entities over the period from September 2007 through February 2012. As in similar studies of corporate single-name CDS term premiums, the authors find that the CDS yield curve slope is driven primarily by market liquidity, returns on local stock markets, and investor risk aversion. They also conclude that the sensitivity of the slope of the sovereign CDS term structure is regime-dependent and can be as much as 10 times higher during periods of unusually elevated market volatility.

The term structure of expected recovery rates implicit in CDS spreads exhibit opposite patterns from the term structure of CDS spreads themselves, which is also consistent with the testable implications of both the expectations and risk premium hypotheses. Doshi (2011) documented that the term structure of expected recovery rates is normally downward-sloping for healthy firms, but reverses and becomes upward-sloping when the reference entity is distressed. Doshi (2011) interprets the positively sloped term structure of recovery rates during distress as an indication of market participants' expectations that future expected recovery rates for the firm will be higher *provided* the firm survives its short-run distress.

Determinants of CDS Risk Premiums

As discussed previously, CDS spreads reflect both expected credit losses and a risk premium that reflects potential unexpected losses and other economically relevant variables. A significant literature has been developed that analyzes both single-name CDS risk premiums and the determinants of CDS spreads. The economic variables that influence CDS spreads can be classified into three categories: (i) reference entity-specific risks; (ii) risks related both to the reference entity and market-wide factors; and (iii) purely systematic or market-wide risks. We discuss these sources of risk to single-name CDS market participants in the next three subsections, respectively.

a) Reference Entity-Specific Risks

According to the Merton (1974) model, higher volatility of a firm's assets should lead to increases in the firm's credit spread (resulting from more asset value uncertainty as well as a higher probability of bankruptcy). Empirically, the literature confirms a strong relation between the volatility of a reference entity's equity price and that entity's single-name CDS spread. All else equal, the higher the volatility of a firm's equity price volatility, the larger will be the spread on that firm's single-name CDS contracts – *see, e.g.*, Skinner & Townend (2002),

Aunon-Nerin *et al.,* (2002), Abid & Naifar (2006), Ericsson, Jacobs, & Oviedo (2009), Greatrex (2009a), Zhang, Zhou, & Zhu (2009), Cao, Yu, & Zhong (2010), Tang & Yan (2010), Raunig & Scheicher (2011), Conrad, Dittmar, & Hameed (2013), Doshi, Jacobs, & Zurita (2014), González & Naranjo (2014), Castellanos, Constantinou, & Ng (2015), Hasan, Liu, & Zhang (2015), and Leccadito, Tunaru, & Urga (2015).[8] Gilchrist & Zakrajšek (2012) find that an adverse shock to the equity valuations of financial intermediaries leads to increases in those entities' CDS spreads that is both immediate and persistent.

The Merton (1974) model also indicates that the greater a firm's leverage, the higher the credit spread. Empirical studies support the importance of leverage in determining corporate single-name CDS spreads – *see, e.g.,* Aunon-Nerin, Cossin, Hricko, & Huang (2002), Ericsson, Jacobs, & Oviedo (2009), Di Cesare & Guazzarotti (2010), Gamba & Saretto (2013), and Hasan, Liu, & Zhang (2015). Some studies have also examined the extent to which accounting information (*e.g.,* earnings and accruals) help explain corporate single-name CDS spreads. Such studies generally conclude that accounting numbers do have some explanatory power, but that accounting measures are at best noisy proxies for the default risks of the reference entities. *See, e.g.,* Callen, Livnat, & Segal (2009), and Batta (2011).

b) Both Reference Entity-Specific and Systematic Risk Factors

Berndt, Jarrow & Kang (2007) compare single-name corporate CDS spreads on contracts that define restructuring as a triggering credit event *vis-à-vis* CDS contracts in which the counterparties exclude restructuring events. They estimate that the average risk premium demanded by

[8] Cao, Yu, & Zhong (2010) present evidence that the relation between a reference entity's stock price volatility and CDS spread is significantly stronger when option-implied volatilities are used as forward-looking measures of a firm's equity price volatility (as opposed to historical measures of volatility).

protection sellers for bearing restructuring risk is six to eight percent of the no- restructuring CDS spread. The authors also find that the restructuring risk premium depends both on firm-specific balance-sheet variables and a systematic macroeconomic risk factor.

The academic literature also empirically substantiates that market liquidity and liquidity risk are strong determinants of single-name CDS risk premiums. More specifically, single-name CDS risk premiums appear to include a risk premium for reference entity-specific liquidity risk and for market-wide liquidity risk.[9] As concerns the former, relative illiquidity and higher bid/ask spreads on both single-name CDSs and bonds issued by the reference entity have an impact on single-name CDS spreads. With respect to the latter, various measures of market liquidity risk have been shown to affect CDS spreads – namely, when markets conditions deteriorate and market liquidity risk rises, protection sellers demand a higher CDS coupon to compensate for the risk that they may be unable to hedge or offset their CDS protection sales quickly and/or without a resulting adverse price impact precipitated by the hedge or offsetting transaction. Studies that have documented the empirical relations between single-name CDS spreads and a liquidity risk premium include Düllmann & Sosinska (2007), Fabozzi, Cheng, & Chen (2007), Tang & Yan (2007), Dunbar (2008), Remolona, Scatigna, & Wu (2008), Greatrex (2009a), Chen, Fabozzi, & Sverdlove (2010), Bongaerts, De Jong, & Driessen (2011), Pu, Wang, & Wu (2011), Chen, Cheng, & Wu (2012), Coro, Dufour, & Varotto (2012), Eichengreen, Mody, Nedeljkovic, & Sarno (2012), Qiu & Yu (2012), Yeh (2012), Annaert, (2013), Bao & Pan (2013), Calice, Chen, & Williams (2013), Díaz, Groba, & Serrano (2013), Gündüz, Nasev, & Trapp (2013), Mayordomo, Rodríguez-Moreno, & Peña (2014), Calice *et al.*, (2015), Kolokolova, Lin, & Poon (2015), Meine, Supper, & Weiβ (2015), and Pires, Pereira & Martins (2015). Brigo, Predescu, & Capponi (2010) and van der Merwe (2015) present

[9] For a detailed discussion of market liquidity risk generally, see van der Merwe (2015).

surveys of the different modeling methodologies proposed in the academic literature for measuring liquidity risk for CDSs.

Liquidity risk is also a determinant of spreads on single-name CDSs with sovereign reference entities. Badaoui, Cathcart, & El-Jahel (2013) analyzed sovereign CDS spreads and estimated that default risk explains 55.6 percent of sovereign CDS spreads, but that market liquidity risk accounts for another 44.3 percent. (The authors find that correlation risk explains the remainder.) Beber, Brandt, & Kavajecz (2009) also find that sovereign default risk and liquidity risk account for most variations in sovereign credit spreads, especially for relatively higher-risk countries. We discuss the issue of differential liquidity between CDS and bond markets again in Section VI.D.

c) Systematic Risk Factors

Another important empirical determinant of single-name CDS spreads is investor sentiment and risk aversion (often measured using the VIX index as a proxy). Irrespective of the perceived credit risk of the underlying reference entity, an increase in market-wide risk aversion leads to increases in CDS spreads, which Remolona, Scatigna, & Wu (2008), Berndt & Obreja (2010), Tang & Yan (2010), Aizenman, Hutchinson, & Jinjarak (2013), Zinna (2013), Doshi, Jacobs, & Zurita (2014), Calice, *et al.,* (2015) Leccadito, Tunaru, & Urga (2015), and others have all empirically substantiated.

Macroeconomic variables are also important systematic risk factors that impact CDS spreads and risk premiums, especially when interaction effects are taken into account (*e.g.,* the correlation between default rates and interest rates) – *see, e.g.,* Hilscher & Nosbusch (2010), Chen, Cheng, & Wu (2012), Gilchrist & Zakrajšek (2012), Doshi, Ericsson, Jacobs, & Turnbull (2013), González & Naranjo (2014), and Schläfer & Uhrig-Homburg (2014). The empirical evidence also indicates that uncertainty about macroeconomic conditions is a significant explanatory variable for CDS spreads. (*See, e.g.,* Baum & Wan, 2010).

A significant amount of empirical research has been conducted to ascertain whether the primary driver in the term

structure of sovereign CDS spreads is a global economic common factor or whether country-specific effects dominate. Through the end of the credit crisis and up to the beginning of the Eurozone sovereign debt crisis, most of the evidence indicates that strong co-movements in sovereign credit spreads were driven by a common global economic factor (generally thought to be changes in the U.S. financial market conditions instead of domestic macroeconomic shocks) – *see, e.g.,* Pan & Singleton (2008), Borri & Verdelhan (2012), Longstaff, *et al.,* (2011) and Ang & Longstaff (2013). For example, Longstaff *et. al.* (2011) studied sovereign credit risk using sovereign CDS data for 26 countries over the 2000-2010 time period and found that sovereign CDS spreads had a significant common component that was more related to U.S. financial market conditions than to local economic measures. They estimated that, on average, the default risk premium accounts for about one-third of CDS spreads, and that the expected credit risk of the specific sovereign reference entity accounts for the remaining two thirds of the credit spread.

Dieckmann & Plank (2012) and Eyssell, Fung, & Zhang (2013) also find that the condition of the global financial system is an important determinant of sovereign CDS spreads. Other studies whose conclusions indicate that global risk factors dominate country-specific risk factors in explaining sovereign CDS spreads include Fender, Hayo, & Neuenkirch (2012), and Sapriza, Zhao, & Zhou (2009).

Beginning with the advent of the Eurozone sovereign debt crisis, several studies have also found linkages between sovereign distress and domestic (rather than global) financial distress – *see, e.g.,* Acharya, Drechsler, & Schnabl (2014) and Kallestrup, Lando, & Murgoci (2016). For example, Kallestrup, Lando, & Murgoci (2016) find that a 1bp increase in domestic banks' risk-weighted exposures to foreign banks is associated with a 0.4bps increase in 5-year sovereign CDS spreads. (*See* Section VII.C for further discussion of the public-private connection between sovereign and commercial credit risk.)

Augustin (2013) examines sovereign CDS spreads for tenors of one, two, three, five, seven, and 10 years on 44 countries in the EMEA region, as well as Latin America, from January 2001

through February 2012. His results indicate that both global and country-specific sources of risk are important drivers of sovereign CDS risk premiums and the term structures of sovereign CDS spreads. Specifically, he finds that local shocks to domestic economies and financial systems have a stronger impact on sovereign CDS spreads than global shocks for countries experiencing distress. For countries not experiencing any significant distress, shocks to the global economy and financial markets tend to dominate shocks to the local economy in their impact on sovereign CDS premiums and term structure slopes.

Single-Name CDS Event Studies

A standard tool in empirical financial economics is the event study.[10] The purpose of an event study is to analyze the informational impact of a significant event on the prices of an issuer's securities. Specifically, event studies can be used to answer two questions about a particular event: (i) Was the event and its impact on the price of the asset in question anticipated in advance by market participants (*i.e.*, "anticipation effect")?; and (ii) Did the event itself have a statistically significant impact on asset prices when and after it occurred (*i.e.*, "announcement effect")?

Event studies are an important and large part of the broad financial economics and econometrics literatures. Most event studies have historically focused on examining abnormal stock returns. Abnormal returns are either higher or lower than the returns predicted by one or more common risk factors. For example, the classic and original version of an event study by Fama, *et al.*, (1969) uses the market model to compute predicted returns – *i.e.*, a model in which the returns on a stock are driven by a measure of the broad market (*e.g.*, the value-weighted index of stocks maintained by the Center for Research in Security Prices, the S&P 500 index, etc.).

Since the advent of single-name CDS trading, academic research began to utilize single- name CDSs in addition to or

[10] For reviews of the event-study methodology, see, e.g., Thompson (1995), MacKinlay (1997), and Binder (1998).

in lieu of equities to examine the informational content of announcements and events. To control for market-wide common factors influencing CDS spreads, CDS event studies generally examine spreads *relative to* an appropriate benchmark or index. The difference between the spread on a CDS for an individual reference entity and the most relevant CDS index is generally known as the adjusted or abnormal spread. Event studies then quantify the size and statistical significance of changes in adjusted spreads both before the event date (to ascertain an anticipation effect) and after (to estimate any announcement effect).

The anticipation and announcement effects of an event are inter-related. At the extreme, if an event is perfectly anticipated by market participants, the entire impact of that event on CDS spreads should result in strong abnormal spreads prior to the event (*i.e.,* the anticipation effect) and virtually no abnormal changes following the actual event (*i.e.,* the announcement effect).

Conversely, if the event is a total surprise to market participants, we would expect to see no abnormal spreads prior to the event (*i.e.,* no anticipation effect) and significant abnormal CDS spreads following the announcement (*i.e.,* a strong announcement effect). When we observe significant abnormal spreads both before and after the event, we can infer both an anticipation and announcement effect. This often occurs when market participants anticipate only part of the information related to the announcement (*e.g.,* the magnitude of the event but not its timing, the likelihood of the event but not its magnitude, etc.).

In this section, we review the literature on event studies involving single-name CDSs.

More specifically, we review the literature on what CDS spreads reveal the about informational content of corporate credit rating actions, how adverse credit events at one reference entity may have spillover effects on other borrowers, the impact of corporate announcements on specific financial results, and more.

Credit Rating Actions

Hull, Predescu, & White (2004) analyze the relationship between CDS spreads (primarily for five-year CDSs on corporate, sovereign, and quasi-sovereign issuers) and ratings announcements over a period from 1998 through 2002. They find that rating agency reviews for downgrade (*i.e.,* "negative watch" events) have a significant impact on CDS spreads, whereas actual downgrades and negative outlooks do not. All three types of credit rating actions, moreover, are anticipated by market participants, although rating reviews are less anticipated than actual downgrades.

Like Hull, Predescu, & White (2004), Norden & Weber (2004) find that rating agency reviews for downgrades lead to significant abnormal changes in CDS spreads and that market participants anticipate rating actions before they occur, with reviews for downgrades being less anticipated than actual downgrades. Unlike Hull, Predescu, & White (2004), Norden & Weber (2004) find that actual downgrades do not seem to matter – *i.e.,* the impact of actual downgrades is fully reflected in single-name CDS spreads prior to the downgrade itself. The results in Hull, Predescu, & White (2004) and Norden & Weber (2004) regarding the anticipation and reaction effects for negative ratings announcements in the single-name corporate CDS market have been generally confirmed in other academic studies, including Daniels & Jensen (2005), Di Cesare (2006), Imbierowicz & Wahrenburg (2009), Brandstack (2010), Galil & Soffer (2011), Bedendo, Cathcart, El-Jahel, & Evans (2013), Finnerty, Miller, & Chen (2013), Norden (2014), and Berg & Streitz (2016). Taking into account intra-industry effects, Cizel (2013) finds that S&P's negative announcements impact intra-industry CDS spreads but that Moody's and Fitch's negative announcements do not.

Most single-name corporate CDS event studies indicate that CDS market participants do not anticipate *positive* rating actions and only focus on negative rating actions. An exception is Finnerty, Miller, & Chen (2013), who find that positive credit rating events can have a significant positive impact on CDS spreads (*i.e.,* causing them to narrow

significantly), despite being less anticipated than downgrades.[11] The data sample in Finnerty, Miller, & Chen (2013), moreover, contains a significantly larger number of observations than most other research on thistopic.

Other event studies involving single-name corporate CDSs have yielded additional insights on the informational content of CDS spreads. For example, Norden & Weber (2012) analyze abnormal price reactions around negative watch rating events for CDSs on both senior and subordinated European bank debt and find evidence that spreads on both CDS types react significantly to downgrade announcements and that, prior to the credit crisis, CDS spreads on subordinated debt reacted more than CDS spreads on senior debt. By contrast, the authors find that reactions of CDSs on senior and subordinated debt were comparable during the crisis. As another example, Imbierowicz & Wahrenburg (2009) find that the size of the anticipation effect depends on the underlying reason for the rating agency action. In particular, the majority of the anticipation effect for negative rating announcements appears to depend on events related to issuers' operating performance.

Lehnert & Neske (2006) find evidence for the announcement effect – *i.e.*, spreads respond to rating actions and are informative. Their empirical results, however, are at odds with the rest of the literature on the anticipation effect in the single-name corporate CDS market.

Specifically, they find that different types of rating announcements are *not* anticipated by market participants. Their sample size, however, is restricted to just 100 European firms and only covers the period from 2001 through 2003. Most papers on this topic published after 2006 confirm or extend the earlier results of Hull, Predescu, & White (2004) and Norden & Weber (2004), suggesting that the results in Lehnert & Neske (2006) may be sample-specific.

Berndt & Ostrovnaya (2014) also find that CDS spreads reveal information about forthcoming adverse credit events.

[11] Micu, Remolona & Wooldridge (2006) also detected an impact of positive rating announcements.

In addition, they find that equity options markets reveal such anticipated negative news around the same time as CDS spreads but that equity markets do not respond to such changes in option prices unless the anticipated adverse credit event is also already reflected in CDS spreads.

Spillover Effects from Adverse Credit Events

a) Corporate Reference Entities

A slightly different branch of the CDS event study literature focuses on the impact that the downgrade of one reference entity may have on other entities. Jorion & Zhang (2007) present a comprehensive analysis of intra-industry spillover effects. Specifically, they analyze single-name corporate CDS spreads to examine potential "contagion" or "spillover" effects – *i.e.*, situations in which an adverse event at one firm causes CDS spreads to increase for other firms in the same industry – and potential "competitive effects" in which an adverse event at one firm benefits one or more competitors to that firm and thus causes the other firms' CDS spreads to decline. They find evidence of contagion effects following Chapter 11 bankruptcy filings and evidence of competitive effects following Chapter 7 filings. Huang & Cheng (2013) extend the analysis of Jorion & Zhang (2007) and find that inter-industry contagion effects are more pronounced for firms with higher "information uncertainty" (measured by the authors as dispersions in analyst forecasts).

In a later paper, Jorion & Zhang (2009) extend their earlier analysis and examine spillover effects on creditors arising from bankruptcy announcements through direct counterparty effects. They find that creditors to firms that announce bankruptcy filings exhibit negative abnormal equity returns (in an event-study context) and higher CDS spreads.

Huang, Shen, & Chen (2012) analyze the reactions of major companies to rival company defaults during the 2007 and 2008 credit crisis years. They investigate two competing hypotheses – *i.e.*, the failure of a rival creates a crisis of confidence for all firms in the same industry (and, hence, a positive correlation between CDS spreads for single reference

entities in the same industry), or the deterioration in the credit quality of one firm in a given industry results in higher investor confidence in the credit quality of its rivals, thereby causing a negative correlation between changes CDS spreads for the downgraded firm and the credit spreads of its rivals. For financial firms with traded single-name CDSs, Huang, Shen, & Chen (2012) find support for the contagion hypothesis – *i.e.,* spreads on single-name CDSs with financial firms as reference entities generally rise both before and after default events experienced by other financial firms. The authors also find support for earlier research that market participants react more to negative credit events than to positive ones, and that CDS market participants anticipate negative shocks. The authors further conclude that, to the extent there are any inter-dependencies in the CDS spreads of non-financial reference entities, those effects were competitive in the early period of the crisis and contagious later in the crisis.

b) Sovereign Reference Entities

For sovereign issuers, spillover effects have been examined as the result of rating agency actions using the event-study methodology. Ismailescu & Kazemi (2010) analyze single-name CDSs on 22 emerging market sovereigns around credit rating announcements. They find a strong anticipation effect for negative rating actions – *i.e.,* market participants anticipate negative rating announcements – and no significant change in CDS spreads in the two days following the actual announcements, although some spillover effects can be observed. Positive rating announcements, however, lead to an immediate and significant reaction in CDS spreads and a strong spillover effect to other emerging market countries from the event country. The degree of the spillover effects of positive events is affected by the credit ratings of the non-event countries and the spillover effect of negative events is affected by the credit rating of the event country.

Blau & Roseman (2014) adopt an approach similar to Ismailescu & Kazemi (2010) and estimate spillover effects on European sovereigns resulting from the downgrade of the United States on August 5, 2011. They estimate no significant

change in U.S. Government CDS spreads following the downgrade, which is consistent with the corporate CDS literature in which negative watch announcements impact CDS spreads but actual downgrades often do not. Their event-study methodology indicates, however, that European CDS spreads experienced significant increases following the U.S. downgrade and that at least some aspect of the U.S. downgrade was anticipated by sovereign CDS market participants.

Afonso, Furceri, & Gomes (2012) analyze 24 European sovereign issuers and the reactions of their CDS spreads to rating agency announcements. The results in Afonso, Furceri, & Gomes (2012) regarding the reaction effect are more consistent with the findings for corporate borrowers discussed in Section IV.B.1 than the sovereigns analyzed by Ismailescu & Kazemi (2010). Specifically, Afonso, Furceri, & Gomes (2012) estimate a significant reaction of credit spreads to negative rating announcements and only a minor reaction to positive announcements. They did not find a significant anticipation effect except within a week or two of the rating announcement date. Consistent with Ismailescu &Kazemi (2010), the authors document a spillover effect, especially from lower-rated to higher-rated countries.

Other Corporate Performance Announcements

Single-name corporate CDS spreads can also be used to examine what market participants anticipate regarding announcements related to specific corporate financial information. For example, the informational content of earnings announcements and "surprises" (*i.e.,* deviations of announced earnings from expected earnings and earnings targets), is examined by Callen, Livnat, & Segal (2009), Greatrex (2009b), Lok & Richardson (2011), Shivakumar *et al.,* (2011), and Elkamhi *et al.,* (2012) using an event-study framework. All of those studies find that earnings announcements are informative (*i.e.,* CDS spreads respond to earnings announcements). Greatrex (2009b) finds that negative earnings announcements are anticipated, and

Elkamhi *et. al.,* (2012) conclude that the impact of accounting information releases on CDS spreads is more than double the impact of credit-relatednews about reference entities.

Palmgren & Tamule (2009) study the reaction of single-name corporate CDS spreads to corporate dividend reduction announcements. The authors present some evidence of both anticipation and announcement effects, although their empirical analysis is based on a small sample of only seven firms and their paper does not indicate whether or not the results are statistically significant.

Sturm (2013/14) analyzes the responses of single-name CDS spreads on bank reference entities related to losses of €1 million or more arising from operational risks, such as fraud.

Although Sturm finds little evidence of a CDS market reaction to the first public announcements of operational risk-related losses, he does find evidence that CDS spreads rise on the settlement dates of such losses. He also documents that banks with relatively higher credit ratings experience greater increases in their CDS spreads following the settlements of operational risk- related losses and that, all else equal, the larger the loss, the larger the increase in the spread.

Other Announcements and Information

The event-study framework can also be used to examine the perceived impact of public policy initiatives, such as government interventions and bailouts. For example, using a novel methodology, Veronesi & Zingales (2010) rely on CDS spreads to estimate the costs and benefits of the U.S. bank bailout plan announced on October 13, 2008. They find significant wealth transfers from taxpayers and stockholders of the banks to the bondholders of the banks receiving bailout funds. Other studies have also used event studies involving CDSs to estimate the benefits and/or costs of bank bailout programs – *see, e.g.,* King (2009), Panetta *et. al.* (2009), and Greatrex & Rengifo (2012).

Demirgüç-Kunt & Huizinga (2013) examine the influence of bank size and government deficits on bank stock prices and CDS spreads using a sample of banks in 20 countries over the

2001-2008 period. Under the belief that some banks may be too big to save ("TBTS"), the authors analyze the relations between bank equity valuations and the country's fiscal balance (which should be positive for TBTS banks) and CDS spreads and fiscal balances (which should be negative for TBTS banks). An alternative transmission channel is that large fiscal deficits associated with prior bank bailouts will tend to reduce banks' equity capital and increase bank CDS spreads. (*See* the related discussion in Section VII.D.) The authors find a significant inverse relation between the state of a country's finances and the valuation of systemically important banks – *i.e.*, the less public funds are available to bail out the large banks, the lower are the amounts of those banks' equity capitalizations. For the same reason, they also concluded that bank CDS spreads were inversely related to a country's fiscal condition (although this finding is called into question in the authors' robustness checks).

Using an event-study framework, Bertoni & Lugo (2014) analyze the impact of investments by sovereign wealth funds in target investment companies and ascertain that CDS spreads of such target companies decline upon the investment announcement. Eisenthal, Feldhutter, & Vig (2016) adopt the event-study methodology to examine how the announcements of leveraged buyouts ("LBOs") impact the credit spreads of target firms. Using single-name CDS spreads as a measure of LBO target firms' credit spreads, the authors find that spreads rise significantly over the 22 days prior to the announcement and during the two-day announcement period but remain stable thereafter. They also find that CDSs with longer-dated maturities exhibit larger spread changes, and that increases in spreads are more pronounced for investment-grade LBO targets.

The use of event studies to analyze the informational content of an event is not confined to announcements and can also be based on information provided by market-based events (*e.g.*, severe credit deteriorations as indicated by significant changes in CDS spreads). The use of the event-study methodology to examine the implications of market-based events is often associated with studies of price discovery

(*see* Section VI.A) or the analysis of contagion and spillover effects (*see* Section VII).

5 Implications of Single-Name CDS Trading for Creditors and CDS Reference Entities

The dominant view prior to the credit crisis was that financial innovations are beneficial to most market participants. (See, e.g., Miller, 1986, 1992; Kane, 1988; Ross, 1989; Finnerty, 1992; and Merton, 1992, 1995). Useful surveys of financial innovation and economic activity can be found in Tufano (2002) and Frame & White (2004). Most credit markets (e.g., the market for CDOs backed by subprime ABS) broke down during the crisis. Although single-name CDS markets continued to function during the crisis, many market participants have nevertheless been reassessing their pre-crisis view of general credit markets and products including single- name CDSs.

In this section, we review the academic literature on the potential benefits and costs of single-name CDSs in the context of relations between CDS reference entities and their lenders. In the first section, we consider how and why CDSs are used by bank lenders, whether bank CDS usage impacts banks' monitoring of borrower credit risk, and whether the availability of CDSs changes the risk-taking behavior of banks. In Section V.B, we examine the impact of single-name CDSs

on the reference entities underlying traded CDSs – specifically, the relations between banks' usage of single-name CDSs and the availability and price of bank credit, and how the beginning of trading of single-name CDSs may impact the reference entities underlying the CDSs.

The Impact of Single-Name CDSs on Bank Lenders

Firms are typically financed using equity and/or debt. Bank loans, publicly traded bonds, and privately placed debt are prevalent types of debt financing. Single-name CDSs provide a mechanism whereby lenders to corporate and sovereign borrowers can mitigate and transfer their credit risks to other firms more willing to bear such risks (including other hedgers as well as speculators, as discussed in Sections III.A.1 and III.A.3, respectively.)

We begin this section with a discussion of the determinants of banks' credit risk transfer decisions – i.e., when and why banks use single-name CDSs. Related to that issue is whether or not the choice of single-name CDSs as a credit risk transfer mechanism has an impact on banks' monitoring of borrower credit risks. In the second subsection below, we consider the empirical evidence on whether single-name CDSs enable banks to achieve their desired risk/return profiles through their risk management investment processes.

Determinants of Bank Usage of Single-Name CDSs and Implications for Monitoring

Several papers have analyzed the economic factors that lead certain lenders to retain their ongoing credit exposures to borrowers vis-à-vis reducing or eliminating their ongoing credit risk. In the latter case, the literature analyzes the empirical determinants of banks' decisions whether to engage in loan sales (through primary syndications or on the secondary market), securitizations, or hedging with single-name CDSs. As discussed in Section III.B.1, a common concern about banks that utilize single-name CDSs for credit risk transfer is that such banks face diminished incentives to monitor the credit quality of their borrowers once the banks

have significantly reduced or eliminated their borrower credit exposures using CDSs. This is a testable hypothesis, and we review the relevant academic research in this section along with the related literature on how banks choose between competing credit risk transfer alternatives.

Minton, Stulz, & Williamson (2009) examine the use of single-name CDSs by U.S. bank holding companies with assets in excess of one billion dollars from 1999 to 2005. They find that only a few of the sample companies (*i.e.,* 23 large banks out of a sample of 395) use CDSs and that those banks only use credit derivatives in their capacity as dealers rather than for hedging their own credit exposures. Their explanation for the apparent lack of single-name CDS usage for hedging is related to the alternatives available to banks for credit risk transfer during their sample period – namely, loan sales and securitizations (usually accomplished by syndications and sales to CLO managers).

If a bank is willing to bear some of the ongoing credit risk but prefers to eliminate the rest of its exposure, the bank can either sell loan participations or the equivalent through the syndication process or convey parts of the loan or loan participations to a balance-sheet CLO. Securitizing the loan by selling it to a CLO, however, only mitigates part of the lender's credit risk. Bank sponsors of balance-sheet CLOs could face moral hazard issues (*i.e.,* incentives to engage in excessively risky lending or inadequate monitoring as a result of a planned securitization) or incentives to engage in adverse selection (*i.e.,* selling only the riskiest of its loans). CLO investors thus advocate that banks which securitize loans to CLOs maintain the

first-loss exposure. This customary arrangement ensures that the bank bears the first default- related losses on the underlying loan collateral. (*See, e.g.,* Duffee & Zhou, 2001). Loan sales are also often accompanied by put-back provisions that enable investors to exchange a loan in the event that it is revealed to have materially different risk characteristics than represented by the seller. In other words, put-back provisions obligate bank sellers to replace non-compliant loans or loans with defective representations with compliant loans.

Hedging with single-name CDSs, by contrast, enables a bank to transfer potentially all of its credit risk while keeping the loan on its balance sheet. Yet, banks using CDSs in turn bear counterparty and certain other risks to which loan sales and securitizations do not expose them. In addition, single-name CDSs include the CTD option for sellers. A physically settled CDS hedge thus exposes a bank to the basis risk that the actual bonds and/or loans of the reference entity being hedged with the CDS do not experience similar price changes as the CTD loan driving the pricing of the CDS. Especially for leveraged borrowers, the leveraged loan and high-yield bond spread can be very volatile, thus making this an important consideration for why banks might prefer loan securitization to CDS hedging.

An implication of the analysis in Minton, Stulz, & Williamson (2009) is that a bank's preference is generally to sell or securitize loans (or to use LCDSs once they became available in 2004). Single-name CDSs are more likely to be used for credit risk transfer when they are more cost-effective than selling or securitizing loans. Indeed, during the 1999-2005 sample period studied by Minton, Stulz, & Williamson (2009), the appetite of CLOs for high-yield debt in particular offered very attractive spreads. Between those low spreads and the basis risk of hedging a loan credit exposure with a single-name CDS, the authors' finding that banks did not make significant use of single-name CDSs to hedge their lending activities is not surprising.

Beyhaghi, Massoud, & Saunders (2016) also analyze banks' risk management choices for their syndicated loan exposures. Specifically, the authors consider the characteristics of both lenders and borrowers to analyze when banks engaged in secondary market loan sales, CDS hedges, or retained borrower credit risk on their balance sheets. The authors determine that capital- and liquidity-constrained banks are more likely to engage in some form of credit risk transfer (as opposed to retaining the credit risks). For banks not facing capital or liquidity constraints, the authors ascertain that relationship bankers are more likely to retain credit risk from their loans on their balance sheets, whereas larger banks are

more likely to engage in loan sales or hedging with CDS protection purchases. Beyhaghi, Massoud, & Saunders (2016) also find that of those loans whose lenders are engaged in credit risk transfer, loans to borrowers with a higher perceived *ex ante* risk profile are more likely to be sold, whereas loans to relatively higher-quality borrowers are more likely to be hedged with CDSs.

Like Beyhaghi, Massoud, & Saunders (2016), Parlour & Winton (2013) find that loan sales are typically used by banks to manage their exposures to higher-risk credits and that CDS protection purchases are chosen for higher-quality loans and borrowers. The authors also conclude that the availability of loan sale and CDS credit risk management solutions leads to excessive monitoring by banks of high-risk credits and insufficient monitoring of lower-risk borrowers. Furthermore, the authors find that this effect is exacerbated for banks with higher costs of equity capital.

Norden, Buston, & Wagner (2014) examine the extent to which banks use single-name CDSs to manage the credit risks of their loans and loan portfolios and/or to reduce economic or regulatory capital and how these uses of single-name CDSs were impacted by the credit crisis. The authors also consider the possibility that CDSs can increase borrower risk (putting upward pressure on spreads) if credit risk transfer by bank lenders leads to incentive problems regarding loan originations and monitoring. To disentangle these effects, they examined banks' gross CDS positions, net CDS positions, and loan pricing. Their results provide evidence that banks use CDSs to manage their own credit exposures more effectively than if other credit risk transfer solutions were chosen, and that corporate borrowers benefit from banks' CDS hedging activities through lower spreads. The authors suggest that these benefits of single-name CDSs persisted through the crisis.

Martin & Roychowdhury (2015) analyze the extent to which the impact of single-name CDSs on lenders' monitoring incentives results in the conservatism of reference entities' financial reporting. The authors conclude that reference entities underlying traded CDSs do indeed adopt less

conservative financial reporting. The authors also determine that less conservative reporting occurs when lenders face lower reputation costs from diminished borrower credit risk monitoring, covenants on reference entities' debt are more restrictive when CDSs are introduced, and lenders engaged in more scrupulous monitoring prior to the introduction of CDSs and their use of those CDSs to hedge their credit exposures.

Single-Name CDSs and Risk-Taking by Banks and Insurers

As discussed in Section III.B.1, the availability of single-name CDSs on the risk-taking decisions of bank lenders is ambiguous as a matter of pure theory. On the one hand, the availability of single-name CDSs as a credit risk management tool may give rise to moral hazard that results in banks making riskier loans and engaging in inadequate ongoing borrower credit risk management. On the other hand, the ability of banks to manage borrower credit risks using single-name CDSs may increase the debt capacity of banks and facilitate additional lending without giving rise to additional risks. The implication of the availability of single-name CDSs on the risk-taking and risk-management decisions of banks thus is an empirical question.

Shao & Yeager (2007) analyze the behavior of bank holding companies to evaluate whether or not banks use CDSs in a manner consistent with their risk/return preferences.

Specifically, the authors examine whether the impact of their CDS activities (taken from Call Report data) on their risk and return, capital, and lending performance was consistent with whether the banks were protection buyers, sellers, or active users. Their findings indicate that credit protection buyers significantly reduced their total risk and increased their capital, which is consistent with using single-name CDSs to hedge the risk of their lending activities.

By contrast, Shao & Yeager (2007) find that credit protection sellers experience increases in their equity volatility, capital ratios, and returns, which makes sense for banks wishing to use CDS as hedging instruments that would

allow them to take on higher risk and achieve higher expected returns. Active users of CDS with no apparent directional trend in their protection purchases and sales, moreover, are found to experience a small increase in risk, a small reduction in returns, and no significant impact on capital. The small reduction in returns, moreover, could be offset by revenues earned elsewhere in the bank – *e.g.*, a bank may be willing to act as an intermediary for a customer at a small apparent loss to preserve its long-term fee-based customer relationship. On the whole, the research of Shao & Yeager (2007) indicates that banks are using CDSs in a manner consistent with their hedging and investment objectives.

In a similar study, González, *et al.*, (2012) investigate whether the use of single-name CDSs by banks reduced or increased the risk profile of European banks. Like Shao & Yeager (2007), they find that European banks using CDSs for hedging experienced an improvement in their level of financial stability, whereas those opting to use CDSs for synthetic bond investments experienced an increase in firm-specific risks.

Fung, Wen, & Zhang (2012) conduct a study of how the use of single-name CDSs by U.S. life and property/casualty insurers impacted the risk-taking decisions of those firms and their valuations. The authors conclude that such firms often use CDSs to generate income and not to hedge their credit exposures, and, as a result, their risk profile became more aggressive. The paper further concludes that insurers' use of single-name CDSs were associated with reduced financial performance and lower firm valuations.

Although there are a number of articles in the academic literature that present theoretical models for how bank usage of CDSs can lead to increased bank risk-taking (*e.g.*, Duffee & Zhou, 2001; Morrison, 2005), there is little *empirical* evidence in support of this. One exception is Phuong (2015), who presents empirical evidence that European banks that are more active in CDS markets tend to originate more risky assets and that increased risk-taking by banks is associated with larger CDS protection purchases.

Another exception is Shan, Tang, & Yan (2014), who find that banks actively engaged in single-name CDS trading have

significantly lower capital ratios. They also find that such banks curtailed lending and raised capital during the credit crisis more than banks with little or no CDS usage, despite having higher pre-crisis operating performance and stock returns.

Single-Name CDSs and Banks' Monitoring of Borrowers' Credit Risks

As noted in Section III.B.1, a widespread concern about single-name CDSs is that their usage by bank lenders can give rise to moral hazard in which banks make riskier loans and/or engage in suboptimal amounts of monitoring borrower credit risks. Yet, even the theoretical literature on bank usage of single-name CDSs is ambiguous on this point. For example, Chiesa (2008) describes various situations in which properly constructed credit risk transfer strategies (*e.g.,* single-name CDS hedges) are commensurate with enhanced borrower credit risk monitoring. The issue of how the availability of single-name CDSs impacts banks' monitoring of borrower credit risks thus is an empirical question.

The availability of single-name CDSs as instruments by which bank lenders can hedge their credit exposures to borrowers, moreover, impacts bank lending and risk-taking behavior depending on the structure of the underlying loan facility. A bank loan facility[1] is typically "transactional" (*i.e.,* akin to public debt issuance and involving one-off lender assessments of borrower credit risks) or "reputational" (*i.e.,* loan facilities in which the borrower and lender have non-public information that materially impacts the terms of the loan and that is not observable to other market participants) (Boot & Thakor, 2000). Syndicated loans are a hybrid of transactional and reputational loans in which a lead arranger conducts the initial credit risk assessment and engages in

[1] Most bank extensions of credit to corporate borrowers are facilities that include multiple "tranches," such as amortizing and non-amortizing term loans, revolving lines of credit, letter of credit facilities, bridge loan facilities that provide interim financing intended to be replaced later with the proceeds of a bond offering, and the like.

ongoing monitoring of borrower credit risk but underwrites or allocates portions of the loan to other syndicate members, whose sole function is to provide capital and purchase their allocated share of the loan. Loan syndicate participants typically retain a relatively small total part of the loan facility (known as the "pro rata" portion of the loan) and then sell the remainder of the loan (known as the "institutional" portion of the loan) in the primary or secondary market to asset managers or CLO sponsors and warehousing agents.[2]

In a typical syndicate, a lead arranger is responsible for both the original credit risk review of the borrower and the ongoing monitoring of borrower credit quality. Lee & Mullineaux (2004) find that loan syndicates have fewer participants when information about the credit risk of the borrower is more limited, thus suggesting that the membership and structure of a loan syndicate are driven at least in part by the need for enhanced monitoring of borrower credit risks. The authors also find that when syndicates place explicit limits on loan sales to non-syndicate members, larger and more diffuse syndicate structures result, which forces non-lead syndicate members to rely relatively more heavily on the lead arranger for the upfront and ongoing credit assessments of the borrower.

Because the actions of a lead arranger in a syndicate are generally not directly observable by other syndicate members whose primary role is to purchase allocated amounts of "pro rata" loans and loan participations, lead arrangers typically must hold larger shares of syndicated pro rata loans than other syndicate members to mitigate the risk of moral hazard. (Dennis & Mullineaux, 2000; Sufi, 2007) The ability of a lead arranger to lay off its credit risk to the borrower using single-name CDSs without the knowledge of other syndicate members, however, limits the ability of the lead arranger to

[2] "Pro rata" loans are loans retained within the lending syndicate and typically include revolving credit facilities, term loan A's, letter of credit facilities, and bridge loan facilities. By contrast, "institutional" loans are loans that syndicate members intend to sell to asset managers or sponsors of CLOs and primarily consist of term loan B's.

signal its greater monitoring efforts arising from larger pro rata loan allocations, and, indeed, defeats the purpose of such larger allocations (Parlour & Winton, 2013).

Streiz (2016) analyzes how the availability of single-name CDSs impacts the structure of loan syndicates. Specifically, he compares syndicate structures before and after the introduction of single-name CDSs with syndicates that lend to borrowers with no actively traded single-name CDSs. The results of his empirical analysis indicate that lead arrangers sell on average three percent less of their pro rata loans after the introduction of CDSs and that the availability of single-name CDSs as hedging instruments is associated with more concentrated syndicates with fewer lender participants (Streiz, 2016).

Song (2013) presents an interesting alternative to the more conventional moral hazard perspective on how CDSs can affect bank credit risk monitoring for syndicated loans.

Specifically, Song (2013) suggests that if a lead arranger instead sells protection in a single-name CDS with the borrower as the reference entity, the lead arranger has essentially pre-committed to higher-quality monitoring. In other words, because a borrower default would impose losses on the lead arranger on its allocated share of the pro rata loans *and* its protection sales, the lead arranger has an incentive to engage in even greater upfront due diligence and ongoing monitoring.

The empirical results in Song (2013) support the hypothesis that lead arrangers selling CDS protection is a substitute for lead arrangers taking larger allocations of pro rata loans and loan participations.[3] In particular, Song's evidence shows that banks with larger amounts of CDS protection sales have smaller amounts of pro rata syndicated loan allocations. She also finds that active CDS dealers functioning as lead

[3] Song (2013) relies on CDS data regarding bank protection sales of the LCDX index. Unlike the rest of the studies summarized here, this paper is thus based on the empirical analysis of a multi-name contract and an LCDS (instead of a CDS). The results she presents are sufficiently informative, however, that we made an exception to our filtering criteria (see Section I.B.1) and included this paper.

arrangers in loan syndicates are associated with larger syndicates and larger loans to borrowers. On the other hand, the presence of multiple active CDS participants or dealers in the same syndicate can attenuate this effect to the extent that non-lead syndicate members sell protection on the borrower to non-syndicate members.

The Impact of the Availability of Single-Name CDSs on Reference Entities

We now consider how the availability of single-name CDSs can impact the reference entities underlying those CDSs. We first review the empirical evidence regarding the impact of single-name CDSs on the supply and cost of bank credit (both to reference entities and in general). In Section V.B.2 we summarize the results of academic research concerning the impact of single-name CDS trading on the capital structure decisions of borrowers underlying traded CDS contracts. A third section below discusses evidence regarding the potential positive and negative externalities arising from the introduction of a single-name CDS. Section V.B.4 concludes with a review of the literature regarding the impact of single-name CDSs and borrower hedging on the bankruptcy decisions of underlying reference entities.

Impact on the Supply of Credit

An often-cited benefit of single-name CDSs is their positive impact on the economy. Because single-name CDSs enable lenders to reduce their credit exposures and monitoring costs, single-name CDSs should, in principle, lead to increased availability of credit and decreased borrowing costs for reference entities, which enables them to use those additional funds to finance productive investment opportunities, thereby increasing aggregate investment and economic growth. (*See, e.g.*, Jarrow, 2011). Whether or not the availability of single-name CDSs actually does lead to reduced borrowing costs for reference entities is an empirical question, and the results are mixed.

Hirtle (2009) empirically analyzes whether increased CDS usage changed the amount of bank borrowing by CDS reference entities by comparing U.S. commercial bank holdings of CDSs and data on commercial and industrial loans issued by U.S. banks for the period from 1997 to 2006. Hirtle's analysis shows that an increase in the use of CDSs is associated with an expansion in the supply of term loans to large borrowers. Hirtle (2009), however, found no increase in the volume of loan commitments or small term loans. Hirtle's analysis also demonstrates that large firms (so-called "named credits") are the primary beneficiaries of CDSs but that those benefits are limited to increases in the tenors and/or sizes of their term loans.[4]

Shan, Tang, & Yan (2014) empirically analyze the relation between the availability of single-name CDSs and bank lending. The authors find that banks actively engaged in single- name CDS trading extend more credit and make larger loans. Such banks, moreover, are more likely to extend larger loans to the reference entities underlying traded single-name CDSs.

Unlike Hirtle (2009) and Shan, Tang, & Yan (2014), Saretto & Tookes (2013) examine the impact of the introduction of single-name CDSs on all types of borrowings by reference entities. Their results indicate that the availability of single-name CDSs as hedging instruments leads to an increase in credit to reference entities, as well as longer debt maturities. The improved access to credit stems mostly from higher lending through the corporate bond market than the bank lending channel. They also find that the impact of CDS availability leads to greater increases in credit and debt maturities during periods in which credit supply is constrained or when unexpected shocks to local credit supplies occur (*i.e.*, when the ability of lenders to hedge borrower credit exposures is the most important).

[4] Non-price terms in a loan – especially tenor – are often as important as the price in a loan.

Impact on Reference Entity Borrowing Costs

The empirical literature indicates that the availability of CDSs as credit risk transfer mechanisms has an ambiguous overall impact on reference entity borrowing costs and that thenet impact depends on the type of borrower.

Ashcraft & Santos (2009) find that the introduction of single-name CDS trading leads to improvements in the borrowing terms for safe and transparent firms in which banks' monitoring incentives are not likely to play a major role. In contrast, borrowing costs are higher for riskier and informationally opaque borrowers following the introduction of CDSs, which the authors attribute to the attenuated incentives of banks to engage in relatively costly borrower monitoring. Despite the ostensibly negative aspect of reduced bank monitoring of more opaque enterprises, the results in Ashcraft & Santos (2009) suggest that the introduction of single-name CDSs do provide an important economic benefit by making it easier for lenders to identify creditworthy borrowers, thereby mitigating adverse selection problems in which "good" and "bad" borrowers cannot be distinguished and are charged a single price. (Akerlof, 1970; Rothschild & Stiglitz, 1976). Hirtle (2009) also finds a separation effect in which the impact of CDS trading depends on the characteristics, reputation, and transparency/opacity of the referenceentity.

Ismailescu & Phillips (2015) analyze the impact of CDS trading in sovereign debt markets and found that the informational role of CDSs is beneficial for closed economies with a high risk of default and for which relatively little financial information is available (absent the CDSs). Ismailescu & Phillips (2015) also show that CDSs improve market liquidity and lower borrowing costs for investment-grade sovereigns, but that CDSs reduce market liquidity and increase borrowing cost for speculative-grade sovereign borrowers.

For large corporate borrowers, the evidence indicates that although the availability of credit and the size of loan facilities are higher after the introduction of single-name CDSs, the

increased credit supply is accompanied by higher borrowing costs on loans by banks that actively hedge using single-name CDSs. For large banks that do not actively hedge, credits extended increase and borrowing costs for reference entities decline (Hirtle, 2009; Shan, Tang, & Yan, 2014).

The introduction of single-name CDS trading is also associated with an increase in the maturity of term loan facilities (Hirtle, 2009; Saretto & Tookes, 2013). Although a non-price term of bank credit facilities, borrowers often consider longer-term debt more desirable – especially large and transparent firms and firms that expect a deterioration in their credit ratings (*See, e.g.,* Diamond, 1991; and Barclay & Smith, 1995). In this sense, the impact of listing CDSs on the maturity structure of borrowers' debt may also be beneficial for certain borrowers.

Norden, Buston, & Wagner (2014) analyze how and through which channel the use of single-name CDSs affect banks' hedging and how borrowers may benefit from any such hedging. They find that banks using single-name CDSs for credit risk transfer purposes do indeed pass the associated benefits and cost savings along to borrowers. They also determine that banks using CDSs to hedge exhibited smaller losses and a more stable supply of loans during the credit crisis.

The borrowing costs of reference entities underlying traded single-name CDSs are also affected by whether or not the corresponding loan facilities specify a credit spread (over a base floating rate like LIBOR) that is fixed or indexed to the borrower's CDS spread. As discussed in Sections IV.A and IV.B, the CDS spread is an observable measure of the reference entity's credit risk. Banks can thus use CDSs to monitor borrower credit quality. Since 2008, moreover, banks have increasingly used single-name CDS spreads for reference entities over the term of loans they have extended in order to calculate the interest payable by borrowers on such loans. The practice of incorporating CDS spreads explicitly into loan pricing is referred to as "market- based" loan pricing, and is especially prevalent on revolving credit lines.

Ivanov, Santos, & Vo (2016) study how market-based pricing has impacted corporate borrowing costs. They ascertain that the borrowing cost on loans with market-based pricing are lower than on similar loans priced with fixed credit spreads, both at origination and over the lives of the loans. The authors attribute the lower cost on loans with market-based pricing to savings arising from reduced monitoring costs, which is supported by the evidence they present that market-based loans have more simplified covenants than loans with fixed credit spreads.

Although the authors considered the possibility that loans with market-based pricing could lead to lower costs because such loans would be easier to hedge with the corresponding CDS, they did not find empirical support for that explanation and attributed the lower borrowing costs exclusively to savings realized by banks and passed on to borrowers arising from the replacement of costly credit monitoring with the information reflected in single-name CDS spreads. The evidence and conclusions in Ivanov, Santos, & Vo (2016) raises concerns that greater reliance by banks on the information contained in CDS spreads could result in an excessive decline in loan and borrower credit monitoring by bank lenders, as discussed in Section V.A.1. To the extent that the aggregated information of all market participants reflected in CDS spreads is higher quality than the credit information a given lender would collect through an enhanced monitoring process, however, this concern is unfounded, and, in fact, CDS-based borrower credit monitoring is in that case preferable to bank-specific monitoring.

Impacts on Reference Entity Corporate Financing Decisions and Capital Structure

Perhaps the most important principle of corporate finance is the Modigliani-Miller ("M&M") proposition that the value of a firm is independent of its financing decisions – *i.e.*, a firm cannot realize a higher valuation simply by altering its capital structure (Modigliani & Miller, 1958). In contrast to actual financial markets, the M&M theory assumes that capital

markets are "perfect" (*e.g.*, no taxes, no costs of financial distress or bankruptcy, no transaction costs), information is equally shared by all market participants (*i.e.*, information is "symmetric"), and that all securities issuers can access the capital markets on equal terms. (Modigliani & Miller, 1958; Fama, 1978)

In an M&M world, the mere fact that a single-name CDS is available to trade for a given reference entity should have no impact on the corporate financing decisions (*e.g.*, capital structure, leverage ratio, dividend policy, hedging policies) of that firm or its cost of capital.

With asymmetric information, market frictions and transaction costs, costs of financial distress and bankruptcy, and unequal access to financial markets, however, the existence of single-name CDSs can in principle impact the financial policies and condition of the reference entity underlying those CDSs. As Miller (1988) explained:

> [T]he view that capital structure is literally irrelevant or that "nothing matters" in corporate finance, though still sometimes attributed to us (and tracing perhaps to the very provocative way we made our point), is far from what we ever actually said about the real world applications of our theoretical propositions. Looking back now, perhaps we should have put more emphasis on the other, upbeat side of the "nothing matters" coin: showing what *doesn't* matter can also show, by implication, what *does*. [emphasis in original] (Miller, 1988).

In this section, we consider the empirical research on how the trading of a CDS on a particular reference entity may impact the corporate financing decisions (*e.g.*, capital structure and leverage) and costs of capital for that reference entity. The results are ambiguous and sample-specific.

Saretto & Tookes (2013) consider how the trading of a single-name CDS affects the amount and maturity of a reference entity's debt. Even for firms with similar credit ratings, Saretto & Tookes (2013) find that firms with traded CDSs have higher leverage ratios and longer debt maturities. Their argument is that because CDSs enable lenders to hedge their exposure to the borrower more easily, lenders are willing

to increase the amount of credit available to firms with traded CDSs. Saretto and& Tookes (2013) thus support the importance of single-name CDSs as a credit risk transfer instrument for lenders.

Danis & Gamba (2016) developed a theoretical model to analyze how the onset of CDS trading would affect a firm's trade-offs between investment, equity financing, and debt financing. Their model incorporates real world costs and frictions, such as equity issuance costs, bankruptcy costs, and debt renegotiation frictions. Danis & Gamba (2016) show that the initiation of CDS trading is associated with increases in the reference entity's leverage and investment but has no appreciable impact on its borrowing costs. In addition, the model shows that the existence of traded CDSs reduces the risk of strategic default but also increases the probability of bankruptcy. After calibrating the model to the underlying data, they find that the introduction of single-name CDSs on public U.S. companies results in an average increase of 5.3% in firm value.

CDS Externalities

Externalities occur when the impact of a given activity (*e.g.*, a CDS transaction) goes beyond the direct participants in the activity and conveys benefits or costs on other market participants that the original transacting parties cannot capture in the price of their transaction. In the classic microeconomics terminology, a positive externality exists when the marginal private benefit to the two counterparties of a transaction is less than the marginal social benefit (*i.e.*, the benefit to other market participants). Conversely, a negative externality occurs when the private marginal cost of a transaction is less than the marginal social cost. (*See, e.g.*, Samuelson, 1954; and Bator, 1958).[5] The difference between the marginal social benefit (cost) and marginal private benefit (cost) is known as the marginal external benefit (cost).

[5] For a contrary perspective on the concept of "social efficiency," see Demsetz (1969).

As the Nobel Prize-winning work of Ronald Coase (and a huge literature that followed) demonstrates, externalities almost always occur when some aspect of market structure, law, regulation, or institutions interfere with the definition or enforcement of property rights for the transacting parties. (Coase, 1960. See aldo, Demsetz, 1964, 1967; Cowen, 1988). In particular, when the prices of transactions serve as a tangible benefit to parties that cannot be charged for the value those prices convey, a positive externality exists because the original parties do not have enforceable property rights in their prices (at least not in all senses).

For example, in 1991 a tunnel system underneath the Chicago Loop flooded, leading to the temporary closure of the Chicago Board of Trade ("CBOT"). During this time, grain elevators pulled down price quotes to farmers because they relied so heavily on futures prices to make their cash market quotes and did not repost those quotes until the futures markets re-opened (Kuserk & Locke, 1994). Although exchanges routinely charge (and generate considerable revenues) for access to their real-time price feeds (especially in today's world in which high-frequency traders demand order book access down to the millisecond or microsecond), not *all* parties that benefit from those prices as signals of supply and demand can be charged for the value of the prices (Mulherin, Netter, & Overdahl, 1991).

Studies of single-name CDSs contemplate both potential positive and negative externalities arising from the introduction of single-name CDS trading. One potential channel by which the trading of CDSs on a reference entity can generate externalities is through the information conveyed in CDS spreads. As discussed in Section IV, the empirical evidence confirms that single-name CDSs contain important information about reference entity credit risk and that CDS spreads reflect both anticipation and announcement effects regarding events that impact the financial conditions of reference entities. As we discuss later in Section VI.A, moreover, the empirical evidence overwhelmingly indicates that new information about reference entity credit is reflected

in CDS spreads before credit spreads observed in the less liquid cash bond market.

The impact of the information contained in CDS spreads on other firms, however, is ambiguous as a matter of theory. On the one hand, this informational role of the CDS market could contribute to a reduction in the cost of a reference entity's debt by reducing the information premium that investors demand on bonds to compensate for their perceived informational disadvantage and, similarly, by reducing the rents that banks can extract from borrowers in connection with their informational advantage (Saretto & Tookes, 2013). On the other hand, if the introduction of CDS trading on a reference entity increases the perceived likelihood of financial distress for that firm (as found in Subrahmanyam, Tang, & Wang, 2014), the resulting negative signal could impact the financial decisions of counterparties and commercial or trade creditors with exposures to the firm that in turn could adversely impact thereference entity.

For example, Li & Tang (2016) postulate that commercial suppliers with trade and commercial exposures to the reference entity (and no listed CDSs on their own debt) may react to the perceived heightened financial distress risk of a reference entity customer through changes in their own leverage ratios. If a supplier's reaction to the seemingly higher distress probabilities at a customer conveyed by the information in its CDS spreads is a perceived increase in revenue risk from that customer, the supplier may react by decreasing its own leverage to absorb potentially higher expected credit losses. Yet, if the listing of a CDS on a particular reference entity enables the lender to cross-hedge its indirect exposure to the supplier (which has no listed CDSs), that could increase the supplier's debt capacity and access to funds, thereby leading to an increase in the supplier's leverage. As Li & Tang (2016) emphasize, the impact of single-name CDSs based on customers of suppliers and on the leverage of those suppliers is an empirical question.

Another possible source of positive externalities arising from CDS trading on a given reference name is improved pricing and compressed spreads for bond issuers resulting

from enhanced cross-market integration. Specifically, because single-name CDSs involve both hedgers and speculators and trading frictions are relatively low for CDSs, CDS markets are generally more liquid than cash bond markets. (*See* Sections IV.B.3 and VI.D.) To the extent that inter-market arbitrage keeps CDS spreads and corresponding cash bond prices tightly in line (a subject to which we return in Section VI.D), CDSs thus can help reduce spreads for issuers and improve access to and costs of financing. (Oehmke and Zawadowski, 2015) To the extent that the introduction of a single-name CDS attracts new traders and inter-market arbitrage volume, moreover, CDSs can promote additional bond market liquidity (Li, Zhang, & Kim, 2011; Sambalaibat, 2014; Shim & Zhu, 2014).

The Empty Creditor and Negative Interest Problems

a) Theory

As discussed earlier in Section III.B.2, single-name CDSs can significantly impact debtor-creditor relationships by enabling creditors to separate their control rights from their cash flow rights and risk exposures. Specifically, creditors that hedge their exposures with single- name CDSs can partially or fully eliminate their credit exposure to a borrower while retaining their rights to participate in discussions related to issues like bankruptcy, reorganization, restructuring, and the like. One possible consequence of this separation is the creation of "empty creditors" that no longer have an economic interest in the efficient continuation of the debtor as a firm, which may lead such creditors to push the debtor into bankruptcy or liquidation even in situations when restructuring would be a more efficient solution. Some financial analysts and others have even raised concerns that CDS protection buyers could force a reference entity into bankruptcy in order to trigger a credit event under their CDS protection purchases, especially if the CDS documentation does not specify restructuring as a credit event. (*See, e.g.*, Pollack, 2003).

Not all empty creditor theories, however, yield adverse implications for borrowers. In a frequently cited paper, Bolton & Oehmke (2011) develop a model to analyze how the increased bargaining power of creditors arising from the availability of single-name CDSs can have a positive impact on reference entity bankruptcy filings. Their model assumes that a firm issues debt to finance a positive net present value investment project and that some lenders choose to purchase CDSs. The model also assumes that the firm cannot credibly commit to pay out cash flows in the future. This "limited commitment" feature of the Bolton and Oehmke model results in the firm being unable to write enforceable financial contracts based on its uncertain future cash flows.

In the Bolton & Oehmke (2011) model, the firm may fail to make payments on its debt for either of two reasons: (i) the firm does not generate sufficient interim cash flows sufficient to cover its contractual interest payment obligations (a "cash flow default"); or (ii) the firm's cash flows are sufficient to service its debt but the firm prefers to use the cash for internal purposes instead of repaying its creditors (a "strategic default"). The possibility of strategic defaults has been widely recognized as a problem arising from incomplete corporate debt contracts (see Bolton & Scharfstein, 1966; Hart & Moore, 1998). When firms cannot credibly commit to repay their debt (*e.g.*, when their cash flows are observable but not verifiable) and payments are not legally enforceable, firms may choose to default on their debt to divert cash flows to themselves even when the cash flows are sufficient to service their contractual debt payment obligations. The risk that firms will engage in a strategic default increases the interest rate lenders will demand from such firms and reduces borrowers' debt capacities (Saretto & Tookes, 2013).

The ability of lenders to purchase credit protection with single-name CDSs, however, gives creditors an advantage in distressed firm debt renegotiations and thereby attenuates the borrowers' incentives to engage in strategic defaults or debt renegotiations that are to the detriment of lenders. According to Bolton & Oehmke (2011), the existence of creditors with increased bargaining power resulting from their CDS hedges

actually plays a useful role by increasing a firm's debt capacity – *i.e.*, credit protection held by existing creditors may make them more willing to issue new debt to finance positive net present value investments, and the existence of hedged creditors with stronger bargaining power can also make other lenders morewilling to extend more credit and at a lower rate. In other words, the availability of single-name CDSs can reduce the costs of contracting related to strategic defaults by improving the contracting technology and mitigating the limited commitment problem that firms face when making incomplete debt contracts (see Arping, 2014).

Kim (2013) explains that CDSs make up for incompleteness in some debt contracts by serving as a pre-commitment device that deters firms from strategic default. Firms with high strategic default incentives thus can be expected to experience relatively larger reductions in their corporate bond spreads following the introduction of CDSs. By giving more credibility to borrowers' commitments to repay their debt (assuming no cash flow default occurs), CDSs contribute to a reduction in the cost of corporate debt. Similar results by Saretto & Tookes (2013) confirm that the frictions CDSs introduce into renegotiation can reduce the risk of strategic default and hence increase debt capacity and/or lower the cost of debt. Salomao (2014) presents a similar argument that reference entities underlying sovereign CDSs are associated with lower sovereign default probabilities, greater debt capacity, and lower borrowing costs because of enhanced bargaining power held by lenders given the restructuring provisions included in typical sovereign CDSs.

b) Empirical Evidence

Because some models of the empty creditor hypothesis imply negative results for borrowers and other models have more constructive implications, it is unclear from first principles whether the existence of creditors hedged with single-name CDS protection purchases is a net benefit or cost to reference entities. Likewise, the empirical evidence on the relation between the existence of empty creditors and the value of firms with traded CDSs is also mixed.

Several studies report empirical results that support the negative implications of the empty creditor hypothesis for firms with traded single-name CDSs. Subrahmanyam, Tang, & Wang (2014) perform an empirical analysis of the effects of CDS trading on the credit risk of reference entities using CDS data on 901 North American firms with CDSs trading between 1997 and 2009. During this period, Standard & Poor's reported 3,863 ratings downgrades and 1,628 bankruptcy filings. The authors' analysis shows that both the likelihood of a rating downgrade and the likelihood of bankruptcy of reference entities increased after CDSs started trading. On average, credit ratings decline by about half a notch within two years of the inception of CDS trading, and the probabilities of bankruptcy more than double (from 0.14% to 0.47%) over the two-year period after CDS trading begins. Subrahmanyam, Tang, & Wang (2014) also find that the negative effects of introducing CDSs on reference entities are more pronounced for firms with larger amounts of CDSs outstanding and when the CDSs do not include restructuring as a credit event.

Examining the period from 2001 through 2008, Peristiani & Savino (2011) find no systematic relation between the existence of CDS trading and bankruptcy events but did observe in the 2004-2008 period that firms with traded single-name CDSs were associated with higher EDFs, which is consistent with the negative implications of the empty creditor hypothesis.

Nevertheless, the authors also identified other explanations for their results that do not depend on misaligned incentives and empty creditors. Specifically, Peristiani & Savino (2011) find that firms with larger-than-normal exposures to institutional investors experience a greater incidence of default, which is consistent with institutional pressures on such firms to engage in fire-sale losses to cover funding liquidity needs (as suggested in the models of Brunnermeier & Pedersen, 2009; Diamond & Rajan, 2011; and Shleifer & Vishny, 2011).

Narayanan & Uzmanoglu (2014) analyze the relation between CDS activity and credit spreads empirically when creditors hedge using single-name CDSs. The authors

conclude that hedged creditors have greater bargaining power in debt renegotiations that could deter firms from strategic default, but they also note that debt renegotiations in those situations could be costly and inefficient. The authors' empirical analysis found that on net, opposing forces resulting from the presence of hedged creditors, higher costs imposed by empty creditors, and the deferral of strategic default are all in force but that the higher costs arising from empty creditors dominates the other effects. Narayanan & Uzmanoglu (2014) show that on average, firms with a higher net notional CDS outstanding have higher cost of debt. The authors also find that the costs imposed by empty creditors are even higher for firms with lower expected recovery rates.

Chakraborty, Chava, & Ganduri (2015) examine the relation between loan covenant violations and borrowers' investment expenditures, loan spreads, overall performance, and bankruptcy filings for firms with traded CDSs relative to firms without CDSs. They find some support for the empty creditor hypothesis – namely, that firms with traded CDSs do not decrease their investment expenditures after covenant violations, but do pay higher loan spreads and experience decreased overall performance. Nevertheless, in contrast to the predictions of the empty creditor hypothesis, the authors also find that such firms do not file for bankruptcy at a higher rate than similar firms without traded CDSs.

Mengle (2009) observes a number of potential practical problems with concerns about the negative impacts of empty creditors and their impact on bankruptcy decisions. In particular, he notes that the real choice faced by hedged creditors is whether to opt for restructuring within a bankruptcy proceeding or an out-of-court restructuring. Restructurings outside of bankruptcy are not typically considered credit events because they are not binding on all debt holders, as discussed in Section II.B.4. The empirical evidence suggests, moreover, that out-of-court restructurings can lead to higher recovery rates (Altman & Karlin, 2009).

Mengle (2009) also recognizes that restructuring within the confines of bankruptcy law has certain benefits – *e.g.*, automatic stays, reduced conflicts amongst different security

holders, access to debtor-in-possession financing, etc. Based on prior empirical corporate finance research, he concludes that firms most likely to benefit from out-of-court restructurings are those firms with complex capital structures (and the security holder conflicts to which they give rise), significant pension liabilities, costly labor contracts, and substantial legacy contingent liabilities (*e.g.*, catastrophic environmental clean-up costs or long-tailed liabilities arising from, say, asbestos or silicosis exposures).

Mengle (2009) contends that the impact of hedged creditors on a firm's bankruptcy decision – *i.e.*, whether the existence of empty creditors leads to more bankruptcy filings even when out-of-court restructurings would be more efficient – is an empirical question. In that context, Altman & Karlin (2009) show that the number of restructuring events (as a percentage of default events) between 1984 and 2009 increased significantly after 2003 (when, as discussed in Section II.B.4, a significant revision in the ISDA *Credit Derivatives Definitions* occurred).

The correlation between the frequency of defaults and restructurings (as a percentage of total defaults), moreover, is nine percent over the whole sample period but jumped to 90 percent after 2003. Because the empty creditor theory implies a larger number of bankruptcies and a lower correlation between defaults and restructurings following the introduction of single-name CDS trading, the evidence summarized in Mengle (2009) and in Altman & Karlin (2009) calls into question (albeit indirectly) the negative implications of the empty creditor hypothesis.

Colonnello, Efing, & Zucchi (2016) analyze publicly traded U.S. firms (excluding utilities and financial institutions) in the period from 2001 through 2014 in order to examine the relation between "strong shareholders" and empty creditors. They conclude that debt holders purchase greater amounts of credit protection using single-name CDSs when strong shareholders have a larger degree of bargaining power in order to ensure a seat at the table during potential debt renegotiations. Following the inception of CDS trading, the authors estimate that the distance to default (a measure of

probability of default) declines by 7.9 percent on average. They also find, however, that firms' investments and market valuations also decline by 7 percent and 8.8 percent, respectively. The net impact of the availability of single-name CDSs for debt holders at firms with strong shareholders thus is ambiguous and depends on the channel through which the impact is viewed.

6 Single-Name SDSs and Inter-Market Relations

In this section, we survey the significant academic literature on the relations between single-name CDSs and the debt, equity, and equity options for reference entities underlying the CDSs. We begin by addressing the issue of price discovery – i.e., in which of the related markets is new information about the reference entity first reflected? In Sections VI.B and VI.C, we summarize the empirical results in the literature concerning the impacts from the introduction of single-name CDS trading on liquidity and volatility in the reference entities' debt and equity markets, respectively. We conclude this section with a discussion of the determinants of the CDS-bond basis and the related empirical research.

Price Discovery

Price discovery is the process by which trading incorporates new information and market participants' expectations into asset prices. Thanks to the relatively low transaction costs and high market liquidity of many derivatives markets relative to their corresponding underlying

cash markets, new information about assets is often reflected in derivatives prices first (see van der Merwe, 2015). In the discussion that follows, we refer to the market in which price discovery first occurs as the primary price discovery market ("PPDM").

a) CDSs vs. Bonds

The empirical evidence regarding the PPDM for corporate reference entities is consistent across different studies and data samples. Namely, essentially all of the studies we reviewed strongly indicate that single-name CDSs lead corporate bonds in price discovery. The result is unsurprising given the illiquidity in cash corporate bond markets, both on an absolute basis and relative to single-name CDSs. The studies that provide empirical evidence in support of single-name CDS markets as the PPDM for corporate reference entities include Longstaff, Mithal, & Neis (2003), Blanco, Brennan, & Marsh (2005), Dötz (2007), Alexopoulou, Andersson, & Georgescu (2009), Baba & Inada (2009), Forte & Peña (2009), Norden & Weber (2009), Delis & Mylonidis (2011), Norden & Weber (2012), Coudert & Gex (2010b, 2013), Das, Kalimipalli & Nayak (2014), and Giannikos, Guirguis, & Suen (2013). Furthermore, Alexopoulou, Andersson, & Georgescu (2009) and Coudert & Gex (2013) show that the price-discovery role of single-name CDSs was even more pronounced after the onset of the credit crisis.

The results for sovereign reference entities are more ambiguous than the results for corporate borrowers and are sample-specific. The following studies empirically investigate the PPDM across sovereign CDS and debt markets:

- Chan-Lau & Kim (2004) estimate price-discovery measures for emerging market economies and conclude that roughly equal price discovery occurs in CDS and bond markets in Bulgaria, Colombia, and Venezuela, but that the bond market leads the CDS market in Brazil and the CDS market leads the bond market in Russia;
- Fontana & Scheicher (2010) examine Eurozone sovereign debt markets and conclude that the sovereign CDS market

is the PPDM in half of their sample and that the sovereign debt market is the PPDM in the other half;

- Ammer & Cai (2011) analyze the sovereign debt of Brazil, China, Colombia, Mexico, the Philippines, Russia, Turkey, Uruguay, and Venezuela and find that the cash bond market is the PPDM for the majority (but not for all) of the countries that the authors analyzed;
- Carboni & Carboni (2011) examine 14 European countries, three Asian countries, and the United States and find that the sovereign CDS market is the PPDM for most countries;
- Li & Huang (2011) evaluated 20 sovereign reference entities' CDS and bond spreads and concluded that the PPDM depends on the particular country but that, over time, sovereign CDS markets have become increasingly more common as the PPDM for sovereign reference entities' credit risks;
- Delatte, Gex, & López-Villavicencio (2012) analyze European sovereign debt and CDS markets and ascertain that sovereign debt markets lead sovereign CDS markets for sovereigns experiencing little or no financial distress but that when sovereigns begin to come under pressure the sovereign CDS market becomes the PPDM (even for countries with relatively low-yield, low-risk bonds);
- O'Kane (2012) evaluates price discovery in European sovereign CDS and debt markets and concludes that the PPDM for Greece and Spain is the sovereign CDS market, the PPDM for France and Italy is the sovereign debt market, and Irish and Portuguese sovereign CDS and debt markets exhibit a feedback loop that makes the PPDM econometrically indeterminate for those countries;
- Alper, Forni, & Gerard (2013) compare CDS spreads with relative asset swap spreads (*i.e.*, spreads between benchmark sovereign debt yields and par interest rate swap rates) for developed, major economies in the 2008-2010 period and ascertain that sovereign CDS markets are the PPDMs primarily as a result of their greater relative liquidity;
- Coudert & Gex (2013) analyze both emerging market

countries and developed countries in the Eurozone and conclude from their empirical analysis that the sovereign CDS market is the PPDM for emerging market countries but that the bond market leads the CDS market for Eurozone sovereigns;

- Gyntelberg, *et al.*, (2013) analyze intraday data on Eurozone sovereigns and find that the sovereign CDS market is the PPDM for the vast majority of sovereign borrowers; and
- Hassan, Ngene, & Yu (2015) investigate price discovery in several emerging markets and estimate that the bond market is the PPDM in Argentina, Colombia, Turkey, South Africa, and Brazil, and that the CDS market is the PPDM for Mexican and the Philippine sovereign debt.

As the results in Coudert & Gex (2013) and Alper, Forni, & Gerard (2013) indicate, price discovery in sovereign debt markets depends on the relative liquidity of cash markets and sovereign CDS markets. Sovereign CDSs are more actively traded on lower-rated, higher-risk sovereign issuers and sovereigns experiencing financial distress, and are less actively traded for higher-rated issuers for which there is less demand for credit protection and less uncertainty about the prospect of an adverse credit event. This result is also consistent with the findings of Delatte, Gex, & López-Villavicencio (2012). The mixed results for sovereign debt thus are likely the result of differences in relative liquidity pools between sovereign debt and CDS markets and other sample- and country-specific considerations.

b) CDSs vs. Equities

Several academic studies have investigated the price-discovery role of single-name corporate CDSs compared to markets for equities issued by corporate reference entities underlying CDSs and options on those equities. In a significant and often-cited paper, Acharya & Johnson (2007) use equities as proxies for public information and examine potential insider trading by banks in the CDS market. They ascertain that significant incremental information is revealed in the CDS market in addition to the information already

available in the equity market and thus conclude that the single-name CDS market is the PPDM. Acharya & Johnson (2007) also find that the new information reflected in single-name CDSs on corporate borrowers is only associated with negative credit news for borrowers that experience actual negative credit developments. The authors also determine that the relative magnitude of increased price discovery in the single-name CDS market is directly related to the strength of the relationships between reference entity borrowers with their banks, which provides support that asymmetric information is at least partially responsible for determining the PPDM.[1]

Single-name CDSs are also found to be the PPDM by Zhu (2006), Flannery, Houston, and Partnoy (2010), Eyssell, Fung, & Zhang (2013), and Berndt & Ostrovnaya (2014). Yet, other studies that have examined the role of single-name CDSs as compared to equity markets reach different conclusions. For example, although Forte & Peña (2009) and Norden & Weber (2009) confirm that the single-name CDS market is the PPDM when compared to corporate bonds, both studies also find that the equity markets of CDS reference entities are the PPDMs when compared to both single-name CDSs and corporate bonds. Byström (2005), Trutwein & Scheireck (2011), Marsh & Wagner (2012), and Hilscher, Pollet, & Wilson (2015) also find evidence that equity markets are the PPDMs when compared to single-name CDSs.

Some research indicates that the PPDM depends on market conditions. For example, Trutwein & Schiereck (2011) and Trutwein, Ramchander, & Schiereck (2011) analyze single-name CDS spreads and corresponding reference entity equity before and during the credit crisis, and Forte & Lovreta (2015) examine 92 European corporate issuers from 2002 through 2008.

[1] Separate and apart from price discovery comparisons of corporate debt and equity markets, some research focuses instead on extracting implied information about equities from traded single-name CDSs – see, e.g., Byström (2016).

Both studies found that equity markets were informationally dominant and function as the PPDMs (compared to CDS markets) during periods of financial distress. Using the longer and larger sample of the two papers, Forte & Lovreta (2015) also conclude that the single-name CDS market is the PPDM during relatively stable periods. Coudert & Gex (2010d) reach similar conclusions that the CDS market is the PPDM during non-crisis periods but find that equity markets lead CDS markets in price discovery during market dislocations.

By contrast, Giannikos, Guirguis, & Suen (2013) find the opposite (based on an analysis of 39 U.S. issuers over the period from 2005 through 2008). Specifically, they conclude from their empirical analysis that the equity market is the PPDM during stable periods but the single-name CDS market is informationally dominant and the PPDM during the crisis period of 2007 and 2008. Similarly, in a study of the 2008-2012 period of European sovereign debt, sovereign CDS, and equity markets located in those sovereign nations, Santamaría, Biscarri, & Benito (2014) find that broad-based equity markets were the PPDMs in the 2008-2009 period, but, when the sovereign debt crisis erupted in 2010, sovereign CDS markets became the PPDMs.

The apparent inconsistency between the findings of Giannikos, Guirguis, & Suen (2013) and Santamaría, Biscarri, & Benito (2014), on the one hand, and Forte & Lovreta (2015), on the other hand, suggests that the relation between equity and CDS markets differs between the United States and Europe. Given the differences in regulations and market microstructures in the U.S. and E.U. and the resulting differential trading and regulatory costs faced by informed traders, this is a plausible explanation. Alternatively, the results may depend on the individual reference borrowers in the sample. For example, different cost structures for the acquisition of information may depend on characteristics of individual reference entities (*e.g.*, small- and large-cap issuers sometimes have differing costs of information acquisition), which could also explain the distinct results in these studies.

Yet another possible explanation for these seemingly inconsistent results is that the PPDM varies depending on the type of new information the markets are processing. For example, Marsh & Wagner (2012) compare the speed of adjustment and lead/lag relations across single-name CDS and equity markets and ascertain that the equity market is the PPDM for new market-wide information and common risk factors but that the single-name CDS market is the PPDM (or that CDS spreads and equity prices reflect new information contemporaneously) for new information that is reference entity-specific. The authors also conclude from their empirical analysis that the CDS market is slower to process positive news than negative news about the underlying reference entity.

Episodic changes in relative market liquidity and depth also appear to impact the price discovery process. For example, Mayordomo, Peña, & Romo (2011) find that the single-name CDS market is the PPDM prior to the outbreak of the credit crisis, but that during the crisis the bond asset swap market becomes the PPDM. In both periods, the cash bond market is the slowestto incorporate new information.

Some research has also analyzed how options on the shares issued by firms that are reference entities underlying single-name CDSs process new information. For example, Berndt & Ostrovnaya (2014) find that equity markets do not respond to abnormal movements in option prices unless that information has already manifested itself in corresponding single-name CDS spreads.

Impacts of Single-Name CDS Trading on Bond Market Quality

As discussed in Section III.B.3, one potential cost of the introduction of single-name CDSs for a reference entity is the potential for adverse impacts on the cash bond market for debt issued by the reference entity. Those adverse impacts could include higher cash market volatility and/or reduced liquidity (to which we collectively refer as "market quality").

Concerns that the introduction of derivatives in general precipitates increased cash market volatility – which is usually blamed on the presence of potentially destabilizing speculators – have been expressed for many decades. Yet, the evidence generally indicates the opposite – *i.e.,* the introduction of derivatives results in a *reduction* in the volatility of the underlying cash market volatility, both because the availability of derivatives to help commercial enterprises manage their price risks hedgers promotes stability in the market and because inter- market arbitrage helps keep prices of derivatives and cash markets in line through the execution of arbitrage trades on opposite sides of the market (*e.g.,* long a futures contract and short the cash) which over time reduces fluctuations in the cash market.

For exchange-listed futures and options, Mayhew (2000) surveys the empirical literature over the 1896-2000 period and examines the impact of the introduction of commodity, fixed income, and stock index futures and individual equity options on the volatility of the underlying cash market products. In Table 5, the second column reports the number of research studies that he surveyed, and the third column reports the number of markets covered across all of those studies. For example, 13 academic analyses of commodity futures were produced over the time period that collectively examined 15 futures markets. (The markets often overlap across the studies.) The last three columns report the number of markets for which the introduction of derivatives led to lower cash market volatility, had no impact or a mixed impact, or led to higher volatility, respectively. As Table 5 indicates, the 77 studies indicate that only 11 percent of the 87 markets analyzed across four asset classes over a period of more than 100 years experienced higher cash market volatility after the introduction of futures and/or options on those products.

Table 5. *Academic Studies of the Impact of the Introduction of Futures Contracts on Underlying Cash Market Volatility, 1896-2000*

Asset Class	# Studies	# Markets	Lower	No or Mixed Impact	Higher
Commodities	13	15	10	4	1
Fixed Income	11	12	4	7	1
Stock Index	36	43	8	28	7
Equity Options	17	17	16	0	1
Total	77	87	38	39	10
Total (%)			44%	45%	11%

Source: Mayhew (2000).

In the aftermath of the financial crisis in 2008 and the sovereign debt crisis in 2011, regulators exhibited renewed interest in the impact of the introduction of CDSs on cash bond markets. For example, Securities and Exchange Commission Chairman Erik Sirri testified before the House Committee on Agriculture that "[the] SEC has a great interest in the CDS market because of its impact on the debt and cash equity securities markets and the Commission's responsibility to maintain fair, orderly, and efficient securities markets. These markets are directly affected by CDS due to the interrelationship between the CDS market and the claims that compose the capital structure of the underlying issuers on which the protection is written" (Sirri, 2008). In this section, we summarize the academic research regarding the impact of the introduction of single-name CDSs on the quality of the markets for the bonds issued by the reference entities underlying those CDSs.

Using an extensive sample of single-name CDS and bond trades between 2002 and 2008 Das, Kalimipalli, & Nayak (2014) show that the average trade size and average turnover (relative to the total outstanding) in corporate bond markets declines in the two-year period subsequent to the inception of single-name CDS trading. Because the CDS market involves active players and is dominated by financial institutions that typically are relatively better informed, it is not surprising that Das, Kalimpipalli, & Nayak (2014) also find evidence of large institutional traders migrating from corporate bond markets to single-name CDS markets after the latter were introduced. This exodus of institutional trades likely explains the apparent

deterioration in bond market quality that the authors found following the introduction of single- name CDSs. Similar empirical results have been documented for equity options and equity markets – *i.e.*, after options on a stock are listed for trading, the price discovery function increasingly occurs in the option market, particularly when the options are more liquid and/or options markets attract larger and better-informed traders (Easley, O'Hara, & Srinivas, 1998; Pan & Poteshman, 2006).

Nashikkar, Subrahmanyam, & Mahanti (2011) study potential liquidity spillover effects from single-name CDSs to bonds and find that bonds with more liquid CDSs have lower yields than comparable bonds with less liquid CDSs. The seemingly adverse impact of the introduction of single-name CDSs on corporate bond markets reported by Das, Kalimpipalli, & Nayak (2014) thus may be a temporary phenomenon. Once liquidity in the single-name CDS market stabilizes, the results of Nashikkar, Subrahmanyam, & Mahanti (2011) suggest that some of that liquidity will positively impact corporate bond market liquidity (either through inter-market arbitrage transactions or through other channels).

Despite the empirical evidence that the introduction of CDSs can have adverse impacts on bond market quality that may be deleterious to some cash bond market participants, there may be offsetting (or more than offsetting) benefits in the single-name CDS market such that there is a *net* benefit from the introduction of single-name CDSs across the two markets based on the same reference entity.

For example, Oehmke & Zawadowski (2016) present a framework for analyzing the implications for corporate bond markets resulting from the introduction of CDSs. Oehmke & Zawadowski (2016) describe the role of CDSs as being similar to liquidity transformation – *i.e.*, single-name CDSs are more liquid alternatives to relatively illiquid corporate bonds for

trading and managing the credit risk of a reference entity.[2] The introduction of single-name CDSs, however, creates opposing forces on bond demand. Assuming (realistically) that trading costs are lower for single-name CDSs than for the corporate bonds, Oehmke & Zawadowski (2016) identify three possible impacts on corporate bond prices resulting from the introduction of single-name CDSs:

- Investors that previously held a long position in a bond may sell the bond and then sell CDS protection as a way of synthetically investing in the bond, which puts *downward pressure* on the cash bond price;
- Investors that previously shorted the bond may unwind their short sales and buy CDS protection because the relatively illiquid bond often trades at a discount to the CDS (*see* Section VI.D.), which may reduce the amount of short selling and put *upward pressure* on the bond price; and
- When the CDS spread of a reference entity is lower than the credit spread on a bond issued by that reference entity (*see* Section VI.D), some investors will become negative basis traders that simultaneously buy the bond and purchase CDS protection; because the combined position of a negative basis trade is hedged, basis traders can usually take leveraged positions that put potentially significant *upward pressure* on the corporate bond price.

The impact from the introduction of single-name CDS trading on the prices of the reference entity's bonds thus is ambiguous as a matter of theory, although Oehmke & Zawadowski (2016) conclude that inter-market arbitrage and cross-market basis trades ultimately compress the CDS-bond basis (*see* Section VI.D) and mitigate the impact of CDS transactions on cash bond prices.

Massa & Zhang (2012) consider the impact that an active single-name CDS market has on the corresponding corporate bond market from the perspective of large institutional

[2] Recent proposals of bond standardization as a way of improving bond market liquidity overlook the benefits provided by a liquid CDS market. See, e.g., BlackRock, (2013).

investors such as insurance companies, banks, and pension funds. A drop in bond market value or a downgrade in bond ratings may force such institutions to raise additional equity or sell their bond investments to remain compliant with their risk-based capital requirements. Such forced bond sales can potentially create or exacerbate market liquidity risks for investors in corporate bonds. If those institutions purchase CDS protection, they could defer their sales of bonds until more stable market conditions prevail. The presence of single-name CDS may also induce arbitrageurs to enter the market. For example, if corporate bonds are temporarily underpriced because of market liquidity risks and shocks, inter-market arbitrage will result in greater liquidity in the bond market.

Impacts of Single-Name CDS Trading on Equity Market Quality

Because of the economic near-equivalence of single-name CDS protection sales and purchases of bonds issued by the reference entity underlying the CDS, the results summarized in the previous section that document the impacts from the introduction of CDS trading on corresponding corporate bond markets are not surprising. Why the introduction of a single-name CDS could impact the liquidity and volatility (*i.e.*, quality) of the market for the stock issued by the reference is less obvious.

The classic insight of Merton (1974) laid the theoretical foundation for our understanding of the relationship between a firm's debt and equity in an options framework. Equity can be viewed as a call option on the firm's assets with a strike price equal to the face value of the firm's debt ("*FV*"), whereas zero-coupon debt can be viewed as a short put option on the firm's assets with a strike price of *FV* plus a riskless loan of *FV*. Culp, Nozawa, & Veronesi (2015) analyze the empirical relations between credit spreads of "pseudo firms" that hold actual, traded securities as assets and document numerous similarities between the credit spreads on the debt of such pseudo firms and actual, observed credit spreads on both the

single-name CDSs and cash bonds issued by comparable securities issuers.

Any relative mispricing across the debt and equity securities issued by the same firm gives rise to potential capital structure arbitrage opportunities. Single-name CDSs are relatively low-cost, liquid, and attractive instruments with which firms can conduct capital structure arbitrage. As long as the gains from arbitraging the mispricing exceed transaction costs, such arbitrage activities help eliminate any relative mispricing of a reference entity's debt and equity and thus enhances the firm's capital structure efficiency, which can lead to a lower cost of capitalfor the firm.

Yet, if single-name CDSs are predominantly traded by informed traders with complex and/or opaque strategies, the information reflected by single-name CDS trades may not be discernible to relatively less-informed traders (Boehmer, Chava, & Tookes, 2015). In that case, market makers may perceive themselves to be at a relative informational disadvantage to informed traders, which will lead them to widen their quoted bid/ask spreads as compensation for providing liquidity to relatively better-informed traders. (Glosten & Milgrom, 1985). Those higher transaction costs may in turn discourage capital structure arbitrage and allow perceived relative mispricings to persist.

Using a sample of NYSE stocks during the period from 2003 through 2007, Boehmer, Chava, & Tookes (2015) investigate the impact of the introduction of CDSs on equity markets and ascertained that equity markets become less liquid and equity prices become less informationally efficient after a market for a single-name CDS emerges. The authors note an increased presence of informed institutional investors following the introduction of CDS trading, as well as a heightened price impact resulting from informed equity trades. The adverse impact of single-name CDS trading is more pronounced for firms that are closer to default and facing greater market uncertainty. Conversely, the authors find that the introduction of single-name CDSs has a less negative (and sometimes a positive) role for healthy firms. They conjecture that their results may be driven by the fact

that there is more speculative trading in CDSs for firms in distress and when market conditions are volatile and that the activities of hedgers are more dominant during stable market conditions.

Haas & Reynolds (2015) reach somewhat similar conclusions. They find that as liquidity in CDS markets tightens, equity market makers that rely on CDS spreads as important sources of information about the credit quality of reference entities reduce their liquidity provision in response to the reduction of information from the CDS market, thereby resulting in a spillover of any market illiquidity from single-name corporate CDS markets to the corresponding equity markets.

The CDS-Bond Basis

The CDS-bond basis is the difference in the credit spread for a given reference entity reflected in single-name CDS spreads and corporate bond spreads. Although the basis can be measured either way, the traditional measure of the CDS-bond basis is to subtract the corporate bond credit spread from the CDS spread. When the CDS-bond basis is negative, an arbitrageur can buy protection on the reference entity and contemporaneously purchase the corporate bond. [3] The arbitrageur in a negative basis trade profits by receiving the relatively higher bond yield and paying the cheaper CDS spread to hedge the credit exposure of the combined position.

In a frictionless market with no impediments to trade and no transaction costs, inter- market arbitrage keeps the prices of bonds and related CDS spreads in line and gives rise to a mean-reverting CDS-bond basis. During normal market conditions, the CDS-bond basis is close to zero, although various institutional details (discussed in Section VI.D.2 below) generally prevent the basis from being exactly zero. Because CDSs and bonds are often used in dynamic hedging or basis trading strategies – both of which depend on the

[3] Alternatively, if the basis becomes materially positive, arbitrageurs sell credit default swap protection and simultaneously short the corporate bond.

convergence of CDS spreads and bond yield spreads – understanding the factors driving the CDS-bond basis and the related empirical evidence highlights the risks associated with these types of strategies.

Measuring the CDS-Bond Basis

In any empirical examination of the CDS-bond basis, care must be taken to properly define the basis so that credit spreads on bonds and CDSs are expressed consistently. To assess the relative value and credit risk of a bond and CDS based on the same reference entity, several different measures of the CDS-bond basis have been developed. The most common such measures are as follows (O'Kane & Sen, 2005, and Choudhry, 2006):

- *Asset Swap/CDS Basis:* This measure of the CDS-bond basis is the difference between the observed CDS spread and the asset swap spread on a bond issued by the reference entity underlying the CDS. The advantage of this measure is that it reflects the carrying cost (possibly negative) of the trade – *i.e.,* the actual cash cost of holding the bond and buying protection on it. For bonds trading well away from par, however, this measure of the basis can be unreliable.
- *z-Spread/CDS Basis:* The *z*-spread on a bond is the spread which, when added to maturity-specific rates on the zero-coupon swap curve at all maturities, reprices the bond to par. Because this is a zero- coupon-equivalent rate, the actual CDS spread must also be adjusted to a zero-coupon-equivalent rate (*e.g.,* by bootstrapping the par CDS curve). Although this measure of the basis does not reflect the cash carrying costs of a basis trade, it is generally considered to be a more economically informative measure of the basis than the asset swap/CDS basis for bonds trading at a discount to from par.
- *Adjusted z-Spread/CDS Basis:* In this measure of the basis, default risk is explicitly incorporated into the potential cash flows on the bond, and the basis is defined as the difference between the *z*-spread of a bond whose price has been calculated using CDS spreads and the *z*-spread of the

actual bond. This is the most direct comparison of theoretical and actual bond spreads.

- *Repo/CDS Basis:* This measure of the basis is essentially the same as the adjusted z-spread except that the spread is expressed as a difference in yields rather than zero-coupon rates. Specifically, the yield is calculated on a hypothetical bond priced off the CDS curve and then compared to the observed yield on the actual cash bond in the repo market.
- *Arbitrage-Pricing Difference ("APD"):* This measure uses the CDS curve to derive a CDS-implied theoretical bond price (see Lando, 1998; Duffie, 1999; and Duffie & Singleton, 1999), which then is compared to the market price of the actual bond. The APD is a very robust measure of the basis that does not suffer the limitations identified in the other measures and can be used to identify relative value opportunities. For example, when the CDS-implied bond price exceeds the market price of the bond, the bond is cheap relative to the CDS, and it can make sense for arbitrageurs or investors to buy the bond and purchase CDS protection to exploit the negative basis. Conversely, a positive basis occurs when the market price of the bond exceeds the CDS-implied bond price and suggests a sale of CDS protection and sale of the bond (see Haworth, Schwarz, & Porter, 2009).

Economic Factors Affecting the Basis

Credit spreads on corporate and sovereign bonds and the single-name CDS contracts for the same reference entity reflect the same underlying credit risk. In principle, differences in the design of the products or differences in the risk premiums across the two products for *non-credit* risks should explain any situations where the CDS-bond basis is not zero (*i.e.*, does not reflect "parity" between the CDS- and bond-implied credit spreads of the reference entity). No-arbitrage requirements stipulate that whenever the CDS-bond basis is sufficiently different from zero, it is theoretically possible to implement a basis arbitrage trade, selling (buying) credit risk in the bond market and buying (selling) credit risk

in the CDS. For the basis trading strategy to be profitable, markets should be relatively liquid with narrow bid-ask spreads, funding for bond purchases should be readily available, and the interbank market should function efficiently. Even under these conditions, this arbitrage strategy is still imperfect as a result of product design differences such as the CTD option owned by protection purchasers in physically settled single-name CDSs and the practical challenges involved with short-selling cash bonds, both of which tend to render the basis slightly positive during normal market conditions (Duffie, 1999).

One simple reason that the CDS-bond basis may not be exactly zero is that the no- arbitrage relation between single-name CDSs and bonds for the same reference entity only holds strictly for floating-rate notes. (Duffie, 1999) As Hull & White (2000) observe, "The difference between the spread on par yield floaters and par yield fixed rate instruments is very small for flat term structures, but noticeable for non-flat term structures" (Hull & White, 2000).

A second significant reason for divergences of the CDS-bond basis from parity is relative differences in liquidity across the single-name CDS and cash bond markets. In particular, the relatively greater illiquidity in the corporate bond market can give rise to a non-zero CDS-bond basis. (*See, e.g.*, Gârleanu & Pedersen, 2011). In fact, this belief is so deeply ingrained in the academic literature that the CDS-bond basis is sometimes used as a *measure* of the market liquidity risk premium in corporate bonds. Although the relative simplicity of that measure of the bond liquidity risk premium is appealing, it ignores other factors that could also affect the CDS- bond basis and thus can lead to biased estimates of bond market liquidity risk premiums.

In addition to relative differences in single-name CDS and bond market liquidity risks, other factors that may impact the CDS-bond basis include the following: the impact of the value of the CTD option owned by protection purchasers in physically settled single-name CDSs, different treatments of accrued interest in CDSs and bonds, short sale restrictions in either or both markets, and counterparty risk in the CDS

market (Chouhry, 2006). The relative importance of these factors, moreover, is not constant over time. For example, Andritzky & Singh (2006) find that the CTD option in sovereign CDSs is significant for sovereign debt trading well below par but is insignificant for relatively low-risk sovereign debt with prices near their par amounts.

The Lehman Brothers credit event in September 2008 and the subsequent global financial crisis introduced a new era in financial markets in which counterparty risks began to affect derivatives prices. Prior to the Lehman Brothers default, derivatives were priced "as if" the credit quality of counterparties was AAA (Duffie & Singleton, 2003). For counterparties rated below AAA, collateral requirements brought the credit risk of the transaction to a AAA-equivalent rating. Subsequent to the Lehman Brothers default, however, most derivatives are now priced to reflect the credit risk of the two counterparties (Veronesi, 2016).

In particular, if the occurrence of a credit event at the reference entity coincides with the default of the CDS protection seller, the CDS buyer is at risk not to receive the full contractually required payment from the CDS protection selling counterparty. CDS buyers facing counterparties with non-trivial perceived credit risk thus will pay less for credit protection than if they were facing otherwise-similar counterparties with lower perceived credit risk. The typical mitigating factors for this type of counterparty risk is the posting of collateral on non-cleared CDSs and the clearing of certain CDSs by CCPs. The empirical evidence confirms that spreads on uncollateralized CDSs reflect counterparty credit risk and gives rise to a non-zero CDS-bond basis (Johannes & Sundaresan, 2007; Bongaerts, De Jong, & Driessen, 2011).

Adler & Song (2010) analyze the theoretical impacts on the CDS-bond basis of economic factors. Table 6 summarizes those factors and the direction of the impact of those factors on the CDS-bond basis.

Table 6. *Factors Influencing the CDS-Bond Basis*

Direction of Basis	Effect	Description
Positive (i.e., CDS spread exceeds bond spread)	CTD option in CDSs	The protection buyer in a physically settled CDS can choose to deliver any eligible bond and receive par value.
	Issuance of new bonds	Pushes up demand for insurance, resulting in a higher price of protection
	Bond short selling abilities	If the reference entity's credit deteriorates, CDS spreads react more quickly than bonds as the demand for credit protection increases.
	Repo specialness	Repurchase agreements on certain bonds that are deliverable into physically settled CDSs put upward pressure on CDS spreads due to limited availability of bonds.
Negative (i.e., bond spread exceeds CDS spread)	Counterparty risk	Premium compensating CDS protection buyer for the risk that the protection seller defaults
	Bond illiquidity	Although the effect can be ambiguous, illiquid bonds trade at higher spreads and therefore reduce the basis.
	Funding risk	The protection seller's funding risk is different than would be incurred if, instead of entering into a CDS, it replicated the CDS by buying the underlying bond with funds borrowed at the risk-free rate.

Empirical Examinations of the Basis

Virtually all empirical investigations into deviations of the CDS-bond basis from the theoretical parity relationship are based on institutional frictions that interfere with the inter-market arbitrage trading strategies that normally would eliminate perceived violations in the law of one price across single-name CDS and related bond markets. For example, De Wit (2006), Bai & Collin-Dufresne (2013), and Mayordomo & Peña (2014) empirically confirm that the institutional issues discussed in the previous section (*e.g.*, trading liquidity, funding costs and constraints, counterparty risk, and margin requirements) explain a significant amount of the variation in the CDS-bond basis prior to, during, and after the credit crisis.

Longstaff, Mithal, & Neis (2003) compare the credit spread in corporate bonds to corresponding single-name CDS credit spreads and find that CDS spreads are lower than corporate bond credit spreads for all firms in their sample – *i.e.*, they

document a systematically negative CDS-bond basis in the cross section of their data. They suggest that tax-related and liquidity components reflected in corporate bond spreads explain the higher credit spreads on corporate bonds. In a follow-up to their 2003 paper, Longstaff, Mithal, & Neis (2005) decompose the CDS-bond basis into default and non-default components and find that the non- default component varies over time and is correlated with bond market illiquidity.[4] Cossin & Lu (2004), Levy (2009), Küçük (2010), and Badaoui, Cathcart, and El-Jahel (2015) also find that illiquidity is a significant explanatory variable for deviations of the CDS-bond basis from parity.

Houweling & Vorst (2005) and Adler & Song (2010) show that the spread on a par fixed-coupon bond over a par default risk-free fixed-coupon bond only equals the CDS premium if the payment dates on the CDS and bond coincide and recovery on default is a constant fraction of face value. These studies thus confirm the parity relation established by Duffie (1999) and show that it only holds exactly for par bonds.

Blanco, Brennan, & Marsh (2005) and Zhu (2006) confirm that the parity relation between CDS and bonds is an equilibrium condition but that substantial deviations from parity can arise in the short run if, for example, the cost of shorting a bond in the repo market is significant. A non-zero CDS-bond basis can also arise from combinations of imperfections in the contract specification of CDSs and measurement errors in computing credit spreads. For example, with no restructuring event specified in the ISDA master agreements, as much as six to eight percent of the CDS spread is a premium paid to protection sellers for bearing restructuring risk (Berndt, Jarrow, & Kang, 2007).

As discussed in Section II.B.6, protection buyers are entitled to choose from a basket of eligible deliverable obligations to be delivered to the protection seller in a physically settled single-name CDSs in exchange for receiving the cash value of the par amount of the delivered bond. Bonds

[4] The authors assumed no liquidity premium in the CDS market; all liquidity effects enter through the cash side of the market.

of a defaulted obligor with different coupon rates, maturities, and depths of subordination do not trade at the same price following a default. As such, the CTD option owned by single-name CDS protection buyers entitles them to deliver any eligible bond, and rational market participants thus will deliver a bond with the lowest price – *i.e.*, the bond with the lowest expected recovery rate. Jankowitsch, Pullirsch, & Veža (2008) find that recovery rates can span a wide range, varying between eight and 47 percent across ratings classes and across industries. As such, the CTD option can be a significant determinant of deviations of the CDS-bond basis from parity (Singh, 2003; Cossin & Lu, 2004; Jankowitsch, Pullirsch, & Veža, 2008).

Bühler and Trapp (2009) show that the CDS-bond basis is sensitive to credit- and liquidity-risk considerations associated with the underlying reference entity. Several studies document a CDS "basis smile" in which issuers with single-A credit ratings have lower CDS spreads than issuers with AA or BBB rated entities. Relatively low CDS spreads for very high- grade firms suggest a greater likelihood of a positive basis, whereas for higher-risk firms other factors (*e.g.*, the CTD option) are relatively more important determinants of the CDS-bond basis.

Coudert & Gex (2010c) consider the relation between secondary market bond prices following credit events at large reference entities and the recovery rates determined through the corresponding auction settlement process. (*See* Section II.B.5(c).) Their empirical analysis of large entities that experienced credit events from 2005 through 2009 includes the Lehman Brothers, Washington Mutual, Fannie Mae, and Freddie Mac credit events. The authors conclude from their empirical analysis that the major drivers of a non-zero CDS-bond basis are counterparty risk (which is magnified when credit events are correlated across protection sellers) and the capital outlay required to support CDS-bond inter-market arbitrage transactions. Brigo & Chourdakis (2009), Morkoetter, Pleus, & Westerfeld (2012), and Haerri, Morkoetter, & Westerfeld (2015) also find that counterparty credit risk impacts the CDS-bond basis. Arora, Gandhi, &

Longstaff (2012), however, present evidence that the effect of counterparty risk is economically small due to the widespread use of collateral in the CDS market.

As discussed in more detail in Section VI.A, information about a reference entity's credit risk is generally reflected in the CDS market before the bond market. Short-lived deviations from parity can thus also arise purely as a result of single-name CDS spreads reflecting new information earlier than bond-based credit spreads (Blanco, Brennan, & Marsh, 2005).

Gârleanu & Pedersen (2011) study the negative CDS-bond basis observed for several months during the credit crisis. The authors attribute the persistently negative basis to differences in margin requirements on corporate bonds and CDSs. For example, with a five percent cost of capital and an initial margin requirement of two percent on the CDS and 20 percent on the repo of an investment-grade corporate bond (all of which were typical during the crisis period), the margin differential between single-name CDSs and bond repos would have been 0.9 percent (*i.e.*, 5% *x* (20% - 2%) = 0.9%), which is close to what was observed at the time.

In the event that financing and margin costs become prohibitively expensive for would-be inter-market arbitrageurs, basis trades will not be executed even in the face of obvious relative mispricings, which can cause a non-zero CDS-bond basis to persist for extended periods of time and by possibly significant amounts. This dynamic was at work particularly during the 2008 phase of the credit crisis when the CDS-bond basis was substantially negative across broad portfolios of both investment-grade and high-yield bonds. During that period of the crisis, the costs of financing inter-market arbitrage became prohibitively expensive for typical arbitrageurs. According to J.P. Morgan, initial margin on corporate bonds and repos increased from five percent in June 2005 to 10 percent in June 2008. In October 2008, margin increased to 20-25 percent, and financing for many hedge funds (potential basis arbitrageurs) was simply not available at any cost (Mitchell & Pulvino, 2012). Various other academic studies have confirmed the role of binding funding

constraints as a significant determinant of the persistent negative CDS-bond basis during the crisis – *see, e.g.,* Fontana (2011), Augustin (2012) and Bhanot & Guo (2012).

Regulatory and economic capital constraints also contributed to the sustained negative CDS-bond basis during the crisis. Specifically, market making in CDS basis trades is balance-sheet intensive and requires a substantial amount of capital. In market making for CDS basis trades involving single-name CDS and cash bond transactions, a dealer acts as an intermediary for both transactions.[5] The dealer's trades involving cash bonds affect its total bond inventory holdings and capital requirements. (Dealers hold surplus inventories of securities for which they make markets. Low dealer inventories therefore have a negative impact on their ability to intermediate markets.) The dealer also faces two different counterparties in two different but related markets (*i.e.,* the bond and the related single-name CDS). These economic considerations for dealers translate into costs for inter-market arbitrageurs that are higher when bank intermediaries face higher funding and capital costs to support such arbitrage activities.

Dealer banks experienced severe capital shortages during the financial crisis, which was exacerbated by dislocations in the repurchase market. (*See, e.g.,* Gorton & Metrick, 2012). As dealers faced binding economic and regulatory capital constraints during the crisis, CDS-bond arbitrage activities were impeded, which reinforced the persistence of a negative CDS-bond basis (Duffie, 2010; Fontana, 2011; Choi & Shachar, 2014). The CDS-bond basis reverted to more normal levels in 2009 subsequent to an improvement in general market conditions and dealers' balance-sheet capacities.

For sovereign CDSs, Foley-Fisher (2010) documents violations between the CDS and bond parity relation in the 2008 – 2009 period and attributes those deviations primarily to constraints on credit protection sales (*e.g.,* the E.U. ban on

[5] CDS-bond basis trades involving single-name CDSs and asset swaps on related bonds are less capital-intensive and costly than arbitrage transactions involving cash bond transactions.

naked shorting using sovereign CDSs) and heterogeneous beliefs amongst CDS traders. Janus, Jinjarak, & Uruyos (2013) also conclude that sovereign CDS trading is driven in part by the disparate expectations of investors.

7 Single-Name CDSs, Interconnectedness, and Systemic Risk

Single-name CDS spreads reflect valuable information about the nature and magnitude of interconnectedness between financial institutions that write CDS protection and the potential systemic risks to which such interconnectedness may give rise. We review the empirical results from the academic literature on the sources and nature of interconnectedness across firms to which single-name CDSs give rise. Our discussion in this section is not primarily concerned with whether CDSs create or exacerbate systemic risk. Instead, we focus in this section on the informational content of single-name CDS spreads as harbingers of potential systemic issues.

Some of the papers that analyze interconnectedness through single-name CDS channels can be interpreted to support conclusions that single-name CDSs result in heightened cross-firm interconnectedness, but other papers reviewed in this section can be interpreted as evidence against any systemic implication of single-name CDSs. (See, e.g., Duffie, 2010; Stulz, 2010, and Tran, 2013).

In Section VII.A, we review the volatilities of CDS spreads and the correlation between volatilities of credit spreads implied by CDSs, cash bonds, and equities. The second section reviews literature discussing sources of interconnectedness. In Section VII.C, we discuss the empirical evidence on spillovers in sovereign CDS markets. Specifically, we review the empirical record for both the U.S. post-Lehman financial crisis and the Eurozone sovereign debt crisis, followed by a review of the significant articles that empirically examine the interplay between sovereign CDSs and foreign exchange markets. Finally, Section VII.D provides an overview on the literature on the interrelation between sovereign and banking/corporate credit risk.

Single-Name CDS Volatility and Correlation

Many firms have securities that are actively traded in the single-name CDS, corporate bond, and stock markets at the same time. Volatilities of CDS spreads, bond yield spreads, and stock prices thus provide a three-dimensional view of the financial condition of reference entities underlying outstanding single-name CDSs. Another useful and related measure is the co- movement of volatilities (i.e., estimated covariance or correlation coefficients) of credit spreads implied by CDSs, cash bonds, and equities. The relative magnitudes of these empirical indicators of co-movements in asset prices across related markets based in the same common reference entities indicate how these different markets are affected by common economic shocks.

Increased risk and greater uncertainty during crises are reflected in elevated volatility of CDS spreads, bond yield spreads, and stock prices when compared to normal markets. For example, Belke & Gokus (2011) analyzed the CDS spreads of four large U.S. banks from 2006 to 2009 and found (not surprisingly) that CDS spread volatilities rose significantly during the crisis and that correlations across CDS spreads also became higher during the crisis. (See also Coudert & Gex, 2010a).

Correlations and covariances are not constant over time and often exhibit elevated levels during times of market-wide uncertainty such as when Lehman Brothers failed. Covariances tend to be higher (lower) in times of high (low) volatility, but variability in covariance has been documented to exist beyond what can be explained only by volatility. Some (e.g., Belke & Gokus, 2011) argue that increased correlations between single-name CDSs and local equity markets during the financial crisis indicate contagion effects, particularly in the banking sector in which different banks are often connected. Nevertheless, causality is not implied by correlation, and more robust analyses are required to identify statically significant cross-market contagion and interconnectedness channels (*see. e.g.,* Section VII.B).

Almer, Heidon, & Schmaltz (2008) analyze the dynamic behavior of the "CDS slope" correlation between short-term (6-month) and long-term (5-year) CDS spreads of banks from 2001 to 2007. The authors show that this correlation exhibits large variations over time. During periods of market distress, spreads tend to co-move, whereas such co-movements subside during normal market conditions. An interesting finding by Almer, Heidon, and Schmaltz is that 5-year single-name CDS spreads (which, as noted in Section II.B.2, is typically the most actively traded maturity) are correlated to the borrower distress proxies contained in the Merton (1974) model (*e.g.,* firm value volatility, stock prices, interest rates) but are not sensitive to cross-market liquidity risk factors.[1] As discussed in Sections IV.B and VI.D, their finding of the insensitivity of single-name CDS spreads to CDS and/or bond market liquidity risk is at odds with the rest of the literature.

[1] Almer, Heidon, & Schmaltz (2008) used systematic proxies for liquidity from the Money and Central Bank Market such as bid-ask spreads of three-month deposits, the bid-ask spread for the overnight money market segment, the government bond swap spread, the amount of ECB tenders, and the number of bidders.

Measuring Interconnectedness Using CDSs

Coudert & Gex (2010a, 2010d) analyze how the financial crises at General Motors ("GM") and Ford in May 2005 affected single-name CDSs on GM and Ford. Specifically, spreads on both firms' CDSs increased significantly prior to their rating downgrades in May 2005. More interestingly, CDS spreads for longer-dated tenors also rose during this period for U.S. and European corporates. The authors estimated correlation coefficients across markets that rose appreciably following the auto manufacturers' credit downgrades, thereby confirming a strong degree of international cross-market integration and market participants' expectations about potential spillover effects.

Especially since the outbreak of the credit crisis in 2007 and the highly publicized failures of firms like Lehman Brothers, the academic literature on the estimation of interconnectedness has burgeoned. Interest in this literature has been fueled by enhanced regulatory scrutiny of systemic risk and the creation of "systemically important financial institutions" as defined by the Financial Stability Board ("FSB") and Financial Stability Oversight Council ("FSOC") for international and U.S. institutions, respectively.

Much of the academic literature on systemic risk today focuses on efforts to quantify the riskiness of specific financial institutions in an interconnected world – *see, e.g.*, Acharya, Pedersen, Philippon, & Richardson (2010), Billio, Getmansky, Lo, & Pelizzon (2012), and Adrian & Brunnermeier (2016). Bisias, Flood, Lo, & Valavanis (2012) present a useful survey of various measures of systemic risk as of 2012. Such measures of systemic risk (ranging from simple examinations of market data to complex econometric models of financial networks) often utilize CDS spreads as inputs to the analysis of interconnectedness.

Some examples of academic studies that utilize single-name CDS spreads to analyze cross-firm interconnectedness include the following:[2]

[2] These examples are not intended to be exhaustive.

- Jacoby, Jiang, & Theocharides (2009) study spillovers of liquidity shocks across single-name CDS, corporate bond, and equity markets and find no evidence of a liquidity spillover effect from bonds to CDSs and a time lag between the reflection of liquidity shocks on single-name CDS spreads *vis-à-vis*both bond and equity markets;
- Kim, Loretan, & Remolona (2010) analyze CDS spreads and EDFs on 38 corporate names from the Asia-ex-Japan area over the period from January 2005 through January 2009 and find that "knock- on" effects from the global (mainly western) credit crisis had some impact on higher EDFs for Asian firms but that the majority of the adverse impacts felt by the Asian companies was attributable to increases in investor risk aversion following the outbreak of the credit crisis;
- Eichengreen, Mody, Nedeljkovic, & Sarno (2012) examine the CDS spreads of the largest 45 financial institutions in the U.S., U.K., Germany, Switzerland, France, Italy, Spain, the Netherlands, and Portugal as measures of their interconnectedness and conclude from their empirical work that a strong common factor explained CDS spreads even before the credit crisis, and that the common factor driving CDS spreads became more pronounced following the outbreak of the crisis;
- Giglio (2011) analyzes bond and CDS spreads to differentiate correlated systemic credit risks from the firm-specific credit risks of individual reference entities;
- Nijskens & Wagner (2011) analyze the 38 banks that began to use CDSs from June 1998 through June 2006 and determine that the introduction of CDSs was commensurate with increases in the banks' equity betas – *i.e.*, after decomposing the beta increase into volatility and correlation effects, the authors conclude that increased interconnectedness is almost entirely a correlation effect, which indicates evidence linking CDS usage with systemic interconnectedness;
- Chen, Cummins, Viswanathan, & Weiss (2013) analyze CDS spreads and stock prices from 2001 through 2011 in the

insurance sector and find strong evidence of interconnectedness between banks and insurers;

- Conrad, Dittmar, & Hameed (2013) estimate joint default probabilities and LGDs for corporate reference entities using both CDS spreads and equity option-implied volatilities and find evidence that increases in default probabilities at systemically important financial institutions precipitate increases in the default probabilities and LGDs of other companies that are reflected in single-name CDS spreads;
- Rodríguez-Moreno & Peña (2013) compare market-based measures of systemic risk using CDS spreads, interbank rates, and stock prices and conclude that systemic risk measures based on CDSs outperform measures based on the other two candidates;
- Yang & Zhou (2013) analyze interconnectedness and spillover effects across 43 large international financial institutions and use CDS spreads to characterize a network comprised of "prime senders, exchange centers, and prime receivers of credit risk information";
- Getmansky, Girardi, & Lewis (2014) analyze the ostensible interconnectedness of CDS exposures across multiple swap dealers and find that the network of dealers was highly concentrated in general and in sovereign CDSs more specifically;

Peltonen, Scheicher, & Vuillemey (2014) construct a network from the bilateral notional CDS exposures across 642 sovereign and financial reference entities and identify a center of the network consisting of 14 dealers, at which a significant concentration of CDS protection sales is apparent;

- Oh & Patton (2015) develop a dynamic model to analyze CDS spreads on U.S. firms from 2006 to 2012 and find that systemic risks arising from CDS interconnectedness was the highest in 2008 and 2009 and remained above pre-crisis levels from 2010 through 2012;
- Zareei (2015) analyzes single-name CDS data and concludes that firms with less interconnectedness and systemic

importance are more likely to experience credit-related jumps in their CDS spreads and are more likely to fail, whereas firms with greater systemic importance exhibit lower failure rates and bankruptcy probabilities;

- Abbassi, Brownlees, Hans, & Podlich (2016) rely on market-based CDS spreads to measure market- based measures of bank interconnectedness and find a strong relation between CDS-based interconnectedness measures and banks' actual risk exposures in wholesale funding, securities investment, and loan markets;
- Cetina, Paddrik, & Rajan (2016) use CDSs as proxies for the risk in banks' trading books in the annual Comprehensive Capital Analysis and Review ("CCAR") stress tests performed annually by the Federal Reserve; and
- Kanno (2016) employs network measures of systemic risk to examine interconnectedness in CDS markets, and draws the conclusion that the risks of contagious defaults spreading from single-name CDS markets to cash bond, equity, and equity options markets are relatively low.

Sovereign CDSs and Spillover Effects

Much of the academic literature that has analyzed sovereign CDS spreads has focused on the relation between macroeconomic fundamentals, financial market conditions, and sovereign credit risk and the transmission channels for financial and macroeconomic shocks across countries. For example, Ang & Longstaff (2013) undertake a comparative analysis of interconnectedness and systemic sovereign risk within the United States (*i.e.*, across different individual U.S. states and the U.S. Treasury) and within Eurozone countries to investigate whether systemic sovereign risk is based primarily on financial market disruptions or macroeconomic shocks. Their conclusion is that the systemic interconnectedness of sovereign credit risk is driven primarily by the financial sector and not by macroeconomic shocks.

Similarly, De Boyrie & Pavlova (2016) find that spillover effects across emerging market sovereigns are driven primarily by shocks in the financial market sector, but also that the

interconnectedness arises primarily from *global* financial market shocks.

Yet, as the discussions below of the Eurozone sovereign debt crisis and the U.S. financial crisis following the failure of Lehman suggests, inferences about financial versus macroeconomic drivers of interconnectedness often depend significantly on sample-specific variables, such as the market (*i.e.,* financial or real economy) from which the primary original shock emanated, the size and international interconnectedness of a country, and the relative sovereign credit risk of a country. We review the empirical evidence below for both the Eurozone sovereign debt crisis and the U.S. post-Lehman financial crisis, and we conclude the section with a review of the significant articles that empirically examine the interplay between sovereign CDS and foreign exchange markets.

Evidence from the Eurozone Crisis

The Eurozone sovereign debt crisis from 2010 through 2012 provides the basis for most academic studies that have analyzed the CDS-bond basis, and these studies have produced a range of often-disparate results. Broto & Pérez-Quirós (2015) analyzed sovereign CDS spreads for the 10 members of the Organisation for Economic Co-operation and Development ("OECD") and found a significant variation in the co-movement of cross-country CDS spreads during the Eurozone crisis period as compared to non-crisis periods. The authors also find that specific contagion effects in the sovereign CDS market vary on a country by country basis. Dieckmann & Plank (2012), Kalbaska & Gątkowski (2012), Calice, Chen, & Williams (2013), Gündüz & Kaya (2013), Blasques, Koopman, Lucas, & Schaumberg (2014), Doshi, Jacobs, & Zurita (2014), Glover & Richards-Shubik (2014), Huang, Chen, & Shen (2014), and Galariotis, Makrichoriti, & Spyrou (2015) present comparable empirical findings that contagion in sovereign CDS markets varies in both direction and magnitude on a country-specific basis.[103] Antón, Mayordomo, & Rodríguez-Moreno (2015), moreover,

document that sovereign CDS spreads for single-name sovereign CDSs that are most often quoted by a common set of swap dealers tend to exhibit higher correlations.

Caporin, Pelizzon, Ravazzolo, & Rigobon (2013) find that the spillover effects across sovereign CDSs in the Eurozone were not dependent on the size of the underlying shocks.

Although the authors documented a change in the size of the propagation of shocks across Eurozone countries in the 2003-2006 and 2008-2011 periods, the degree to which shocks from one country were transmitted to another actually declined in the post-Lehman period. The authors interpret their results as indicating that post-Lehman transmission mechanisms of shocks across sovereign CDS markets to private bank funding markets were the result of larger shocks and not a series of similar, correlated shocks across multiple countries.

Groba, Lafuente, & Serrano (2013) examine spillover effects from peripheral Eurozone countries to central E.U. members in the period from January 2008 through July 2012. In contrast with the conventional view that shocks were transmitted from central European countries to the periphery, the authors find that shocks were transmitted in the opposite direction, thus indicating a common global shock that propagated through Eurozone sovereign debt markets at an uneven pace. A significant conclusion (in line with Pan & Singleton, 2008) from this study is that a major component of risk premiums on sovereign CDSs is based on market- wide, systematic risks and is not merely a market-based revision of expected country-specific credit risks. (*See* Section IV.B.3.) Dockner, Mayer, & Zechner (2013) and Consiglio, Lotfi, & Zenios (2016) also show that sovereign CDS spreads are driven mainly by global factors, but that country-specific risks still explain some variations in CDS returns (in magnitudes that differ depending on the country).

Significant evidence also suggests that observed co-movements in sovereign credit spreads across different countries were not primarily the result of contagion *within the financial market* but rather were the product of transmissions of country-specific *macroeconomic shocks*. (*See, e.g.,*

Aizenman, Hutchinson, & Jinjarak, 2013; Manasse & Zavalloni, 2013; and Shoesmith, 2014). Using spreads on sovereign CDSs and long-term sovereign debt (as well as ratings for those debt instruments), Beirne & Fratzscher (2013) show that the main explanation for the rise in sovereign debt yields and CDS spreads during the Eurozone crisis was the deterioration of country-specific macroeconomic fundamentals and the transmission of macroeconomic shocks across countries, and was not the result of regional spillover effects or financial market contagion.

Kim, Salem, & Wu (2015) find a similar result by analyzing the impact of macroeconomic news from the U.S., Eurozone countries, and China on sovereign CDS spreads. Not surprisingly, they find that macroeconomic news has a significant impact on sovereign credit spreads. Better than expected news reduces sovereign CDS spreads, and vice versa. News regarding the three major economies that the authors studied also have significant macroeconomic spillover effects on sovereign CDS spreads for other countries.

Yet, the literature is not unambiguous on this issue. For example, Sgherri & Zoli (2009), Caceres, Guzzo, & Segoviano (2010), Revoltella, Mucci, & Mihaljek (2010), Longstaff, Pan, Pedersen, & Singleton (2011), and Heinz & Sun (2014) conclude that spreads on sovereign CDSs during the Eurozone crisis were more the result of global investor sentiment and risk aversion than country-specific macroeconomic problems. Similarly, Aretz & Pope (2013) find that sovereign credit risk reflected in CDS spreads is explained primarily by global and industry risk factors and not country-specific risks.

Lehman Brothers and the Credit Crisis

Sovereign CDS spreads have also been used to analyze the diffusion of the U.S. subprime and global credit crisis through other global financial markets. Dooley & Hutchison (2009) analyzed the spillover effects from the single-name CDSs on distressed institutions during the credit crisis vis-à-vis sovereign CDS spreads for emerging-market economies. The authors conclude that emerging markets were somewhat

insulated from the crisis before the Lehman Brothers failure in 2008, but were infected by the deteriorating situation of the U.S. financial system and global credit markets thereafter (Dooley & Hutchison, 2009). This evidence contradicts the prevalent view before the crisis that emerging markets were well-insulated from adverse financial sector shocks in the rest of the world.

Dumontaux & Pop (2013) rely on single-name CDS and equity market data to examine the spillover effect of the Lehman Brothers failure on to other financial institutions. They provide evidence of significant abnormal jumps in CDS spreads following the collapse of Lehman in September 2008 and conclude that those jumps reflect upward revisions in market participants' assessments of the future credit risks of surviving firms that had characteristics similar to Lehman.

Wang & Moore (2012) studied the extent to which the sovereign CDS markets of 38 developed and emerging countries became integrated with the U.S. market during the credit crisis. Their evidence revealed that the Lehman shock strengthened cross-market integration interaction effects, especially across developed markets. Wang & Moore (2012) attribute the shift in the relations between developed and emerging market economics to the low absolute levels of U.S. interest rates.

Sovereign CDSs and Currency Market Linkages

Carr & Wu (2007) find that sovereign CDS spreads for both Brazil and Mexico are significantly affected by the level of implied volatility and the slope of the implied volatility curve derived from currency options markets. Some studies have investigated the transmission mechanisms between sovereign credit risk and currencies in more detail. For example, Hui & Chung (2011) examine information flows between sovereign CDSs and foreign exchange options for 11 countries in the Eurozone during the European sovereign debt crisis. Employing a methodology similar to the price discovery analyses reviewed in Section VI.A, the authors find that from September 2009 through April 2010, at the height of the

Eurozone sovereign debt crisis, significant and strong flows of information occurred between sovereign debt and foreign exchange markets. In a broader sample from 2006 through 2010, such flows were less pronounced and no clear direction of information transmission could be identified. Hui & Fong (2011) find similar results.

Huang & MacDonald (2014) analyze the relation between sovereign CDS spreads and returns on foreign exchange "carry trades" – *i.e.*, speculative strategies in which investors borrow in a currency with a low interest rate and invest the proceeds of that loan in a higher-yielding currency in order to try and exploit deviations from uncovered interest parity. Although popular with many investors, the seemingly regular and positive excess returns that such trades generate are regarded as an anomaly. (*See, e.g.*, Hansen & Hodrick, 1980, and Fama, 1984). Huang and MacDonald find that sovereign CDS premiums together with a market liquidity risk premium explain over 90 percent of cross-sectional variation in excess returns on carry trades.[3]

De Santis (2015) investigates quanto sovereign CDS spreads (*i.e.*, spreads on sovereign CDSs that incorporate price differences between Euros and U.S. dollars) and finds that sovereign yields of French, Italian, and Spanish sovereign bonds are significantly affected by the perceived risk that those countries could exit the Eurozone and have their debt redenominated in a devalued legacy currency after controlling for exchange rate, global, regional, and liquidity shocks. Like other papers, De Santis (2015) also finds evidence of spillover effects in which shocks to domestic economies arising from foreign redenomination risk are larger than the domestic shocks in some European countries. Pu & Zhang (2012a) also examined the spreads between Euro- and dollar-denominated sovereign CDSs and found a significant increase in those spreads during the European sovereign debt crisis.

[3] Pavlova & De Boyrie (2015) also examined the relation between carry trade returns and sovereign CDS spreads. Because those authors used a multi-name CDS index (i.e., the iTraxx SovX Asia Pacific CDS index), we do not separately summarize that paper here.

Interrelated Sovereign and Banking/Corporate Credit Risks

A number of studies have empirically analyzed the relations between financial distress in a country's banking sector and the sovereign credit risk of the country. Such relations can run both directions causally, especially if sovereign bailouts of banks or the banking sector are associated with the crisis. In that case, such bailouts of a distressed national banking sector can lead to higher costs that can put fiscal pressure on the sovereign, thereby resulting in increased sovereign credit risk. Evidence that bank bailout programs by governments lead to increased sovereign credit risk and sovereign CDS spreads is presented in Attinasi, Checherita, & Nickel (2009), Sgherri & Zoli (2009), Alter & Schüler (2012), Ejsing & Lemke (2011), Mody & Sandri (2011), and Demirgüç-Kunt & Huizinga (2013).

Increased sovereign credit risk also puts pressure on the national banking sector by reducing government bond values (which, all else equal, decline when sovereign credit risk is higher, as shown in Gennaioli, Martin, & Rossi, 2014), reducing the value of future government guarantees, and jeopardizing the sovereign rating assigned to the country by the major rating agencies.[4] Acharya, Drechsler, & Schnabl (2014) describe this as the "sovereign-bank loop."

Based on bank and sovereign CDS spread data from January 2007 through April 2011 for all Eurozone countries (as well as Denmark, Norway, Sweden, Switzerland, and the United Kingdom), Acharya, Drechsler, & Schnabl (2014) report that bank bailouts did in fact shift credit risk from national banks to sovereigns, which caused an increase in sovereign credit risk and CDS spreads. The authors also find that the resulting increase in sovereign credit risk caused an increase in national bank credit risk and bank CDS spreads, even after controlling for common risk factors across banks

[4] As a general rule, a private corporation cannot have a higher credit rating than the country rating. For example, the downgrade of a country from A- to BBB+ would cause the contemporaneous downgrade of A-rated private corporate debt to BBB+.

and bank-specific risk attributes. Alter & Schüler (2012), Alter & Beyer (2013), Billio *et. al.* (2013), Gerlach-Kristen (2013), Battistini, Pagano, & Simonelli (2014), Li & Zinna (2014), Gątarek & Wojtowicz (2015), and Haerri, Morkoetter, & Westerfeld (2015) find similar evidence supporting the sovereign-bank risk loop.

Erce (2015) finds for 10 Eurozone countries that the sovereign risk feeds back more strongly into banking system risk than vice versa. Gross & Kok (2015) study 23 sovereign and 41 bank reference entities in Europe, Japan, and the United States and conclude that credit risk was generally spread from banks to sovereigns in 2008 but that contagion moved in the opposite direction from sovereigns to banks during the Eurozone sovereign debt crisis. Ohno (2013) finds evidence of the sovereign-bank loop within European countries that received bailout funds but does not find significant evidence that those shocks were transmitted to peripheral Eurozone countries not experiencing fiscal crises. Billio *et. al.* (2013) and Gross & Kok (2015) use network and interconnectedness measures like those summarized in Section VII.B to propose a measure of the systemic sovereign-bank loop.

Increased sovereign risk also leads to increased borrowing costs for non-financial corporations (although, unlike banks, the causation appears to be unidirectional). For example, Augustin *et. al.* (2015) analyze the spillover effects following the first Greek bailout announcement on the corporate sector and ascertained that a 10 percent increase in sovereign credit risk led to a 1.1 percent increase in reference entity credit risk. Bedendo & Colla (2015) similarly find that heightened sovereign risk results in higher corporate spreads and borrowing costs with a more pronounced effect for non-financial borrowers that depend directly on government support, firms whose sales are primarily in the domestic market, and firms that are dependent on bank financing. Haerri, Morkoetter, & Westerfeld (2015) report empirical evidence of similar relations.

Avino & Cotter (2014) analyze the information conveyed by both bank and sovereign single-name CDS spreads in the 2004-2013 period for six major European economies from a

price discovery perspective (as discussed in Section IV.C). By examining both the informational efficiency of bank and sovereign CDS spreads and the relative speeds of adjustment in the two markets, the authors conclude that both markets play important price discovery roles. For developed economies that were relatively healthy during the sample period, the authors conclude that bank CDSs were the PPDMs. For distressed economies (*e.g.*, Portugal and Spain), however, sovereign CDS markets tended to be the PPDMs both during the credit crisis and Eurozone sovereign debt crisis.

De Bruyckere, Gerhardt, Schepens, & Vander Vennet (2013) analyze the linkage between bank and sovereign credit risk at a more granular level in the 2007-2012 period. The authors ascertain that banks with relatively less capital, more limited accesses to funding, and a more limited focus on traditional banking activities are more vulnerable to risk spillover effects. The authors also found that the connection between sovereign and banking shocks depends on the nature of government bailout programs vis-à-vis the banking sector.

8 Conclusion

We have summarized in this review the mechanics of single-name CDSs based on corporate and sovereign reference entities, the markets in which they trade, and the documentation and market practices governing the trading of these products. We also have reviewed and summarized over 260 empirical research studies of single-name CDSs concerning the informational content and determinants of CDS spreads, the impacts of single-name CDS availability on lenders and reference entity borrowers, the relations between single-name CDS markets and related debt and equity markets, and the interconnections and systemic issues surrounding single-name CDSs to elucidate the economic benefits and costs of these products.

We considered four major subject areas into which most single-name CDS research can be divided. The summary of our conclusions based on our assessment of the empirical evidence in the academic literature is as follows:

- The informational content and determinants of single-name CDS spreads:
    - Single-name CDS spreads contain valuable information about the probability and severity of

adverse credit events that the underlying reference entity may experience during the life of the CDS contract.
    - Single-name CDS spreads include both expected losses and a risk premium that protection sellers demand to compensate for reference entity-specific and systematic risks (both credit-related and non-credit-related).
    - Single-name CDS spreads are anticipatory and contain information regarding future announcements about the credit risks and financial conditions of the underlying reference entities.
- Implications of single-name CDS trading for lenders and reference entity borrowers:
    - Single-name CDSs enable financial institutions to achieve their desired risk/return profiles and commercial objectives. Little empirical evidence supports the often-voiced belief that banks' usage of single-name CDSs translates into more aggressive and riskier lending decisions.
    - The empirical evidence regarding the impact of bank CDS usage on the ongoing monitoring of their borrowers' credit risks is mixed.
    - Single-name CDSs positively impact the supply of credit to borrowers that are reference entities underlying traded CDSs.
    - The impact of single-name CDSs on the cost of credit to borrowers that are reference entities underlying traded CDSs depends on the characteristics of the borrowers and whether or not the credit spread in their loans is fixed or indexed to borrowers' CDS spreads.
    - The availability of traded single-name CDSs can influence the capital structure and corporate financing decisions of reference entity borrowers.
    - The existence of creditors with hedged exposures to borrowers (so-called "empty creditors") and the amount of hedged credit risk have ambiguous

implications for the bankruptcy decisions of reference entities underlying single-name CDSs.

- Relations between single-name CDS markets and related debt and equity markets:
    - Single-name CDSs are the primary markets for price discovery when compared to corporate bonds and often also lead equity markets in processing new information about underlying reference entities.
    - The introduction of single-name CDS trading has adverse impacts on the liquidity of related debt and equity markets, at least initially.
    - The CDS-bond basis is driven by differences in market liquidity, funding costs, counterparty risk, and the design of the financial products.
- Single-name CDSs, interconnectedness, and systemic risk:
    - Although single-name CDSs on corporate and banking reference entities are a source of interconnectedness and contain information that may be valuable to policy makers in measuring potential systemic risk, no significant empirical evidence indicates that single-name CDSs are inherently de-stabilizing or a major threat to systemic stability.
    - Sovereign CDSs are significant transmission mechanisms for economic shocks but not a proximate cause of those shocks.
    - A "sovereign-bank" loop exists in which the financial condition of the banking sector and sovereign credit risk are interconnected. Single-name CDS spreads for banks and sovereigns provide strong information that government bailout programs of banks significantly intensify this feedback loop.

Appendix

Additional Tables

Table 3. *Single-Name CDS Auctions, 2005 – May 2016*

Reference Name	*Tier*[a]	*Auction Date*
Collins & Aikman Products Co.	SNR	06/14/05
Collins & Aikman Products Co.	SUB	06/23/05
Delta Air Lines Inc.	SNR	10/11/05
Northwest Airlines Inc.	SNR	10/11/05
Delphi Corp.	SNR	11/04/05
Calpine Corp.	SNR	01/17/06
Dana Corp.	SNR	03/31/06
Dura Operating Corp.	SUB	11/28/06
Dura Operating Corp.	SNR	11/28/06
Quebecor World Inc.	SNR	02/19/08
Tembec Industries Inc.	SNR	10/02/08
Federal Home Loan Mortgage Corp.	SNR	10/06/08
Federal Home Loan Mortgage Corp.	SUB	10/06/08
Federal National Mortgage Association	SNR	10/06/08
Federal National Mortgage Association	SUB	10/06/08
Lehman Brothers Holdings Inc.	SNR	10/10/08
Washington Mutual Inc.	SNR	10/23/08
Landsbanki Islands hf.	SUB	11/04/08
Landsbanki Islands hf.	SNR	11/04/08
Glitnir banki hf.	SUB	11/05/08
Glitnir banki hf.	SNR	11/05/08
Kaupthing banki hf.	SUB	11/06/08
Kaupthing banki hf.	SNR	11/06/08
Tribune Company	SNR	01/06/09

Republic of Ecuador[b]	SNR	01/14/09
Equistar Chemicals, LP	SNR	02/03/09
Lyondell Chemical Company	SNR	02/03/09
Millennium America Inc.	SNR	02/03/09
Nortel Networks Corp.	SNR	02/10/09
Nortel Networks Limited	SNR	02/10/09
Smurfit-Stone Container Enterprises Inc.	SNR	02/19/09
Station Casinos Inc.	SNR	03/31/09
Chemtura Corp.	SNR	04/14/09
Great Lakes Chemical Corp.	SNR	04/14/09
The Rouse Company LP	SNR	04/15/09
LyondellBasell Industries AF SCA	SNR	04/16/09
Abitibit-Consolidated Inc.	SNR	04/17/09
Charter Communications Holdings LLC	SNR	04/21/09
Capmark Financial Group Inc.	SNR	04/22/09
Idearc Inc.	SNR	04/23/09
Bowater Inc.	SNR	05/12/09
Syncora Guarantee Inc.	SNR	05/27/09
JSC BTA Bank	SNR	06/10/09
R.H. Donnelley Corp.	SNR	06/11/09
General Motors Corp.	SNR	06/12/09
JSC Alliance Bank	SNR	06/18/09
Visteon Corp.	SNR	06/23/09
Six Flags Inc.	SNR	07/09/09
Lear Corp.	SNR	07/21/09
Bradford & Bingley PLC	SNR	07/30/09
Bradford & Bingley PLC	SUB	07/30/09
Thomson	SNR-B3	10/22/09
Thomson	SNR-B2	10/22/09
Thomson	SNR-B1	10/22/09
CIT Group Inc.	SNR	11/20/09
Thomson	SNR	12/10/09
Hellas Telecomm (Luxembourg) II	SUB	12/15/09
JSC Naftogaz of Ukraine	SNR	12/16/09
Financial Guaranty Insurance Company	SNR	01/07/10
Cemex SAB de CV	SNR	02/18/10
Aiful Corp.	SNR	03/25/10
Japan Airlines Corp.	SNR	04/22/10
Ambac Assurance Corp.	SNR	06/04/10
Truvo Subsidiary Corp.	SNR	07/15/10
Takefuji Corp.	SNR	10/28/10
Anglo Irish Bank	SUB-B3	12/09/10
Anglo Irish Bank	SUB-B2	12/09/10
Anglo Irish Bank	SNR-B3	12/09/10
Anglo Irish Bank	SNR-B2	12/09/10
Anglo Irish Bank	SNR/SUB-B1	12/09/10
Ambac Financial Group	SNR	12/10/10
Anglo Irish Bank (Restructuring)	SNR/SUB	02/02/11
Allied Irish Bks PLC	SNR	06/30/11

Allied Irish Bks PLC	SUB	06/30/11
Bank of Ireland[c]	SNR/SUB-B1	07/28/11
Bank of Ireland[c]	SNR-B2	07/28/11
Bank of Ireland[c]	SNR-B3	07/28/11
Bank of Ireland[c]	SNR-B6	07/28/11
Bank of Ireland[c]	SUB-B2	07/28/11
Bank of Ireland[c]	SUB-B3	07/28/11
Bank of Ireland[c]	SUB-B6	07/28/11
Irish Life and Permanent	SNR-B1	07/29/11
Irish Life and Permanent	SNR-B2	07/29/11
Irish Life and Permanent	SNR-B3	07/29/11
Irish Life and Permanent	SUB-B1	07/29/11
Irish Life and Permanent	SUB-B2	07/29/11
Irish Life and Permanent	SUB-B3	07/29/11
Irish Life and Permanent (Restructuring)	SNR-B1	10/05/11
Irish Life and Permanent (Restructuring)	SNR-B2	10/05/11
Victor Company of Japan	SNR	11/09/11
Dynegy Holdings LLC	SNR	11/29/11
SEAT Paginegialle SPA	SUB	12/09/11
The PMI Group Inc.	SNR	12/13/11
AMR Corp.	SNR	12/15/11
Northern Rock (Asset Management) PLC	SNR-B1	02/02/12
Northern Rock (Asset Management) PLC	SNR/SUB-B2	02/02/12
Eastman Kodak Company	SNR	02/22/12
Hellenic Republic[b]	SNR	03/19/12
Elpida Memory Inc.	SNR	03/22/12
ERC Ireland Finance Limited	SNR	03/29/12
Sino-Forest Corp.	SNR	05/09/12
Houghton Mifflin Harcourt Publishing	SNR	05/30/12
Residential Capital LLC	SNR	06/06/12
Overseas Shipholding Group Inc.	SNR	12/06/12
Edison Mission Energy	SNR	01/16/13
SNS Bank NV	SNR/SUB-B1	04/04/13
SNS Bank NV	SNR/SUB-B6	04/04/13
Bankia SA	SNR/SUB-B1	06/05/13
Bankia SA	SNR/SUB-B2	06/05/13
Bankia SA	SNR/SUB-B3	06/05/13
Bankia SA	SNR/SUB	06/05/13
Urbi, Desarollos Urbanos, SAB de CV	SNR	06/06/13
CODERE Fin Luxembourg SA	SNR	10/09/13
OGX Petroleo e Gas Participacoes SA	SNR	12/04/13
Energy Future Holdings Corp.	SNR	05/21/14
Energy Future Intermediate Holding Co. LLC/EFIH Finance Inc.	SNR	05/21/14
Texas Competitive Electric Holdings Co. LLC	SNR	05/21/14
Argentine Republic[b]	SNR	09/03/14

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Caesars Entertainment Operating Co.	SNR	02/19/15
RadioShack Corp.	SNR	03/05/15
Sabine Oil Gas Corp.	SNR	06/23/15
Alpha Appalachia Hldgs Inc.	SNR	09/17/15
Republic of Ukraine[b]	SNR	10/06/15
Abengoa SA	SNR	01/14/16
Pacific Exploration & Production Corp.	SNR	04/06/16
Peabody Energy Corp.	SNR	05/04/16
Norske Skogindustrier ASA	SNR-B2	06/22/16
Norske Skogindustrier ASA	SNR-B3	06/22/16
Norske Skogindustrier ASA	SNR-B4	06/22/16
Portugal Telecom International Finance BV	SNR	07/21/16
Commonwealth of Puerto Rico[d]	SNR	08/17/16
Grupo Isolux Corsan Finance BV	SNR	08/24/16

Source: Creditex/Markit NOTES: a: "SNR" and "SUB" refer to senior and subordinated obligations of the reference entity, respectively. In cases where the notation includes "Bx" (e.g., B1 or B6), this refers to a basket of obligations deliverable under the CDS. The basket numbers themselves do not have any economic significance – e.g., B1 is not necessarily less risky than B2. b: Italicized reference entities are sovereigns. c: The Governor and Company of the Bank of Ireland. d: The Commonwealth of Puerto Rico is an unincorporated territory of the United States.

Appendix

Table 7. *CDS Data Used in Empirical Studies Reviewed*

Article	Sample Period	Type (#) of CDS Reference Entities[a]	Reference Entity Notes	Region(s) of Reference Entities[b]	CDS Tenor(s) (years)	CDS Data Source(s)
Abbassi, Brownlees, Hans, and Podlich (2016)	1/2006-12/2013	Financial Institutions (13)	Financial Institutions Sample Restricted to Banks	Germany	1, 2, 3, 5, 7, 10	Markit
Abid and Naifar (2006)	5/2000-5/2001	Corporates (73)		Global	N/A	UBS
Acharya and Johnson (2007)	1/2001-10/2004	Corporates (79)		North America	5	CreditTrade
Acharya, Drechsler, and Schnabl (2014)	1/2007-4/2011	Financial Institutions (36), Sovereigns (15)	Financial Institutions Sample Restricted to Banks	Austria, Belgium, Denmark, France, Germany, Great Britain, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland	N/A	Bloomberg, Datastream, Markit
Adler and Song (2010)	1998-1/2006	Sovereigns (16)		Argentina, Brazil, Chile, China, Colombia, Korea, Mexico, Malaysia, Panama, Peru, Philippines, Poland, Russia, Turkey, Venezuela, South Africa	1, 3, 5, 10	JP Morgan
Afonso, Furceri, and Gomes (2012)	1/2003-10/2010	Sovereigns (24)		Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Poland, Portugal, Romania Slovakia, Slovenia, Spain, Sweden, United Kingdom	5	Datastream
Aizenman, Hutchinson, and Jinjarak (2013)	2005-2010	Sovereigns (50)		Global	3, 5, 10	CMA Datavision
Alexopoulou, Andersson, and Georgescu (2009)	1/2004-10/2008	Corporates (29)		Europe	5	Datastream
Almer, Heidorn, and Schmaltz (2008)	1/2001-12/2007	Financial Institutions (58)		Global	0.5, 5	Markit
Alper, Forni, and Gerard (2013)	1/2008-10/2010	Sovereigns (18)		Australia, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden,	5	Markit

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				United Kingdom., U.S.		
Alter and Beyer (2013)	10/2009-7/2012	Sovereigns (11), Financial Institutions (9), Index (4)	Financial Institutions Sample Restricted to Banks, Sovereign Sample includes Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, United Kingdom	5	CMA, Datastream, Bloomberg
Alter and Schüler (2012)	6/2007-5/2010	Sovereigns (7), Financial Institutions (14)	Financial Institutions Sample Restricted to Banks	France, Germany, Italy, Ireland, the Netherlands, Portugal, Spain	5	Datastream
Ammer and Cai (2011)	2/2001-3/2005	Sovereigns (9)		Brazil, China, Colombia, Mexico, Philippines, Russia, Turkey, Uruguay, Venezuela	5	Markit
Andritzky and Singh (2006)	7/2002-1/2003	Sovereigns (1)	Brazil	Latin America	1, 3, 5	Bloomberg, CreditTrade, Datastream, quotes directly provided by traders
Ang and Longstaff (2013)	5/2008-1/2011	Sovereigns (12), States (10)	States include California, Florida, Illinois, Massachusetts, Michigan, Nevada, New Jersey, New York, Ohio, Texas	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, U.S.	1, 2, 3, 4, 5	Bloomberg
Annaert, De Ceuster, Van Roy, and Vespro (2013)	12/2003-9/2010	Financial Institutions (32)	Financial Institutions Sample Restricted to Banks	Europe	5	Datastream
Antón, Mayordomo, and Rodriquez-Moreno (2015)	1/2008-10/2011	Sovereigns (11)	For Robustness Checks: additional non-EMU Sovereign (39)	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain	5	CMA
Arce, Mayordomo, and Peña (2013)	1/2004-2/2012	Sovereigns (11)		Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain	5	CMA
Aretz and Pope (2013)	2006 - 2008	Corporates (N/A)		Global	N/A	Old Mutual Asset Management

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Arora, Gandhi, and Longstaff (2012)	3/2008-1/2009	Corporates (125)	CDX index constituents	North America	5	Bloomberg
Ashcraft and Santos (2009)	Q1/2001-Q2/2005	Corporates (111/152)	111 firms in bond analysis; 152 firms in loan analysis	N/A	5	Markit
Attinasi, Checherita, and Nickel (2009)	7/2007-3/2009	Sovereigns (11), Index (1)	Index Sample consists of the iTraxx Financials Senior	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain	N/A	Bloomberg
Augustin (2012)	1/2004-9/2010	Corporates (177)		U.S.	5	CMA Datavision
Augustin (2013)	1/2001-2/2012	Sovereigns (44)		Global	1, 2, 3, 5, 7, 10	Markit
Augustin (2014)	5/2003-8/2010	Sovereigns (38)		Americas, Europe, Africa, the Middle East and Asia	1, 2, 3, 5, 7, 10	Markit
Augustin, Boustanifar, Breckenfelder, and Schnitzler (2015)	2/2010-6/2010	Corporates (226)		Global	5	CMA Datastream
Aunon-Nerin, Cossin, Hricko, and Huang (2002)	1/2008-2/2000	Corporates (323), Sovereigns (69)		Global		London Interdealer Broker
Avino, Conlon and Cotter (2016)	2004-2012	Financial Institutions (60)	Financial Institutions Sample Includes Banks, Diversified Banks, and Financial Services	Europe	5	Markit
Avino and Cotter (2014)	1/2004-3/2013	Financial Institutions (28), Sovereigns (6)	Financial Institutions Sample Restricted to Banks	Europe	5	CMA, Datastream, Thomson Reuters
Baba and Inada (2009)	4/2004-12/2005	Financial Institutions (4)	Financial Institutions Sample Restricted to Banks	Japan	5	Bloomberg
Badaoui, Cathcart, and El-Jahel (2013)	11/2005-9/2010	Sovereigns (9)		Chile, Korea, Mexico, Colombia, Peru, Brazil, Philippines, Indonesia, Turkey	5	Thomson Reuters
Badaoui, Cathcart, and El-Jahel (2015)	11/2005-9/2010	Sovereigns (3)		Brazil, Turkey, Philippines	1, 3, 5, 7, 10	Thomson Reuters
Bai and Collin-Dufresne (2013)	1/2006-12/2011	Corporates (487)		U.S.	5	Markit
Bao, Pan (2013)	1/2004-9/2010	Corporates (N/A)	Sample Size Varies Each Year; Average of 303 Companies	N/A	5	CMA
Batta (2011)	6/1997 - 5/2004	Corporates (242)		N/A	5	CreditTrade
Battistini, Pagano, and Simonelli (2014)	4/2010-3/2013	Countries (15)		Global	5	Bloomberg
Beber, Brandt,	4/2003-	Countries (10)	Corporate Sample	Europe	3, 5, 7, 10	Lombard Risk

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and Kavajecz (2009)	12/2004		Restricted to Entities in European Union Member States			
Bedendo, Cathcart, El-Jahel, and Evans (2013)	2/2004-1/2010	Corporates (249)		U.S.	5	CMA Datavision
Bedendo and Colla (2015)	1/2008-12/2011	Corporates (118), Sovereigns (8)	Sovereign Sample Includes Belgium, Finland, France, Germany, Italy Netherlands, Portugal, Spain	Europe	5	Markit
Beirne and Fratzscher (2013)	9/2008-9/2011	Sovereigns (31)		Euro area (10), Other Advanced (7), Latin America EME (5), other EME (9)	N/A	Bloomberg
Belke and Gokus (2011)	1/2006-12/2009	Financial Institutions (4)		U.S.	5	CMA, Datastream, Thomson Reuters
Berg and Streitz (2016)	7/2010-7/2012	Sovereigns (57)		Worldwide	N/A	DTCC
Berndt, Douglas, Duffie, Ferguson, and Schranz (2005)	9/2000-8/2003	Corporates (69)		U.S.	5	CIBC
Berndt, Jarrow, and Kang (2007)	7/1999-6/2005	Corporates (1521)	60 CDSs in the study are index products	U.S. (929), Non-U.S. (532)	5	ValuSpread, Lombard Risk
Berndt and Obreja (2010)	1/2003-12/2008	Corporates (150)	Corporate Sample Restricted to Euro-denominated CDSs	Europe	5	Bloomberg
Berndt and Ostrovnaya (2014)	1/2002-11/2006	Corporates (144)	Corporate Sample Includes Companies from 9 Different Industries	U.S.	5	Markit
Bertoni and Lugo (2014)	1/2003-10/2010	Corporates (1429)		N/A	5	CMA, Datastream
Beyhaghi, Massoud, and Saunders (2016)	1/2003-12/2007	Corporates (202)		U.S.	5	Markit
Bhanot and Guo (2012)	6/2008-9/2009	Corporates (35)		U.S.	N/A	Bloomberg
Billio, Getmansky, Gray, Lo, Merton, and Pelizzon (2013)	1/2001-3/2012	Sovereigns (17)		Austria, Belgium, Germany, Spain, France, Greece, Ireland, Italy, Netherland, Portugal, Denmark, Sweden, United Kingdom, Norway, Switzerland, U.S., Japan	5	Bloomberg
Blanco, Brennan, and	1/2001-	Corporates (33)	Corporate Sample	Europe and U.S.	5	CreditTrade and JP

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Marsh (2005)	6/2002		Restricted to Investment-Grade Companies			Morgan
Blasques, Koopman, Lucas, and Schaumburg (2014)	2/2009-5/2014	Sovereigns (9)		Belgium, France, Germany, Ireland, Italy, Netherlands, Portugal, Spain	N/A	Bloomberg
Blau and Roseman (2014)	7/2011-9/2011	Sovereigns (31)		Asia, Europe, U.S.	5	Bloomberg
Bongaerts, De Jong, and Driessen (2011)	1/2004-12/2008	Corporates (595)		U.S.	5	CMA, Datastream
Brandstack (2010)	1/2000 - 6/2009	Corporates (160)	Corporate Sample Restricted to Investment-Grade Companies	U.S.	5	Bloomberg
Broto and Pérez-Quirós (2015)	1/2007-12/2012	Sovereigns (10)		Belgium, France, Germany, Greece, Ireland, Italy, Portugal, Spain, United Kingdom, U.S.	10	CMA, Datastream, Thomson Reuters
Bühler and Trapp (2009)	6/2001-6/2007	Corporates (155)	Corporate Sample Restricted to Euro-denominated CDSs	N/A	5	Bloomberg
Byström (2016)	1/2004-1/2013	Corporates (22)	Corporate Sample Restricted to USD-denominated CDSs	U.S.	1, 5, 10	Datastream
Caceres, Guzzo, and Segoviano (2010)	6/2005-1/2010	Sovereigns (10)		Europe	N/A	Datastream
Calice, Chen, and Williams (2013)	8/2005-10/2010	Sovereigns (10)		Austria, Belgium, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain	5, 10	CMA, Datastream, Thomson Reuters
Calice, Mio, Štěrba, and Vašíček (2015)	9/2007-2/2012	Sovereigns (5)		Spain, Portugal, Ireland, Czech Republic, Poland	5, 10	Bloomberg
Callen, Livnat and Segal (2009)	2002-2005	Corporates (508)	Corporate Sample Restricted to USD-denominated CDSs	N/A	1, 3, 5, 7, 10	Lombard Risk
Cao, Yu, and Zhong (2010)	1/2001-12/2006	Corporates (301)	Corporate Sample Restricted to USD-denominated CDSs	N/A	5	Markit
Caporin, Pelizzon, Ravazzolo, and Rigobon (2013)	11/2008-9/2011	Sovereigns (8)		France, Germany, Greece, Ireland, Italy, Portugal, Spain, United Kingdom	5	Datastream
Carboni and Carboni (2011)	9/2008-9/2010	Sovereigns (18)		Europe (14), Asia-Pacific (3), U.S. (1)	5	CMA, Merrill Lynch
Carr and Wu (2007)	1/2002-3/2005	Sovereigns (2)		Mexico and Brazil	1, 3, 5	Bloomberg
Castellanos, Constantinou, and	1/2007-2/2011	Corporates (20)		U.S.	0.5, 1, 2, 3, 4, 5, 7, 10	HSBC

Appendix

Ng (2015)						
Cetina, Paddrik, and Rajan (2016)	2013-2015	Corporates (3173-4297)	4,297 (as of 11/09/12), 3,651 (as of 10/11/13), and 3,173 (as of 10/3/14)	N/A	N/A	DTCC, Markit
Chakraborty, Chava, and Ganduri (2015)	1994-2012	Corporates (507)		U.S.	N/A	Markit, CMA Datavision, and Bloomberg
Chan-Lau and Kim (2004)	3/2001-5/2003	Sovereigns (8)		Brazil, Bulgaria, Colombia, Mexico, the Philippines, Russia, Turkey, Venezuela	5	CreditTrade, Deutsche Bank
Chen, Cheng, and Liu (2008)	4/2003-5/2004	Corporates (44)		Global	1, 2, 3, 5, 7, 10	JP Morgan
Chen, Cheng, and Wu (2012)	5/2003-10/2007	Corporates (310), Financial Institutions (90)	Number of reference entities reported are averages	N/A	1, 2, 3, 5, 7, 10	Investment Bank
Chen, Cummins, Viswanathan, and Weiss (2013)	2/2002-5/2008	Financial Institutions (33)	Financial Institutions Sample Includes Banks and Insurance Companies	Global	5	Markit
Chen, Fabozzi, and Sverdlove (2010)	2/2000-4/2003	Corporates (584)		U.S.	5	Creditex
Chernov, Gorbenko, and Makarov (2013)	1/2006-12/2011	Auctions (26)		Global	N/A	Creditfixings
Chiaramonte and Casu (2010)	1/2005-3/2009	Financial Institutions (57)	Financial Institutions Sample Restricted to Banks	U.S. (7), Europe (43), Asia (7)	5	Datastream
Choi and Shachar (2014)	7/2007-6/2009	Financial Institutions (35)		U.S.	All	DTCC, Markit
Christensen (2007)	3/2001-6/2005	Corporates (1)	Corporate Sample Limited to Ford Motor Co.	U.S.	1, 3, 5, 7, 10	Markit
Cizel (2013)	1/2003-3/2011	Corporates (169)		U.S.	5	CMA, Thomson Reuters
Colonnello, Efing, and Zucchi (2016)	1/2001-12/2014	Corporates (5770)	Corporate Sample Includes Companies with and without CDS Trading	U.S.	N/A	DTCC, Markit
Conrad, Dittmar, and Hameed (2013)	7/2006-10/2010	Corporates (119)		Global	5	CMA, Bloomberg
Consiglio, Lotfi, and Zenios (2016)	10/2008-3/2016	Sovereigns (N/A)		Europe	5	N/A
Coro, Dufour, and Varotto (2012	1/2006-7/2009	Corporates (135)		Europe	5	GFI Group
Cossin and Lu (2004)	1/2002-7/2003	Corporates (39)		Europe	5	Bloomberg, Morgan Stanley
Coudert and Gex (2010a)	1/2004 - 2/2007	Corporates (226)		U.S. and Europe	5	Bloomberg, Datastream

Appendix

Coudert and Gex (2010b)	2005 - 2009	Corporate (26), Sovereign (1)	CDS Auction Data	Global	N/A	Bloomberg, Creditex, ISDA, Markit
Coudert and Gex (2010d)	6/2004-12/2005	Corporates (120)	Corporate Sample Restricted to Entities in the CDX.NA.IG, iTraxx Europe Main, CDX.NA.HY, iTraxx Europe Crossover	U.S.	5	Bloomberg, Datastream
Coudert and Gex (2013)	1/2007-3/2010	Financial Institutions (17), Sovereigns (18)	Financial Institutions Sample Restricted to Banks	Argentina, Austria, Belgium, Brazil, Denmark, Finland, France, Lithuania, Mexico, the Netherlands, Greece, Ireland, Italy, the Philippines, Poland, Portugal, Spain, Turkey	5	Bloomberg, Datastream
Daniels and Jensen (2005)	2000-2002	Corporates (72)		U.S.	5	JP Morgan
Danis and Gamba (2016)	1994-2013	Sovereigns (N/A)		U.S.	N/A	N/A
Das, Hanouna, and Sarin (2009)	Q3/2001 - Q1/2005	Corporates (230)	Sample Restricted to USD-denominated CDSs and excludes Financial Institutions	N/A	1, 2, 3, 5, 10	Bloomberg
Das, Kalimipalli, and Nayak (2014)	8/2001-12/2008	Corporates (350)		U.S.	5	Bloomberg
De Boyrie and Pavlova (2016)	1/2010-7/2014	Sovereigns (14)		Brazil, Russia, India, China, South Africa, Mexico, Indonesia, South Korea, Turkey, United States, Portugal, Italy, Ireland, Spain	5	Thomson Reuters
De Bruyckere, Gerhardt, Schepens, and Vander Vennet (2013)	2007-2012	Financial Institutions (40), Sovereigns (15)	Financial Institutions Sample Restricted to Banks	Sovereigns are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Norway, Portugal, Spain, Sweden, the Netherlands, United Kingdom	5	Bloomberg, CMA
De Santis (2015)	9/2011-11/2013	Sovereigns (4)		Italy, Spain, France, Germany	3, 5	Thomson Reuters
De Wit (2006)	1/2004-12/2005	Corporates (92), Sovereigns (11)		Global	3, 5, 10	Bloomberg
Delatte, Gex, and López-Villavicencio (2012)	1/2008-7/2010	Sovereigns (10)		Austria, Belgium, Denmark, France, Greece, Ireland, Italy, Netherlands, Portugal, Spain	5	Datastream
Delis and Mylonidis	7/2004-5/2010	Sovereigns (4)		Greece, Italy, Portugal, Spain	10	Bloomberg

(2011)						
Demirgüç-Kunt and Huizinga (2013)	2001-2008	Financial Institutions (62 in CDS Sample and 1045 in Market-to-Book Sample)	Financial Institutions Sample Restricted to Banks	Worldwide	5	Markit
Di Cesare (2006)	8/2001-7/2005	Financial Institutions (42)	Financial Institutions Sample Restricted to Banks	U.S. (11), Europe (27), Japan (4)	5	Bloomberg
Di Cesare and Guazzarotti (2010)	1/2002-3/2009	Corporates (167)		U.S.	5	Bloomberg
Díaz, Groba and Serrano (2010)	6/2006-3/2010	Corporates (85)		Europe	1,3,5	Markit
Dieckmann and Plank (2011)	1/2007-4/2010	Sovereigns (18)		Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, the Netherlands, Poland, Portugal, Slovenia, Spain, Sweden, United Kingdom	10	Markit
Dockner, Mayer, and Zechner (2013)	1/2006-2/2012	Sovereigns (10)		Austria, Belgium, France, Greece, Ireland, Italy, Netherlands, Portugal, Slovakia, Spain	1, 3, 5, 7, 10	Bloomberg and Datastream
Dooley and Hutchinson (2009)	1/2007-2/2009	Sovereigns (14)		Argentina, Brazil, Chile, Colombia, Mexico, China, South Korea, Malaysia, Czech Republic, Poland, Hungary, Russia, South Africa, Turkey	5	N/A
Doshi (2011)	1/2001 - 3/2008	Corporates (46)	Corporate Sample Restricted to USD-denominated CDSs	N/A	3, 5, 7	CRSP & Compustat
Doshi, Ericsson, Jacobs, and Turnbull (2013)	1/2011-12/2010	Corporates (95)	Corporate Sample Restricted to Entities in the DJ.CDX.NA.IG	North America	1, 3, 5, 7, 10	Markit
Doshi, Jacobs, and Zurita (2014)	1/2001-6/2012	Sovereigns (28)		Brazil, Chile, Colombia, Mexico, Peru, Austria, Belgium, Finland, France, Germany, Ireland, Italy, Portugal, Slovenia, Spain, Hong Kong, Japan, Malaysia, Philippines, South Korea, Thailand,	1, 5, 10	Markit

				Czech Republic, Israel, Poland, Russia, South Africa, Turkey, United Kingdom		
Dötz (2007)	1/2004-10/2006	Corporates (36)	Corporate Sample Restricted to Entities in the iTraxx Europe	Europe	5	Bloomberg, Thomson Financial Datastream
Düllmann and Sosinska (2007)	2/2002-6/2005	Financial Institutions (3)	Financial Institutions Sample Restricted to Banks	Germany	3, 5, 10	Bloomberg
Dumontaux and Pop (2013)	1/2008-12/2008	Financial Institutions (85)		U.S.	1, 5, 10	Thomson Reuters
Dunbar (2008)	1/2004 - 8/2006	Corporates (41)	Corporate Sample Restricted to USD-denominated CDSs	U.S.	1, 3, 5, 7, 10	Bloomberg, JP Morgan
Eichengreen, Mody, Nedeljkovic, and Sarno (2012)	7/2002-11/2008	Corporates (45)	Corporate Sample Restricted to Banks and Insurers and USD-denominated CDSs	Global	5	Bloomberg
Eisenthal, Feldhutter, and Vig (2016)	2001-2015	Corporates (43)		U.S.	3, 5, 10, 30	Markit
Ejsing and Lemke (2011)	1/2008 - 6/2009	Corporates (10)		Austria, Belgium, Germany, Spain, France, Greece, Ireland, Italy, the Netherlands, Portugal	5	Datastream
Elkamhi, Jacobs, and Pan (2014)	10/2004-6/2007	Corporates (152)	Corporate Sample Restricted to Entities in the CDX Index	North America	1, 3, 5	Markit
Elkhami, Jacobs, Langlois, and Ornthanalai (2012)	1/2002-3/2008	Corporates (87)	Corporate Sample Restricted to Entities in the CDX Index	North America	5	Markit
Erce (2015)	9/2005-1/2014	Financial Institutions (48), Sovereigns (10)	Financial Institutions Sample Restricted to Banks	Germany, Italy, France, Spain, Ireland, Greece, Portugal, Belgium, Netherlands, Austria	5	Bloomberg, Datastream
Ericsson, Jacobs, and Oviedo (2009)	1/1999-12/2002	Corporates (N/A)		Global	5	CreditTrade
Eyssell, Fung, and Zhang (2013)	1/2001 - 12/2010	Sovereigns (1)	Sovereign Sample Restricted to USD-denominated CDSs	China	5	Markit
Fabozzi, Cheng, and Chen (2007)	2/2000-4/2003	Corporates (562)		Europe, U.S.	1, 2, 3, 4, 5	Creditex
Fender, Hayo, and	4/2002-12/2011	Sovereigns (12)		Bulgaria, Russia, Turkey, Brazil, Colombia, Peru,	5	Markit

Neuenkirch (2012)				Venezuela, China, Malaysia, the Philippines, Thailand, South Africa		
Flannery, Houston, and Partnoy (2010)	1/2006-3/2009	Corporates (302)		North America	5	Markit
Foley-Fisher (2010)	12/2007-3/2010	Sovereigns (10)		Greece, Ireland, Spain, Portugal, Italy, France, Netherlands, Belgium, Finland, Austria	5, 10	Bloomberg, CMA
Fontana (2011)	1/2006-8/2009	Corporates (37)		U.S.	5	Thomson Financial Datastream
Fontana and Scheicher (2010)	1/2006-6/2010	Sovereigns (10)	Sovereign Sample Restricted to USD-denominated CDSs	Austria, Belgium, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain	10	Bloomberg
Forte and Lovreta (2015)	1/2002-12/2008	Corporates (92)	Corporate Sample Excludes Financial Institutions	Europe	5	GFI
Forte and Peña (2009)	9/2001-6/2003	Corporates (17)	Corporate Sample Excludes Financial Institutions	Europe (15), U.S. (2)	5	Banco Santander
Galariotis, Makrichoriti, and Spyrou (2015)	11/2008 - 1/2014	Sovereigns (10)		Germany, Austria, Belgium, France, Greece, Ireland, Italy, Netherlands, Portugal, Spain	5	Bloomberg, Datastream International, DTCC
Galil and Soffer (2011)	1/2002-6/2006	Corporates (N/A)		N/A	5	Markit
Gamba and Saretto (2013)	1/2002-12/2010	Corporates (276)		U.S.	5	Bloomberg
Gârleanu and Pedersen (2011)	9/2005-12/2009	Corporates (N/A)		U.S.	N/A	"A major broker-dealer"
Gątarek and Wojtowicz (2015)	1/2004-6/2014	Sovereigns (16)		Poland, Netherlands, France, Belgium, Denmark, Finland, Sweden, Austria, Switzerland, United Kingdom, Ireland, Italy, Spain, Portugal, Greece, Germany	5	CMA, Datastream, Thomson Reuters
Gerlach-Kristen (2013)	8/2005-8/2012	Financial Institutions (12), Sovereigns (6)	Financial Institutions Sample Restricted to Banks	Sovereigns include Germany, Greece, Ireland, Italy, Portugal, Spain	5	Datastream
Getmansky, Girardi, and Lewis (2014)	1/2012-12/2012	Corporates & Sovereigns (20)	Sample Restricted to Contracts with U.S. Counterparties or Affiliated with U.S.	Global	N/A	DTCC

Appendix

			Entities or U.S. Reference Entities			
Giannikos, Guirguis, and Suen (2013)	1/2005-12/2008	Financial Institutions (39)		U.S.	5	CMA
Giglio (2011)	1/2004 - 6/2010	Financial Institutions (15)	Financial Institutions Sample Restricted to Banks	Europe, U.S.	5	Bloomberg, CMA
Glover and Richards-Shubik (2014)	Q3/2005-Q3/2011	Sovereigns (13)		Europe	5	CMA
González and Naranjo (2014)	7/2002 - 6/2012	Corporates (20)		U.S.(12), Europe(8)	5	Bloomberg, Compustat and official regulatory filings
González, Gil, Agra, and Santomil (2012)	2006-2010	Corporates (134)		Europe	All	Financial Statements
Greatrex (2009a)	1/2001-3/2006	Corporates (333)		U.S.	5	Markit
Greatrex (2009b)	1/2001-4/2006	Corporates (476)		U.S.	5	Markit
Greatrex and Rengifo (2012)	7/2006-12/2009	Corporates (348)		U.S.	5	N/A
Groba, Lafuente, and Serrano (2013)	1/2008 - 7/2012	Sovereigns (14)		Austria, Belgium, Germany, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Denmark, Sweden, United Kingdom	1, 3, 5	Datastream
Gross and Kok (2013)	1/2008-4/2013	Financial Institutions (41), Sovereigns (23)	Financial Institutions Sample Restricted to Banks	Austria, Belgium, Bulgaria, Czech Republic, Germany, Denmark, Spain, France, Greece, Hungary, Ireland, Italy, Japan, Lithuania, Latvia, Netherlands, Poland, Portugal, Sweden, Slovenia, Slovakia, United Kingdom, U.S.	5	N/A
Gündüz and Kaya (2013)	1/2004-10/2011	Sovereign (10)		Austria, Belgium, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain	10	Markit
Gündüz, Nasev, and Trapp (2013)	1/2009 - 6/2011	Corporates (70)		Germany	5	DTCC
Gupta and Sundaram (2015b)	11/2006 - 12/2013	Auctions (73)		U.S.	N/A	Creditex, Markit, DTCC
Gyntelberg, Hördahl, Ters, and Urban (2013)	10/2008-5/2011	Sovereigns (7)		France, Germany, Greece, Ireland, Italy, Portugal, Spain	5, 10	CMA
Haas and Reynolds (2016)	1/2008-12/2013	Corporates (492)		U.S.	5	GFI, Thomson Reuters
Haerri,	1/2009-2011	Companies (107)		Europe	5	Bloomberg

Morkoetter, and Westerfeld (2015)						
Han and Zhou (2011)	8/2002-12/2009	Corporates (695)		North America	1, 2, 3, 5, 7, 10	Markit
Hasan, Liu, and Zhang (2015)	2001-2011	Financial Institutions (161)	Financial Institutions Sample Restricted to Banks	Global	5	Markit
Hassan, Ngene, and Yu (2015)	N/A-11/2013	Sovereigns (7)		Argentina, Brazil, Mexico, Colombia, Philippines, South Africa, Turkey	5	Bloomberg, Datastream, Thomson Reuters
Heinz and Sun (2014)	1/2007-12/2012	Sovereigns (24)		Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovak Republic, Slovenia, Turkey, Ukraine, Greece, Italy, Ireland, Portugal, Spain, Austria, Belgium, France, Germany, Netherlands	5	Bloomberg, Datastream
Helwege, Maurer, Sarkar, and Wang (2009)	1/2005-3/2009	Auctions (43)		U.S.	N/A	ISDA, Creditex, Markit
Hilscher, Pollet, and Wilson (2015)	1/2001-12/2007	Corporates (783)		U.S.	5	Datastream, DTCC, Markit
Hirtle (2009)	Q2/1997-Q4/2006	Financial Institutions (57)	Financial Institutions Sample Restricted to Banks			Call Reports
Houweling and Vorst (2005)	5/1999-1/2001	Corporates/Sovereigns (225)	Corporate Sample Restricted to USD and Euro-denominated CDS; Quotes on Euro denominated CDS are only observed from 3/2000-1/2001	Global	0.08, 0.5, 1, 2, 3, 4, 5, 7, 10	creditex, CreditTrade, and quotes from commercial and investment banks
Huang and Cheng (2013)	1/2004 - 12/2010	Corporates (200)		U.S.	5	Thomson Datastream
Huang and MacDonald (2014)	9/2005 - 1/2013	Sovereigns (26)		Europe	5	Bloomberg, Datastream, Markit, CMA Datavision
Huang, Shen, and Chen (2012)	1/2007-12/2008	Financial Institutions (73)/Corporates (395)		U.S.	5	Thomson Reuters, Datastream
Huang, Shen, and Chen (2014)	9/2005-5/2010	Sovereigns (47)		Global	5	Thomson Reuters, Datastream
Hui and Chung	1/2006 -	Sovereigns (11)		Austria, Belgium, Finland, France,	5	Bloomberg

(2011)	4/2010			Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain		
Hui and Fong (2011)	12/2007 - 8/2011	Sovereigns (N/A)		U.S. & Japan	0.08, 0.25, 5	Bloomberg
Hull, Predescu, and White (2004)	1/1998-5/2002	Corporates (1502), Sovereigns (60), Quasi-Sovereign (37)		North America (798), Europe (451), Asia (330), Other (20)	5	GFI
Imbierowicz and Wahrenburg (2009)	1/2001-12/2007	Corporates (472)		North America (185), Europe (153), Asia (133), Latin America (1)	5	Bloomberg, Datastream
Ismailescu and Phillips (2015)	1/2001-9/2010	Sovereigns (41)		Global	5	Datastream, Markit, Thomson Reuters
Ivanov, Santos, and Vo (2016)	2005-2012	Corporates (62)		N/A	5	Markit
Jacoby, Jiang, and Theocharides (2009)	1/2001-12/2008	Corporates (N/A)	Corporate Sample Restricted to USD-denominated CDSs	U.S.	5	Bloomberg, Markit
Jakovlev (2007)	1/2003 - 12/2006	Corporates (50)	Corporate Sample Excludes Financial Institutions	Europe	5	Datastream
Jankowitsch, Pullirsch, and Veža (2008)	1/2003-1/2005	Corporates (12)		Europe	All	Thomson Reuters
Janus, Jinjarak, and Uruyos (2013)	2010-2011	Sovereigns (50)		Global	5	CMA
Jorion and Zhang (2007)	1/2001-12/2004	Corporates (820)		North America	5	Markit
Jorion and Zhang (2009)	1/2001-12/2005	Corporates (178)	Corporate Sample Restricted to USD-denominated CDSs	North America	5	Markit
Kalbaska and Gątkowski (2012)	8/2005-9/2010	Sovereigns (9)		Portugal, Ireland, Italy, Greece, Spain, France, Germany, United Kingdom, U.S.	5	Datastream
Kallestrup, Lando, and Murgoci (2016)	Q1/2004-Q4/2010	Corporates (33), Sovereigns (17)	Corporate Sample Restricted to USD- or Euro-denominated CDSs	Sovereigns are Austria, Australia, Belgium, Switzerland, Germany, Denmark, Spain, France, United Kingdom, Greece, Ireland, Italy, Japan, the Netherlands, Portugal, Sweden, the United States	5	CMA, Fitch
Kim (2013)	2/2001-3/2008	Corporates (136)		U.S.	5	Markit
Kim, Salem, and Wu (2015)	11/2007-3/2012	Sovereigns (19)		Australia, China, Indonesia, Japan, Korea, France, Germany, Greece, Italy, Portugal, Russia, Spain, South Africa, Turkey,	5	Thomson Reuters

				United Kingdom, Argentina, Brazil, Mexico, U.S.		
King (2009)	1/2008-1/2009	Financial Institutions (28)	Financial Institutions Sample Restricted to Banks	Europe, U.S.	5	Markit
Kolokolova, Lin, and Poon (2015)	1/2001-5/2012	Corporates (356)	Corporate Sample Excludes Financial Institutions	U.S.	1	Markit
Küçük (2010)	1/2004-5/2008	Sovereigns (21)		Emerging Markets	5	CMA
Lando and Mortensen (2005)	7/1999-12/2003	Sovereigns (65), Other (1,425)		Global	1, 3, 5, 7, 10	Lombard Risk Systems Limited
Leccadito, Tunaru, and Urga (2015)	1/2001-11/2006 and 6/2008-3/2013	Corporates (198-207 and 626-647)	Sample Sizes Depend on Methodology and Sample Period	N/A	0.5, 1, 2, 3, 4, 5, 7, 10, 15, 20, 30	Markit
Lehnert and Neske (2006)	8/2000-8/2003	Corporates (100)	Corporate Sample Restricted to entities in the TRAC-X Europe index	Europe	5	JP Morgan
Levy (2009)	1/2000-5/2008	Sovereigns (16)	Sovereign Sample Restricted to entities in the Lehman Brothers MSCI Emerging Market Index	Brazil, Chile, China, Colombia, Malaysia, Mexico, Panama, Peru, Philippine, Poland, Russia, South Africa, South Korea, Turkey, Ukraine, Venezuela	5	Bloomberg
Li and Huang (2011)	1/2004-7/2008	Sovereigns (20)	Sovereign Sample Restricted to USD-denominated CDSs	China, Korea, Czech Republic, Israel, Malaysia, Poland, Hungary, Russia, Mexico, Colombia, Egypt, Morocco, Peru, Brazil, Indonesia, Philippines, Turkey, Venezuela, Argentina, Pakistan	5	Thomson Reuters
Li and Tang (2016)	6/1997-4/2009	Corporates (N/A)	Sample Sizes Depend on Methodology and Sample Period	North America	N/A	CreditTrade, GFI
Li and Zinna (2014)	1/2008-12/2013	Financial Institutions (21)	Financial Institutions Sample Restricted to Banks	Germany, France, Italy, Spain	5	CMA
Li, Zhang, and Kim (2011)	1/2001-12/2008	Corporates (145-288)	Sample Restricted to USD-denominated	N/A	0.5, 1, 2, 3, 5, 7, 10, 15, 20, 30	Markit

Appendix

			CDSs and Sample Size Varies by Period			
Longstaff, Mithal, and Neis (2003)	3/2001-10/2002	Corporates (68)		U.S.	5	Citigroup
Longstaff, Mithal, and Neis (2005)	3/2001-10/2002	Corporates (68)		U.S.	5	Citigroup
Longstaff, Pan, Pedersen, and Singleton (2011)	10/2000-1/2010	Sovereigns (26)		Global	5	Bloomberg
Manasse and Zavalloni (2013)	1/2006-3/2012	Sovereigns (15)		Germany, France, Italy, Spain, Belgium Greece, Portugal, Ireland, Netherland, Austria, Finland, Sweden, Norway, United Kingdom, Northern Ireland, Denmark	N/A	Thomson Reuters
Marsh and Wagner (2012)	1/2004-10/2008	Corporates (193)		U.S.	5	Anonymous Credit-Oriented Hedge Fund
Martin and Roychowdhury (2015)	1/2002-12/2009	Corporates (529)	Corporate Sample Excludes Financial Institutions	U.S.	N/A	CMA
Massa and Zhang (2012)	1/2001-12/2009	Corporates (N/A)	158122 bond-month observations	U.S.	5	Markit
Mayordomo and Peña (2014)	11/2005-4/2011	Corporates (38)	Corporate Sample Excludes Financial Institutions	Europe	1, 2, 3, 4, 5	GFI
Mayordomo, Rodriguez-Moreno, and Peña (2014)	1/2005-3/2012	Corporates (401)	Corporate Sample Excludes Financial Institutions	Global	5	CMA
Meine, Supper, and Weiβ (2015)	1/2004-9/2010	Corporates (228)		U.S.	5	CMA
Micu, Remolona, and Wooldridge (2006)	1/2001-3/2005	Corporates (439)		U.S. (246), Europe (114), Japan (79)	5	Markit
Minton, Stulz, and Williamson (2009)	1/1999-12/2005	Financial Institutions (395)	Financial Institutions Sample Restricted to Banks		All	FR Y-9C filings
Morkoetter, Pleus, and Westerfeld (2012)	9/2004-12/2009	Reference (198)		Europe, North America	5	Bloomberg
Narayanan and Uzmanoglu (2014)	10/2008-12/2012	Corporates (169)		U.S.	All	CMA, DTCC, Markit
Nashikkar, Subrahmanyam, and Mahanti (2011)	7/2002-6/2006	Corporates (1,167)		U.S.	All	CMA, GFI
Ni and Pan (2011)	8/2008-11/2016	Corporates (395)		N/A	N/A	CMA
Nijskens and Wagner (2011)	6/1998-6/2006	Financial Institutions (38)	Financial Institutions Sample	Europe (9), North-America (25), Asia (2), Australia (2)	N/A	US FDIC Call Reports

Appendix

			Restricted to Banks			
Norden (2014)	1/2000-12/2005	Corporates (95)		Europe, U.S.	5	CreditTrade and anonymous European bank
Norden and Weber (2004)	7/1998-12/2002	Corporates (90)		Europe (58), U.S. (24), Asia (8)	5	Anonymous European Bank
Norden and Weber (2009)	7/1998-12/2002	Corporates (58)		Europe (35), U.S. (20), Asia (3)	5	CreditTrade and anonymous European bank
Norden and Weber (2012)	1/2001-12/2008	Financial Institutions (20)	Financial Institutions Sample Restricted to Banks	Europe	5	Bloomberg, CreditTrade
Norden, Buston, and Wagner (2014)	1/1997-12/2009	Financial Institutions (1046)	Financial Institutions Sample Restricted to Banks (918 Banks had CDS Positions)		All	Call Reports
Oehmke and Zawadowski (2016)	10/2008-12/2012	Corporates (123)		U.S.	1-30	DTCC, Markit
Oh and Patton (2015)	1/2006-4/2012	Corporates (100)	Corporate Sample Restricted to Entities in the CDX.NA.IG Series 17		5	Markit
Ohno (2013)	7/2007-10/2011	Financial Institutions (31), Sovereigns (8)		Sovereigns are Belgium, France, Germany, Italy, Ireland, Spain, Portugal Greece	N/A	Markit
O'Kane (2012)	1/2008-9/2011	Sovereigns (7)		Portugal, Ireland, Italy, Greece, Spain, France, Germany	5	Bloomberg
Palmgren and Tamuile (2009)	1989-2007	Corporates (7)		U.S.	1, 3, 5, 7, 10	Research Insight
Pan and Singleton (2008)	3/2001-8/2006	Sovereigns (3)		Mexico, Turkey, Korea	1 ,2, 3, 5, 10	CreditTrade
Pavlova and De Boyrie (2015)	9/2008-8/2013	Sovereigns (10)	Sovereign Sample Restricted to Entities in the Markit iTraxx SovX Asia Pacific Index	Australia, Japan, Thailand, Malaysia, New Zealand, China, Indonesia, Korea, Philippines, Vietnam	5	Datastream
Peltonen, Scheicher, and Vuillemey (2014)	12/30/2011	Financial Institutions (602), Sovereigns (40)		Sovereign Sample Includes 18 G20 Sovereigns and 22 European Sovereigns	5	DTCC
Peristiani and Savino (2011)	2001-2008	Corporates (N/A)		U.S.	N/A	Bloomberg, DTCC, Markit
Pires, Pereira, and Martins (2015)	8/2002-2/2007	Corporates (260)		Europe, U.S.	5	Bloomberg
Pu and Zhang (2012a)	1/2008-12/2010	Sovereigns (10)		Austria, Belgium, Finland, France, Germany, Portugal, Ireland, Italy,	5	Bloomberg

				Greece, Spain		
Pu and Zhang (2012b)	10/2000-4/2011	Sovereigns (54)		Africa, Asia, Europe, Middle East, South America	5	Bloomberg
Pu, Wang, and Wu (2011)	1/2001-12/2007	Corporates (523)	Corporate Sample Restricted to USD-denominated CDSs	U.S.	5	Markit
Qiu and Yu (2012)	2001-2008	Corporates (732)		North America	5	Markit
Raunig and Scheicher (2011)	3/2003-10/2006	Corporations (86)	Corporate Sample Restricted to Entities in the iTraxx Europe and iTraxx Crossover	Europe	N/A	N/A
Remolona, Scatigna, and Wu (2008)	1/2002-5/2006	Sovereigns (24)		Latin America, Central and Eastern Europe, Asia, Middle East, Africa	5	Markit
Revoltella, Mucci, and Mihaljek (2010)	2000-2009	Sovereigns (14)		Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Croatia, Turkey, Serbia, Kazakhstan, Russia	5	Bloomberg
Rodríguez-Moreno and Peña (2013)	1/2004-11/2009	Corporates (33), Index (2)	Corporate Sample Restricted to Banks, Index Sample Includes CDX IG 5y and iTraxx Europe 5y	Western Europe (20), U.S. (13)	5	Datastream, Markit, Thomson Reuters
Salomao (2014)	1/2008-3/2011	Sovereigns (1)		Greece	5	Datastream
Sambalaibat (2014)	1/2004-1/2012	Sovereigns (65)		N/A	5	CMA, DTCC
Santamaría, Biscarri, and Benito (2014)	1/2008-6/2012	Sovereigns (13)		Spain, Portugal, Italy, France, Ireland, United Kingdom., Greece, Germany, Austria, Belgium, Netherlands, Finland, Denmark	5	CMA
Sapriza, Zhao, and Zhou (2009)	10/2000-12/2007	Sovereigns (13)		Argentina, Brazil, Colombia, Mexico, Panama, Peru, Venezuela, Bulgaria, Poland, Russia, Turkey, Ukraine, Philippines	5	Bloomberg
Saretto and Tookes (2013)	2002-2010	Corporates (122)		U.S.	N/A	Bloomberg
Schläfer and Uhrig-Homburg (2014)	1/2001-12/2007	Corporates (17)	Corporate Sample Restricted to USD-denominated	U.S.	5	Markit

Appendix

			CDSs and Excludes Financial Institutions			
Schneider, Sögner, and Veža (2010)	1/2/2001-5/30/2008	Corporates (278)		U.S.	1, 3, 5, 7, 10	Markit
Sgherri and Zoli (2009)	1/2003-3/2009	Sovereigns (11)		Austria, Belgium, Finland, France, Germany, Greece, Italy, Ireland, Netherlands, Portugal, Spain	10	Datastream
Shan, Tang, and Winton (2014)	6/1997 - 4/2009	Corporates (921)		U.S.	N/A	CreditTrade, GFI, Markit
Shan, Tang, and Yan (2014)	6/1997 - 4/2009	Financial Institutions (43)	Financial Institutions Sample Restricted to Banks	U.S.	N/A	FR Y-9C filings, OCC reports
Shao and Yeager (2007)	1/1997-12/2005	Financial Institutions (2,246)	Financial Institutions Sample Restricted to Bank Holding Companies; Maximum Sample Size is Shown	U.S.	All	FR Y-9C filings
Shim and Zhu (2014)	1/2003-6/2009	Corporates (116)		Hong Kong, SAR, Japan, Korea, Malaysia, Singapore	5	Markit
Shivakumar, Urcan, Vasvari, and Zhang (2011)	2001-2008	Corporates (710)		U.S.	5	Markit
Shoesmith (2014)	4/2007-3/2012	Sovereigns (8)		France, Italy, Spain, Netherlands, Belgium, Austria, Finland, Portugal	N/A	Bloomberg
Silva, Vieira, and Vieira (2016)	1/2008-12/2015	Sovereigns (84)		Global	3, 5, 7, 10	Bloomberg, DTCC, Thomson Reuters
Skinner and Townend (2002)	9/1997-2/1999	Sovereigns (29)		Global	N/A	CDS trade tickets
Song (2013)	2006-2008	Financial Institutions (40)	Financial Institutions Sample Restricted to Banks	U.S.	All	FR Y-9C filings
Streitz (2016)	2000-2010	Corporates (327)		U.S.	All	Bloomberg, CMA
Sturm (2013/14)	1/2004-9/2010	Financial Institutions (33)	Financial Institutions Sample Restricted to Banks	Europe	5	CMA
Subrahmanyam, Tang, and Wang (2014)	6/1997-4/2009	Corporates (901)		North America	All	CreditTrade, GFI, Markit
Tang and Yan (2007)	6/1997-3/2006	Corporates (120)	Sample Size is Averaged	U.S.	5	CreditTrade
Tang and Yan (2010)	6/1997-11/2006	Corporates (176)		U.S.	5	CreditTrade, GFI
Trujillo-Ponce, Samaniego-Medina, and Cardone-Riportella (2014)	2002-2009	Corporates (51)	Corporate Sample Restricted to Entities in the FTSEuroFirst 100 Index	France, Germany, Italy, Netherlands, Spain, United Kingdom	All	Markit

Appendix

Trutwein and Schierek (2011)	1/2007-12/2008	Financial Institutions (13)	Financial Institutions Sample Restricted to Banks	U.S.	5	Markit
Trutwein, Ramchander, and Schiereck (2011)	4/2005-3/2008	Corporates (295)		North America	5	Markit
Veronesi and Zingales (2010)	1/2007-10/2008	Financial Institutions (9)	Financial Institutions Sample Restricted to Banks	U.S.	5	Datastream
Wang and Moore (2012)	1/2007-12/2009	Sovereigns (38)		Global	5, 7	Datastream
Yang and Zhou (2013)	1/2007-9/2008	Financial Institutions (43)		U.S., United Kingdom, Germany, Switzerland, France, Italy, Netherlands, Spain, Portugal	5	Bloomberg, CMA
Yeh (2012)	2001-2008	Corporates (N/A)		North America	5	Markit
Zareei (2015)	1/2010-12/2012	Corporates (50)		U.S.	N/A	N/A
Zhang, Zhou, and Zhu (2009)	1/2001-12/2003	Corporates (307)		U.S.	5	Markit
Zhu (2006)	1/1999-12/2002	Financial Institutions (8), Corporates (16)	Financial Institutions Sample Restricted to Banks	U.S. (19), Europe (3), Asia (2)	5	CreditTrade
Zinna (2013)	4/2003-11/2007	Sovereigns (8)		Brazil, Colombia, Malaysia, Mexico, Peru, Philippines, Russia, Turkey	1, 2, 3, 5, 10	JP Morgan

Notes: (a) The numbers in parentheses indicate the numbers of reference entities within a particular sample. For studies which analyze the impact of CDS usage on certain corporations, the numbers in parentheses indicate the numbers of corporations in the respective samples. E.g., for studies which analyze the impact of CDS usage on bank lending behavior, the numbers in parentheses indicate the numbers of banks in the samples.
(b) The numbers in parentheses indicate the numbers of reference entities per region in studies that analyze more than one region.

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Single-Name Credit Default Swaps: A Review of the Empirical Academic Literature

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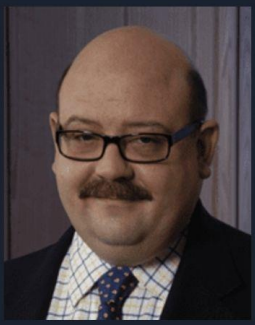
ISBN: 978-625-8190-83-0 (e-Book)
KSP Books 2023



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