

Choi, Jaewon; Shachar, Or

Working Paper

Did liquidity providers become liquidity seekers?

Staff Report, No. 650

Provided in Cooperation with:

Federal Reserve Bank of New York

Suggested Citation: Choi, Jaewon; Shachar, Or (2013) : Did liquidity providers become liquidity seekers?, Staff Report, No. 650, Federal Reserve Bank of New York, New York, NY

This Version is available at:

<https://hdl.handle.net/10419/93653>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Federal Reserve Bank of New York
Staff Reports

Did Liquidity Providers Become Liquidity Seekers?

Jaewon Choi
Or Shachar

Staff Report No. 650
October 2013



This paper presents preliminary findings and is being distributed to economists and other interested readers solely to stimulate discussion and elicit comments. The views expressed in this paper are those of the authors and are not necessarily reflective of views at the Federal Reserve Bank of New York or the Federal Reserve System. Any errors or omissions are the responsibility of the authors.

Did Liquidity Providers Become Liquidity Seekers?

Jaewon Choi and Or Shachar

Federal Reserve Bank of New York Staff Reports, no. 650

October 2013

JEL classification: G12, G01

Abstract

The misalignment between corporate bond and credit default swap (CDS) spreads (i.e., CDS-bond basis) during the 2007-09 financial crisis is often attributed to corporate bond dealers shedding off their inventory, right when liquidity was scarce. This paper documents evidence against this widespread perception. In the months following Lehman's collapse, dealers, including proprietary trading desks in investment banks, provided liquidity in response to the large selling by clients. Corporate bond inventory of dealers rose sharply as a result. Although providing liquidity, limits to arbitrage, possibly in the form of limited capital, obstructed the convergence of the basis. We further show that the unwinding of precrisis "basis trades" by hedge funds is the main driver of the large negative basis. Price drops following Lehman's collapse were concentrated among bonds with available CDS contracts and high activity in basis trades. Overall, our results indicate that hedge funds that serve as alternative liquidity providers at times, not dealers, caused the disruption in the credit market.

Key words: CDS-bond basis, limits to arbitrage, credit default swaps, liquidity, corporate bonds, Volcker rule

Choi: University of Illinois at Urbana-Champaign (e-mail: jaewon.choi@illinois.edu). Shachar: Federal Reserve Bank of New York (e-mail: or.shachar@ny.frb.org). The authors thank Viral Acharya, Itamar Drechsler, Robert Engle, Joel Hasbrouck, and seminar participants at the Early Career Women in Finance Conference 2013 and at the University of Illinois for helpful comments and discussions. They also thank Peter Axilrod, Marisol Collazo, Michael Kopcak, and Gary Kotlyar of the Depository Trust and Clearing Corporation for providing the data and explaining their features. The views expressed in this paper are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

1 Introduction

In the months following Lehman Brothers’ bankruptcy, the previously close relationship between credit default swap (CDS) and corporate bond prices, i.e. the CDS-Bond basis, broke down. Potentially profitable arbitrage opportunities were left unexploited. Many questioned the role of dealers in the corporate bond market (e.g., [Gârleanu and Pedersen, 2011](#), [Augustin, 2012](#), [Fontana, 2011](#), [Duffie, 2010](#), and [Bai and Collin-Dufresne, 2010](#)) as the mispricing widen. Theoretically, such a mispricing should not exist if dealers are able and willing to absorb “immediately” the demand or supply of clients, who rely on the presence of these dealers in the market when they initiate or liquidate a trade. Whether dealers performed their role as liquidity providers in the CDS and corporate bond markets in the crisis is an open empirical question.

Many newspaper articles and academic papers (e.g., [Mitchell and Pulvino, 2012](#)) assert, based on little evidence, that the unwinding of pre-existing arbitrage trades by dealers is one of the main causes for the large negative basis. Lack of data regarding the trading activity in these over-the-counter (OTC) markets poses a challenge for a rigorous empirical analysis of the dealers’ liquidity provision, especially in time of stress. One window into the corporate bond market that aid the argument that dealers did not “lean against the wind” is the aggregate holdings of primary dealers data published by the Federal Reserve Bank of New York. The unloading of dealers’ aggregate inventory in corporate securities¹ (see Figure 1) is taken by various studies, for example, [Bai and Collin-Dufresne \(2010\)](#), as an evidence for the excessive risk-taking of dealers followed by deleveraging, leading to the failure of dealers in liquidity provision.

We tackle this issue in this paper. Employing unique databases for CDS and corporate bond trades, we examine dealers’ concurrent trading in these markets during the 2007-2009 financial crisis when the demand for liquidity is supposedly very high. Specifically, we ask the following questions. Were dealers in the OTC markets seeking liquidity themselves, rather than providing liquidity, and adding to the large deviation in the CDS-bond basis? Did the deleveraging by corporate bond dealers drive

¹The debt securities that must be reported by the primary dealers, include: bonds, notes, debentures; covered bonds; debt issued under the FDIC’s Temporary Liquidity Guarantee Program Debt Guarantee Program; CMOs and REMICs (including residuals) issued by entities other than federal agencies and GSEs, even if the collateral for the CMO or REMIC consists of GNMA pass-through securities, FHLMC participation certificates, or FNMA pass-through securities; stripped securities (both the IO and PO components) issued by entities other than federal agencies and GSEs, even if the securities that have been stripped consist of GNMA pass-through securities, FHLMC participation certificates, or FNMA pass-through securities; commercial paper; and privately placed securities (e.g., 144a securities). In April 3rd 2013, the Federal Reserve Bank of New York started collecting primary dealers’ holdings of non-federal agency and GSE-issued MBS as a distinct asset class instead of in the corporate securities category. If the proportion of these non-federal agency and GSE-issued MBS securities has remained unchanged since the crisis in the primary dealers’ portfolios, it would imply that the “de-leveraging” was less extreme than what emerges from Figure 1.

the large negative basis aftermath of Lehman Brothers’ bankruptcy? Who and what were then driving the negative basis? These questions are important in light of the recent regulatory debate whether the dealers should be given more discretion in liquidity provision.

First, we document a stylized fact that dealers in the corporate bond market were indeed deleveraging at the onset of the financial crisis until the fall of Bear Stearns. However, contrary to the common perception that dealers were unloading bonds following liquidity shocks due to the Lehman Brothers’ collapse, we find that the deleveraging has started to stabilize and dealers actually increased their corporate bond holdings throughout 2008. During the period after the collapse of Lehman Brothers, when corporate bond prices were severely distressed, dealers’ bond inventories sharply increased. This evidence suggests that dealers were providing liquidity when their clients were demanding immediacy, and were performing their role as liquidity providers.

We then formally examine whether dealers provide liquidity in the presence of a mis-pricing between corporate bonds and CDS. Our empirical analysis provides very strong evidence for liquidity provision by corporate bond dealers. Specifically, dealers’ trades are associated negatively with corporate bond price changes, an indication that bond dealers provide immediacy when the other traders need to trade and drive prices away from no-arbitrage pricing. Liquidity provision by corporate bond dealers was the strongest especially after the Lehman Brothers’ collapse, which suggests that given the large negative liquidity shocks following the collapse, clients were desperately dumping bonds in the market and seeking liquidity. Our results contrast with the common notion that dealers dumped their cash bond positions, as suggested by [Mitchell and Pulvino \(2012\)](#) and [Bai and Collin-Dufresne \(2010\)](#). In addition, we find no evidence of liquidity seeking by end-users in the CDS market.

We investigate dealers’ liquidity provision deeper. Although end-users demanded liquidity after the Lehman’s collapse, it is possible that their demand for liquidity was due to a “convergence trade” that aims to close price gaps between CDS and bonds. In our regression analysis, however, we do not find evidence that clients were engaged in such a trading strategy in September 2008. Rather, it seems that clients drove bond prices away from no-arbitrage pricing, especially when the basis was large and negative. Also, the economic magnitudes for liquidity demand by clients are large after the Lehman Brothers’ bankruptcy. A one-standard deviation change in the sell trades by clients is associated with a 12 basis points daily price decrease, which is more than five times of price drops in the Pre-Lehman Brothers periods. These results show a strong demand for immediacy by clients when they sold off bonds following the Lehman collapse.

Although corporate bond dealers provided liquidity, the provision was not without frictions, as evident by the large price changes associated with clients' liquidity demand. Also, we do not find that dealers traded more aggressively to close the price gaps when bond prices fell significantly. The overall evidence is consistent with limits-to-arbitrage (Shleifer and Vishny, 1997). In particular, limited capacity for liquidity provision due to the lack of capital in financial intermediaries, as noted by Duffie (2010). In the CDS market it seems that the liquidity provision by dealers was limited due to congestion of counterparty exposures as proposed by Shachar (2013).

Having documented that dealers were engaged in liquidity provision, we move on to the following question: who and what drove the negative basis. Proprietary trading desks of investment banks are unlikely to be the trigger, since our measure of dealers' trading include those of proprietary trading desks by the same dealer banks. We conjecture that the CDS-bond basis trading by other highly levered traders, i.e. hedge-funds, were the driver behind the basis. As Mitchell and Pulvino (2012) emphasize, the deleveraging of highly levered hedge-funds instigated by the failure in the rehypothecation lending market could be the main reason for liquidity demand in the corporate bond market, following the Lehman Brothers' collapse.

Unwinding of hedge-funds' arbitrage positions can cause massive selling pressure in the corporate bond market. In a so-called negative basis trade, arbitrageurs buy relative cheap cash bonds with funding and hedge the long position with CDS. In the event of simultaneous exits of arbitrageurs due to a sudden deterioration in the funding market, price drops should be much greater among bonds with CDS contracts traded actively (similar to impact of hedge-funds' withdrawals in the equity market as described in Franzone and Plazzi, 2013). Indeed, we find dealers' liquidity provision was concentrated among bonds with CDS contracts, which is suggestive of the unwinding of the basis trades as the driver of the negative basis. Specifically, we find bond returns are 9% lower on average if there are available CDS contracts for the bonds.

We also find that bond prices drop more when the basis is more negative and the bonds are "easier" for basis trading at the end of August 2008, the month before the Lehman Brothers' collapse. We proxy the *easiness* of a basis trade by the maturity of the bonds at that time. Five-year maturity CDS contracts are the most prevalent ones. If the bond maturity is five year at the end of August and the basis is also large and negative, it is more likely that there were more basis arbitrage trading involved with the bond. Following the negative funding shock in September 2008, massive selling of corporate bonds is concentrated for those bonds, which we confirm in our empirical analysis.

Our empirical evidence strongly suggests that the disruption in the cash market is

due to excessive arbitrage trading by hedge-funds that was enabled by the existence of derivative contracts. This reveals a new aspect that the CDS market can impact on the cash market and adds to the growing literature on the impact of CDS on the real economy. For example, [Bolton and Oehmke \(2011\)](#) show the implications of the empty creditor problem when debtors have access to CDS contracts, and [Kim \(2013\)](#) provides some empirical evidence on the ex-ante impact of empty creditors on corporate debt contracting. [Saretto and Tookes \(2013\)](#) show that firms have lower financing costs and can lengthen debt maturity when there are available CDS contracts. [Subrahmanyam et al. \(2012\)](#) show that CDS contracts can exacerbate the credit risk of the reference entity. We add to this literature by providing a novel evidence that the existence of derivative contracts can disrupt the underlying cash market.

Our overall result has an important implication for the Volcker rule that is underway to rein in dealers’ risk-taking in the OTC market. The rule prohibits proprietary trading by banks except for market-making activities. As [Duffie \(2012\)](#) points out, however, once the proposed rule by the regulating agencies – the Office of the comptroller of the Currency, the Board of Governors of the Federal Reserve System, the Federal Deposit Insurance Corporation, and the Securities and Exchange Commission – would be implemented, the capacity of liquidity provision by market-makers will be reduced, and eventually, other institutional investors, including hedge-funds, will fill in the void. This is not a very desirable outcome, because our evidence points out that the unwinding of hedge-funds’ positions can be detrimental to the cash market, and thus to the funding costs of corporations. Since dealers are typically banks and regulated by capital requirements, they can take a better role in providing liquidity. They also have incentives to provide liquidity even in the worst liquidity crisis to maintain their reputation as market-makers.

Our paper is organized as follows. Section [2](#) describes the main datasets and the sample construction. Section [3](#) establishes the stylized fact that although dealers de-levered on aggregate in the period leading to the crisis, the de-levering paused in the period immediately after Lehman’s debacle and dealers actually increased their corporate bond holdings. Section [4](#) examines more formally whether dealers absorbed end-users’ demand and documents evidence for dealers’ liquidity provision throughout the financial crisis. In Section [5](#) we propose an alternative explanation for the existence of the large negative basis in the autumn of 2008. Section [6](#) concludes.

2 Data Description and Variable Constructions

The basis is a by-product of the bond and CDS markets confluence. As such, our analysis requires information about the concurrent activity in these OTC markets. In this section, we first describe the corporate bond and the single-name CDS markets, as well as the datasets that provide us a window into traded prices and quantities. Then, we present the key variables in our analysis, particularly the dealers' flows and the bond-CDS basis.

2.1 The Corporate Bond Data

A complete picture of the trading in the corporate bond market is necessary for understanding the liquidity provision process. To that end, we combine Mergent Fixed Income Dataset (FISD), an enhanced version of Trade Reporting and Compliance Engine (TRACE) dataset, and FISD Bond Purchases and Sales by Insurance Companies.

Mergent FISD provides bond characteristics, and issuance and redemptions information on publicly-traded corporate bond in the US. From that dataset, we obtain the following information: coupon rate, annual payment frequency, issuing date, maturity date, amount outstanding, corporate actions, and rating.

The characteristics of the bond issues are augmented with traded price and quantities. TRACE covers all secondary OTC corporate bond trades in corporate bonds, over 99% of the total volume, with the remainder retail trades on NYSE. All Financial Industry Regulatory Agency (FINRA) members are required to report their transactions within 15 minutes, though 80% are now within 5 minutes. We exploit an enhanced version of TRACE where it specifies whether a trade is between two dealers, or between a customer and a dealer, as well as the customer's trading direction. Moreover, unlike the standard TRACE where trade sizes are capped at \$5,000,000 for investment-grade bonds and \$1,000,000 for speculative-grade bonds, the enhanced dataset includes untruncated positions, information previously not disseminated to the public. These enhanced features allow us to track interdealer and dealer-client flows, and the associated traded prices.

Corrected or cancelled records in TRACE remain in the system, while a new corrected record of the transaction is filed at the same date, or on a later day than that of the actual transaction, hence we eliminate these duplicate entries, reversed and canceled trades, as described in [Dick-Nielsen \(2009\)](#). We also eliminate potential influential outliers in terms of price and/or trade size that deviate from the surrounding reports. These outliers are usually a result of manual errors, where the decimal point was entered incorrectly. Since TRACE does not record position changes driven by

firms' actions, such as, amount called or issue matured, we use the FISD database to incorporate changes driven by issuing firms' actions.

Consistent with the literature, we exclude from our sample bonds with embedded options or special pricing conditions such as convertible, callable or putable bonds, and bonds with sinking funds provisions in order to eliminate pricing impacts from contractual differences. Since we later align the bonds transactions data with the CDS data, and focus on the most liquid 5-year CDS contract, we include only mid-term bonds which have 3-10 remaining years till maturity (i.e. we update the time-to-maturity for each bond every day, and condition on the time left).

The third dataset, FISD Bond Purchases and Sales by Insurance Companies, focuses on the activity of significant players in the US corporate bond market, the insurance companies. Insurance companies are required to report their bond trades to National Association of Insurance Commissioners (NAIC), and the dataset contains actual transactions of insurance companies on more than 79,000 unique issues for almost 8,000 issuers from 1994 onwards. We also exploit the type classification of insurance firms (Health, Life, and Property & Casualty), and in Section 4.3 we zoom into the trades of life insurance firms that hold about 40% of all corporate bonds (Schultz, 2001). We filter out corporate actions, to get a clean measure of the changes in inventory from secondary market trading of insurance firms.

Once we merge these three datasets, we apply several filters. We filter when-issued transactions, trades with commission special sale conditions or special price transactions. We also exclude bonds in the months of issuance or redemption, and bonds with maturity less than one-year.

2.2 The CDS Market Data

Ideally, we would have liked to have a comprehensive databased of CDS transactions as we have for the corporate bond market. However, lack of data on trading activity in the CDS market is the main impediment for studying the CDS market in general, and for exploring the liquidity provision by dealers in this market and across cash/derivatives markets in particular. Hence, our analysis is done in two stages. First, we study a broad sample of CDS contracts using quoted spreads from Markit. Second, we study a smaller sample of US financial firms, which we have their actual CDS transactions.

The main sample of CDS used in this study consists of single-name CDS contract on US reference entities between January 2005 until June 2011. We use end-of-day CDS quotes from Markit Group, a financial data provider, specialized in security and derivatives pricing. Markit gathers end-of-day composite CDS spreads from major dealers, and averages them for each CDS contract after eliminating outliers. The basis

calculation requires the price difference of bonds and CDS on the same underlying company. Therefore, we match each single-name CDS contract to one or more bond issues, depending how many were issued. CDS contracts of subsidiary companies are first matched to their own bond issues if such exists. If not, then they are matched to their parent company. If both the parent and its subsidiary are in the sample, then we exclude the subsidiary. Once the bond and the CDS are matched, we exploit the full term structure of the CDS spreads to evaluate the basis, and we use the associated quoted modified restructuring clause² spread that is matched by maturity to the specific bond.

For a subset of single-name CDS contracts in the main sample we also have a unique and extensive transaction level dataset, provided by the Depository Trust & Clearing Corporation (DTCC), a data depository of swaps transactions. The reference entities of the CDS contracts are all financial firms, and the sample period is between February 2007 and June 2009. The DTCC data is part of its automated Trade Information Warehouse as the electronic central registry for CDS contracts that was established back in November 2006. Since that time, the vast majority of CDS contracts traded have been registered in the Warehouse. In addition, all of the major global CDS dealers have registered in the Warehouse many of the contracts that were executed among each other before that date. We use the transactions to construct CDS positions of dealers and hedge-funds on those financial reference entities. For further details about the dataset see [Shachar \(2013\)](#).

After the merge of TRACE’s prices and quantities, FISD Mergent’s bond characteristics, Markit’s quoted prices, and DTCC’s quantities, we complete the dataset by merging it with equity information from CRSP.

To be included in the sample of the regressions, we require each bond to have corresponding TRACE transactions and CDS quotes. For CDS volume regressions, we further restrict to the sample to financial firms due to the availability of the DTCC volume data. We excluded bonds with option features or floating rate coupons in the basis calculation. Time to maturity should be between 3 and 10 years. There are total of 73 firms with 2,092 bonds available.

2.3 The Key Variables

Three variables stands at the heart of our analysis: the CDS-Bond Basis, the net flow of corporate bonds, and the net flow of CDS contracts.

²We use modified restructuring clause as it was the most commonly traded until April 2009, which is the heart of our sample period and it also minimizes the impact of the cheapest-to-deliver option.

2.3.1 The CDS-Bond Basis

Both corporate bonds and CDS contracts price the underlying company's credit risk. The *basis* measures the pricing differential of credit risk between the two markets. Formally, the bond-CDS basis at time- t is defined as the difference between the CDS premium, $CDS(t)$, and the bond credit spread, $CS(t)$: $Basis(t) = CDS(t) - CS(t)$.

Evaluating this relation in practice requires a choice of an appropriate discount rate and a comparable bond spread measure with CDS spreads. Longstaff et al. (2005) assume that the benchmark risk-free rate is the Treasury rate and find significant differences between CDS spreads and bond yield spreads. Blanco et al. (2005) use the swap rate as the risk-free rate and find CDS spreads to be quite close to bond yield spreads. Houweling and Vorst (2002) show that swap or repo rates are used as the risk-free rate, rather than the Treasury rate. We use general collateral repo rate as the default-free interest rate, as recommended by Duffie (1999).

As for the *comparable* bond spread, there is a variety of metrics for calculating the bond spread. For example, Z-spread, par asset swap spread, and Par-Equivalent CDS Spread (PECS). While Blanco et al. (2005) and Fontana (2011) employ simply use the difference between the CDS price and the credit spread, which is calculated as the difference between the interpolated 5-year yield on the risky bonds and the 5-year swap rate, we follow the PECS methodology (Morgan, 2009), as Bai and Collin-Dufresne (2010).

Specifically, given a term structure of default probabilities and recovery rate, we calculate the implied survival probabilities for a firm. By applying a parallel shift to the survival curve, we use the following equation to match the price of the bond to the expected value of the cash flows:

$$\begin{aligned} \text{Bond Price} = & \text{Coupon} \sum_{i=0}^N (t_i - t_0) S(t_0, t_i) R_f(t_i) + S(t_0, t_N) R_f(t_N) \\ & + \text{Recovery} \sum_{i=0}^N [S(t_0, t_{i-1}) - S(t_0, t_i)] R_f(t_i) \end{aligned}$$

where $(t_i - t_0)$ is the length of time period i in years; $S(t_0, t_i)$ is the probability of survival to time i , at time t_0 ; and, $R_f(t_i)$ is the risk-free discount factor to time i . Once we have matched the bond price, we convert these survival probabilities back into implied CDS spread, which refer to as PECS. The PECS is essentially a bond credit spread consistent with the recovery rate and term structure of default probabilities priced into the CDS market.

To investigate whether the existence of the basis and its magnitude are related to

the possibility of an arbitrage trade (see Section 5), we construct a *proxy basis*, using the CDX.NA.IG and CDX.NA.HY indices, as a counterfactual test for bonds without a matched CDS contract. Each bond is matched to the term-structure implied yield that is extracted either from the CDX.NA.IG or from the CDX.NA.HY, depending on the bond’s rating. We calculate the proxy basis for all bonds in our sample. As a check for the validity of using this proxy, we calculate the correlation between the proxy basis and the “true” basis for the sub-sample of bonds that do have a matched single-name CDS.

2.3.2 Net Flows and Inventory

We construct the net order flow of corporate bond dealers, using the enhanced TRACE with untruncated trade size. Since each transaction identifies whether the reported trade is a buy, a sell, or an interdealer trade, we define the net order flow of bond issue i at day t as:

$$Q(\text{Bond}, i, t) := \sum_{n=1}^{N_t} \text{Buy}(\text{Bond}, i, n) - \text{Sell}(\text{Bond}, i, n) \quad (1)$$

where the buy and sell orders are from the dealers’ perspective, and N_t is the total number of transactions on day t . Using the daily net flow, we then construct the dealers’ inventory at the bond issue level:

$$I(\text{Bond}, i, t) := I(\text{Bond}, i, 0) + \sum_{\tau=0}^t Q(\text{Bond}, i, \tau) \quad (2)$$

where $I(\text{Bond}, i, 0)$ is the initial inventory of bond i before the the existence of the TRACE system.

Similarly, on the CDS market front, we calculate net order flows and inventories of dealers for the sub-sample of financial firms. Unlike the bond transactions, the DTCC transactions do not include identification whether the dealer was the buyer or the seller. Thus, we assume that the clients are the ones that initiate the trade. More formally, we define:

$$Q(\text{CDS}, i, t) := \sum_{n=1}^{N_t} \text{Buy}(\text{CDS}, i, n) - \text{Sell}(\text{CDS}, i, n) \quad (3)$$

$$I(\text{CDS}, i, t) := I(\text{CDS}, i, 0) + \sum_{\tau=0}^t Q(\text{CDS}, i, \tau) \quad (4)$$

where $I(\text{CDS}, i, 0)$ is the initial position of CDS i before it was reported to DTCC.

For a deeper understanding of the players in these OTC markets, we also take advantage of the insurance firms' corporate bond holdings, as well as the insurance firms and hedge-funds' CDS holdings, and we construct their net order flow variables in the same fashion.

2.3.3 Control Variables

Funding liquidity, counterparty risk, and collateral quality are some of the mechanisms that might drive the dynamics of the basis (e.g, [Gârleanu and Pedersen \(2011\)](#), [Bai and Collin-Dufresne, 2010](#), [Fontana, 2011](#), [Augustin, 2012](#)). We do not aim to run a horse race between these possible explanations, but rather to see whether dealers provide liquidity in the face of these frictions. In our empirical analysis we try to control for these alternative stories. The data for the control variables are collected from Bloomberg, CRSP, and Markit.

In a negative basis trade, an arbitrageur should sell the relatively more expensive credit risk, i.e. buy the reference bond and a matching credit protection. To initiate such a trade, an arbitrageur could borrow a fraction of the bond's value, while incurring a haircut. To fund this trade, an arbitrageur would post the bond as collateral on a repo agreement. The repo contract needs to be rolled over as long as the trade has not been closed out. This leg of the trade exposes the arbitrageur to *funding cost risk*. These combined two forces can explain a downward spiral of the basis, when funding constraint becomes binding. Then, basis trades will be unwound and margin calls will increase, consistent with [Gârleanu and Pedersen \(2011\)](#).

To control for the funding cost risk we need to measure the borrowing rate, which can be measured as the Libor-OIS spread, or as the Repo Spread. Libor-OIS spread captures the difference between the average expected cost for unsecured borrowing over the term of the loan in the overnight interbank market and the overnight index swap. The Repo spread captures the difference between the collateralized and uncollateralized interest rates, i.e, as (3-month General Collateral Repo Rate - 3-month Treasury Rate). We use both of these specifications as a proxy of funding illiquidity in our analysis.

To proxy for counterparty risk we construct two indices that are constructed from aggregating stock prices and CDS spreads, respectively, of the primary dealers. The constituents of these indices change over time, depending on them meeting the capital requirements under the Basel Capital Accord, with at least \$100 million of Tier I capital for a bank or above \$50 million of regulatory capital for a broker-dealer. We then calculate the value-weighted return of the index.

In addition to these control variables, we account for market volatility, using the VIX index, and for rating of the bond issue, using S&P and Moody's ratings.

3 Dealers’ Corporate Bond Inventory During the Financial Crisis

It is commonly hypothesized that dealers accumulated highly levered positions during the boom period before the financial crisis (e.g., [Adrian and Shin, 2010](#), [Acharya and Viswanathan, 2011](#), [Acharya and Richardson, 2009](#)). During the credit boom, dealers accumulated net long credit (long in corporate bonds), mainly because of abundant funding liquidity in the market, and hedged the credit exposure typically by going long in CDS markets. This is supported by the aggregate holdings of primary dealers data published by the Federal Reserve Bank of New York [1](#).

This accumulation of corporate bond positions by dealers have been pointed out by many ([Bai and Collin-Dufresne, 2010](#), [Mitchell and Pulvino, 2012](#), and [Fontana, 2011](#)) as one of the key drivers of the large negative basis during the financial crisis. Large negative shocks during the financial crisis, especially the ones caused by the collapse of Lehman Brothers and Bear Stearns, forced levered financial institutions, who are typically dealers in the corporate bond market, to unload long bond positions. Given the initial large long position in the bond market, the unwinding of corporate bonds by dealers might have put a large selling pressure in the market. Since provision of liquidity is important for well-functioning This is especially bad for market liquidity, because it was exactly the period in which many investors were seeking liquidity. If dealers who are supposed to provide liquidity seek liquidity, the liquidity of the market will worsen greatly, which leads to a great price decrease, away from the fundamental values.

Using our database, we document evidence against this widespread perception. The advantage of our database is that we can analyze dealers’ trades for TRACE eligible bonds. The time series of aggregate inventory by corporate bond dealers are plotted in [Figure 2](#). In the beginning of the crisis, we find that corporate bond dealers de-levered, consistent with the deleveraging hypothesis. However, going through the period of the two investment bank failures, dealers start to increase bond inventory. In [Figure 3](#), we plot inventory of AAA and non-AAA investment grade bonds. For non-AAA investment grade bonds, we find a rapid increase in bond holdings by dealers following the Lehman Brothers’ bankruptcy. The plots suggest that bond dealers provided liquidity after the negative liquidity shocks, when market liquidity was the most scarce.

4 Were Dealers Providing Liquidity During the Crisis?

In this section, we examine dealers' liquidity provision more formally. We examine how dealers' net flow in the CDS and bond market affected CDS and Bond price changes and the basis. Liquidity provision will be identified by the reaction of dealers to clients' order flow. An aggressive demand of end-users to sell will lead dealers to revise prices downward. Hence, flows of liquidity providers are expected to be negatively correlated with price changes.

4.1 Baseline Regression

The baseline regressions aim to capture the impact of CDS and bond net flows on their prices changes, and on the basis. We consider the following specifications:

$$\Delta p(\text{CDS}, t) = c_1 + \alpha_1 \text{basis}(t-1) + \beta_1 Q(\text{CDS}, t) + \text{ctrls} + \varepsilon_{1t} \quad (5)$$

$$\Delta p(\text{CS}, t) = c_2 + \alpha_2 \text{basis}(t-1) + \beta_2 Q(\text{Bond}, t) + \text{ctrls} + \varepsilon_{2t} \quad (6)$$

$$\Delta \text{basis}(t) = c_3 + \alpha_3 \text{basis}(t-1) + \beta_3 Q(\text{CDS}, t) + \gamma_3 (-Q(\text{Bond}, t)) + \text{ctrls} + \varepsilon_{3t} \quad (7)$$

where $p(\text{CDS}, t)$ is the CDS spread of an underlying entity i with the closest maturity to the bond; $p(\text{CS}, t)$ is the par-equivalent spreads of a bond issued by the same underlying entity; $\text{basis}(t) (\equiv p(\text{CDS}, t) - p(\text{CS}, t))$ is the difference between the CDS and the par-equivalent bond spreads; $Q(\text{CDS}, t)$ is the CDS net order flow of dealers on day t ; $Q(\text{Bond}, t)$ is corporate bond net order flow of dealers. Note that we sign dealers' bond net order flow as negative. Since bond spreads and prices are negatively related, the negative sign should simplify the interpretation of coefficients. ctrls refers to the mix of control variables that includes changes in Libor-OIS and Repo-Treasury spreads (3 months) for uncollateralized and collateralized funding conditions, respectively; the change in VIX to capture aggregate uncertainty; and, the counterparty indices as detailed in Section 2.3.3.

The first two specifications (5-6) allow us to analyze whether dealers' trades provide or seek liquidity in each market. Positive signs on β_1 and β_2 imply that dealers' buying (selling) pushes prices up (down), which suggests that dealers do not absorb end-users' demand.

The third regression specification, Equation 7, reveals whether dealers provide liquidity when prices deviate from or converge to the *equilibrium*. By equilibrium, we mean relative pricing implied by the no-arbitrage principle between CDS and corporate bonds. By examining basis changes, we can examine whether dealers were acting

differently when prices are off from equilibrium. Also, potentially we can distinguish liquidity-based trading from information-based trading.

The lagged basis on the RHS in each model captures the idea that CDS and bond prices are cointegrated (Blanco et al., 2005). Prices could deviate away from equilibrium, and error correction (or convergence) will depend on how far prices are away from the relative pricing. Even without trading volumes, prices can adjust to the equilibrium level, because dealers will adjust quotes accordingly. This error correction, or the lagged basis term, captures this convergence effect.

To examine dealers' liquidity provision throughout different phases of financial crisis, we divide the sample period into the three sub-periods. The first sub-period, *Crisis 1*, is the first period of the crisis from July 1st 2007 to September 15th 2008 when Lehman Brothers' collapsed. This period marks the beginning of the meltdown of the financial market and includes the collapse of Bear Stearns. The second period, *Crisis 2*, is the period right after the Lehman Brothers' collapse till the basis reached its bottom, as seen from Figure 4. The third period, *Crisis 3*, is the recovery period from February 2009 to June 2009 where the large gaps in basis started to converge. Changes in CDS, PECS, and basis are winsorized at the 0.25% both at the top and bottom, which involves 520 observations out of 104,052.

We first provide statistics on dealer volumes and trades in Table 1. We report averages and standard deviations for the basis, CDS spreads, par-equivalent bond spreads, and dealers' buy and sell quantities in both the bond and CDS markets. We find that the basis patterns across the crisis periods are different between AAA and non-AAA bonds. The average basis is positive for AAA bonds with the basis becoming greater over the course of the financial crisis. In contrast, the basis is negative for non-AAA investment grade and high yield bonds.

On average, bond dealers buy \$3-\$5 million dollars worth of bonds in face value. Corporate bond dealers tend to sell more in periods other than *Crisis 2*, which is consistent with the idea of deleveraging. However, in *Crisis 2* period, buy quantities in non-AAA bonds are bigger than sell quantities, indicating that bond dealers were providing liquidity post-Lehman period.

In Table 2, we report the regression results of (5), (6), and (7) for each sub-period. The results show strong liquidity provision by bond dealers. In the first columns of each panel of the sub-periods, bond dealers trades are always negatively associated with bond price changes. The large negative coefficients on bond trades imply that when liquidity is scarce in the market and bond traders need liquidity, bond dealers tend to provide liquidity. The economic magnitudes are also sizable. During the peak of the financial crisis, one standard deviation change in dealer trades is associated with

6 basis points of bond trades. In the CDS market, the coefficients on CDS quantities do not have large negative coefficients except in *Crisis 3* period, implying that the market is relatively liquid, but when the shock hit, CDS dealers absorbed the demand.

We move on to the next two columns to investigate dealers' liquidity provision activity when prices deviate away from relative values. In other words, we examine how dealers' trading activity covaries with contemporaneous net quantities. We find no indication that CDS trades are associated with basis changes, and thus CDS dealers' trades were not particularly associated with liquidity provision. In the basis regressions, the fourth columns, we find that dealers' trades are not statistically significant in all sub-periods. We can see that bond dealers provide liquidity even when the bond prices fall or rise compared to CDS prices. This indicates that given large changes in bond prices, dealers were important in providing liquidity. A flip side of this result is that end-users in the bond market were driving prices away from the fundamental, or large basis in CDS/bond prices. Overall, the results are inconsistent with the common belief that bond dealers were driving the basis.

4.2 Good vs. Bad Liquidity Seeking

The previous results in Table 2 do not answer in what direction the dealers were providing liquidity to clients. Clients could sell or buy bonds and drive prices away from the relative pricing. For example, when the basis is negative, liquidity-seeking sell orders in bonds will drive bond prices further down, which can be seen as "bad" liquidity seeking. In contrast, if clients buy bonds and drive prices up when the basis negative, this liquidity demand of clients can be viewed as "good" liquidity seeking, because the clients are converging prices back to normal.

To investigate good vs. bad liquidity seeking, we divide the sample into positive and negative basis cases and examine how dealers buy and sell quantities are associated with price changes. Specifically, we investigate the following regression specification, separately for cases where lagged basis $\text{basis}(t-1)$ is positive and negative:

$$\begin{aligned} \Delta \text{basis}(t) = & c_3 + \alpha_3 \text{basis}(t-1) + \beta_1 Q(\text{CDS}, \text{buy}, t) + \beta_2 Q(\text{CDS}, \text{sell}, t) \\ & + \gamma_1 (-Q(\text{Bond}, t)^{\text{buy}}) + \gamma_2 (-Q(\text{CDS}, \text{sell}, t)) + \text{ctrls} + \varepsilon_{3t} \end{aligned} \quad (8)$$

The buy and sell net flows are defined as positive and negative quantities: $q_{i,t}^{\text{buy}} \equiv q_{i,t} 1_{q_{i,t} > 0}$ and $q_{i,t}^{\text{sell}} \equiv q_{i,t} 1_{q_{i,t} < 0}$. Similar to the previous specification, negative signs on the coefficients indicate dealers trade to provide liquidity when clients seek liquidity.

Dividing the sample into the positive and negative basis is helpful in determining whether dealers were trading to reduce price gaps (or basis). To understand, consider

when the lagged basis is negative. In other words, CDS spreads are narrower than bond credit spreads, or bond prices are too low compared to CDS-implied prices. In this case, a negative coefficient on the buy bond quantity means that dealers are buying when clients are already selling cheap bonds. This implies that dealers are providing liquidity exactly when the market needs it the most. Now, suppose the coefficient is positive. In this case, dealers' buy volumes are associated with a bond price increase, which means that bond dealers are trading to tighten the gap between the CDS and bond spreads.

Table 3 provides the results of regression (8). The results show that throughout the financial crisis, bond dealers were providing liquidity, especially when clients were selling bonds and demanding liquidity. For example in *Crisis 2* when basis is negative, dealers' buy volume shows strong liquidity provision with a highly statistically significant coefficient of -12.54 . This indicates that it was the period when clients dumped corporate bonds right after Lehman Brothers' collapse and basis became more negative. This result is consistent with dealers providing liquidity to bad liquidity seeking by clients, because dealers were buying when prices were falling. In comparison, dealers' sell net flow is not associated with strong liquidity provision except for the negative basis case in *Crisis 3* period. In that period, the coefficient on sell net flow is -5.70 and statistically significant at 1% level. This provides only a weak evidence for good liquidity seeking where clients were correcting negative basis by buying bonds aggressively.

CDS dealers show weak evidence for liquidity seeking as well. For example, in *Crisis 3* period when basis is positive, CDS dealers' sell net flow has a coefficient of 5.08 with statistical significance being at the 1% level. These sell trades by dealers narrowed CDS spreads, which might have exacerbated the negative basis.

The results in Table 3 document that bond dealers' liquidity provision was mostly concentrated when clients were selling. Next, we examine whether dealers' liquidity provisions were more active when basis was large. To that end, we interact lagged absolute basis with volumes:

$$\begin{aligned} \Delta \text{basis}(t) = & (\beta_1 + \beta_2 \cdot |\text{basis}(t-1)|) Q(\text{CDS}, \text{buy}, t) + (\beta_3 + \beta_4 \cdot |\text{basis}(t-1)|) Q(\text{CDS}, \text{sell}, t) \\ & + (\gamma_1 + \gamma_2 \cdot |\text{basis}(t-1)|) Q(\text{Bond}, t)^{\text{buy}} + (\gamma_3 + \gamma_4 \cdot |\text{basis}(t-1)|) Q(\text{Bond}, t)^{\text{sell}} \\ & + \alpha_3 \text{basis}(t-1) + c_3 + \varepsilon_t \end{aligned} \quad (9)$$

If liquidity provision is stronger when basis is larger, then we expect the coefficients on the interaction term to be negative. The results are provided in Table 4. The results indicate bond dealers' liquidity provision are stronger when basis is wider. For example, in *Crisis 2* period when the liquidity is supposedly is the most scarce, the coefficient

on the interaction with $|\text{basis}(t - 1)|$ is -18.29 , which is statistically significant at the 1% level.

However, the results also exhibit interesting trading behavior of corporate bond dealers. We find that dealers are seeking liquidity in some cases. The first case is when lagged basis is negative in *Crisis 1*. The coefficient is 54.84, showing that dealers were buying to drive bond prices up. This can be viewed as a price correction by bond dealers when basis is negative (bonds cheap relative to CDS). During *Crisis 1* period when dealers have relatively more flexibility, they even try to tighten the pricing gaps. Another interesting liquidity seeking cases occur during *Crisis 2* and *Crisis 3* when lagged basis is positive, possibly a flight-to-quality by dealers. Remember that positive basis is concentrated among AAA bonds. Dealers were also chasing for these AAA bonds along with other traders. Since AAA bonds were coveted, there was not a strong selling pressure for AAA bonds, and thus even when dealers were buying them prices went up.

To further shed light on this potential flight-to-quality phenomenon, we examine equation (8) across AAA, non-AAA investment grades, and high yields. We report the results in Table 5.

4.3 Liquidity Seeking by Insurance Companies

The results in the previous section demonstrate that, contrary to the common perception, dealers in the corporate bond markets provided liquidity when their counterparties were seeking liquidity. Who are these counterparties who seek liquidity?

Insurance companies, pension companies, mutual funds, and hedge-funds often invest in corporate bonds. Of these players in the corporate bond markets, we investigate the daily trading behavior of insurance companies, using their secondary market trading volumes recorded in the NAIC database. The database classify insurance companies to: life, property & casualty, and health. Figure 5 depicts buy (positive) and sell (negative) flows by insurance companies. At the daily volume level, the trading activity of insurance companies is very volatile. We find some weak evidence for sell-off following the Bear Stearns' and Lehman Brothers' collapses, although not very pronounced.

In Table 6, we formally investigate liquidity demand by insurance companies by estimating Equation (8). We find, in aggregate, that insurance companies are liquidity seekers on average, as reflected by positive coefficients on their sell net flows. Their trades, however, are not associated with price falls in *Crisis 2* in a statistically significant way. This is an indication that insurance companies, along with dealers and proprietary trading by investment banks, did not drive the large negative basis following the Lehman collapse.

5 The CDS Market and the Negative Basis During the Financial Crisis

The results in the previous section show strong liquidity demand by non-dealer corporate bond traders. Still, the results do not answer the question of what drove the basis during the crisis. There have been several studies tackling this question, for example, [Gârleanu and Pedersen \(2011\)](#), [Augustin \(2012\)](#), [Fontana \(2011\)](#), [Duffie \(2010\)](#), and [Bai and Collin-Dufresne \(2010\)](#). Although the conclusions of the papers differ slightly, the common theme is that many factors that might have driven the basis were not able to answer the question completely.

In this section, we propose a new channel that can help explain the large negative basis during the financial crisis. We focus on the role of the CDS-bond arbitrage trading. Specifically, we argue that the large liquidity seeking in the corporate bond market was concentrated among bonds with available CDS contracts. For these bonds, highly levered players in the market, most likely hedge-funds, had to delever their cash positions following Lehman Brothers' collapse, and as a result, corporate bond dealers had to take long credit positions and provide liquidity, as we show in the previous section. Given the massive selling pressure from clients, corporate bond prices with available CDS contracts fall dramatically, although dealers were buying those bonds dumped by CDS-bond basis traders. If the large negative basis is driven mainly by highly levered non-dealer basis traders, we should observe that bond dealers did not have to provide liquidity and bond prices might not have fallen dramatically following the bankruptcy of Lehman Brothers. In [Section 5.1](#) we provide results supporting this hypothesis.

5.1 Dealers' Inventory for Bonds with Available CDS vs. Unavailable CDS

We first show the difference of dealers' holdings of corporate bonds with available CDS and unavailable CDS. The pattern in [Figure 6](#) clearly shows that dealers increased inventory for bonds with available CDS in the period immediately after Lehman Brothers' collapse, which means that clients demanded liquidity only for CDS bonds. This pattern raises the question why did holders of bonds with available CDS seek liquidity, while holders of bonds with unavailable CDS did not?

We hypothesize that the large liquidity demand and also large basis deviation during the financial crisis are the result of pre-crisis, bond-CDS arbitrage activity. Basis arbitrageurs were typically levered players. Their holdings were concentrated among

bonds with available CDS. Given large negative shocks, they had to unlever their cash, or bond positions. This unwinding of arbitrage positions might have driven the large negative basis.

Who would be these levered players demanding liquidity by unwinding the cash bond positions? Our results in the previous section strongly suggest that they are hedge-funds. Typically, highly levered basis arbitrageurs are dealers, proprietary trading desks in investment banks, and hedge-funds. Our measures for dealer trades includes those by prop trading desks, which leaves hedge-funds as the liquidity demanders during the months following the Lehman collapse. [Mitchell and Pulvino \(2012\)](#) demonstrates how hedge-funds demanded liquidity in more detail.

5.2 Bond Price Changes Following Lehman Brothers' Collapse

We examine both bond returns and “proxy basis” changes following the Lehman Brothers' collapse. Supposedly, it was the period when the corporate bond liquidity was the most scarce, which emerged in the form of a large negative basis. The negative shock following the collapse might have driven corporate bond selling differently, based on the availability of CDS contract.

Our measure for CDS availability is based on [Saretto and Tookes \(2013\)](#), who assume that a CDS exists if they find a quote in Bloomberg. In addition, we employ another measure for basis arbitrage activity. If arbitrage activity trigger the sell-off by end-users, the stronger the selling pressure of corporate bonds by end-users, the greater the arbitrage activity is. Therefore, we employ a measure for the easiness to execute basis trading. We use the maturity of the bonds at that time. CDS contracts with a five-year maturity are the most prevalent ones. If the bond maturity is five-year at the end of August and the basis is also large and negative, it is more likely that there were more basis arbitrage trading involved with the bond.

We first plot the price changes of corporate bonds following the Lehman Brothers' collapse for corporate bonds with available CDS and unavailable CDS. [Figure 7](#) shows that bond prices fell dramatically following the Lehman Brothers' collapse. As consistent with our hypothesis, the bond price drop is more drastic for bonds with CDS contracts.

To examine the price changes for bonds, we run the following regression:

$$\text{Ret}(t) = c_1 + \beta_1 \text{CDS}^{\text{exists}} + \beta_2 \text{basis}(\text{Aug}) \text{Mat5Y}(\text{Aug}) + \text{Controls} + \varepsilon_t \quad (10)$$

where $\text{Ret}(t)$ is monthly bond returns constructed from TRACE; $\text{CDS}^{\text{exists}}$ is a dummy variable that equals 1 if the bond has a CDS contract with a quote in Markit, and 0 otherwise; and $\text{basis}(\text{Aug})\text{Mat5Y}(\text{Aug})$ is the basis level at the end of August of 2008 times an indicator variable that takes the value of 1 if the bond’s maturity at the end of August of 2008 is in the range of 4.5 to 5.5 years. For a dependent variable, we also include the proxy basis calculated using CDS indices of corresponding ratings. We run the regression for the period from September 2008 to October 2008, since it is the period when bond prices experienced severe selling pressure following the Lehman Brothers’ default.

Table 7 details the regression results. Consistent with our hypothesis that the unwinding of basis trading caused severe negative basis following the Lehman Brothers’ collapse, we find that bonds with available CDS contracts experience much lower returns in September and October of 2008. Specifically, we find that bond monthly returns are 9% lower if the bond has available CDS contracts (see first column of Table 7). The coefficient is statistically significant at the 1% confidence level, and the economic magnitude is substantial.

Furthermore, we find positive and highly statistically significant coefficient for the interaction term $\text{basis}(\text{Aug})\text{Mat5Y}(\text{Aug})$, which also strongly support our hypothesis. The coefficient implies that bond returns are lower if the bonds’ maturity is close to five years at the end of August 2008 and they have more negative basis, in which case there are supposedly active basis arbitrageurs right before the Lehman Brothers’ default. Given the negative shock at the default, there might have been dramatic unwinding of basis trading, which could have caused massive selling in corporate bonds. We find similar results when proxy basis is used as the dependent variable. Overall, the results support the hypothesis that unwinding of basis trading caused big negative basis during the financial crisis.

6 Conclusions

In this paper we attempt to gain better understanding of the relation between the trading activity and the disruptions in the CDS and corporate bond markets. We use corporate bond and CDS transactions datasets to construct the position of dealers in both markets over time, and the position of hedge-funds in the CDS market. We focus on the additional effect of dealers’ and hedge-funds’ positions to explain the pricing deviations beyond funding costs, counterparty risk, and market illiquidity. By examining dealers, who are expected to provide liquidity and be responsive to demand / supply pressures, and hedge-funds, who usually involved in the basis arbitrage, we

distinguish who of these two “suspects” affected the basis, either by not providing liquidity, or by not engaging in the arbitrage trade.

Given the ongoing debate about the possible effects of the underway regulations in the corporate bond market and the CDS market that are aimed towards more investor-to-investor trading, it is key to understand the building blocks of trading at times when the trading mechanism seems to be naturally evolved and the corresponding frictions of this mechanism.

The combined dataset of bonds and CDS positions at the firm level also opens the door for investigation of other research questions about the feedback between the two markets. For example, settlement and CDS auctions, the empty credit problem, naked versus covered trading, bankruptcy outcomes, etc.

References

- Acharya, V. V. and M. Richardson (2009). Prologue: A Bird’s-Eye View: The Financial Crisis of 2007–2009: Causes and Remedies. In *Restoring Financial Stability*, pp. 1–56.
- Acharya, V. V. and S. Viswanathan (2011). Leverage, Moral Hazard, and Liquidity. *The Journal of Finance* 66(1), 99–138.
- Adrian, T. and H. S. Shin (2010). Liquidity and Leverage. *Journal of Financial Intermediation* 19(3), 418–437.
- Augustin, P. (2012). Squeezed Everywhere: Can We Learn Something New From the CDS-Bond Basis? *Working Paper*.
- Bai, J. and P. Collin-Dufresne (2010, November). The Determinants of the CDS-Bond Basis During the Financial Crisis of 2007-2009.
- Blanco, R., S. Brennan, and I. W. Marsh (2005). An Empirical Analysis of the Dynamic Relation between Investment-Grade Bonds and Credit Default Swaps. *The Journal of Finance* 60(5), 2255–2281.
- Bolton, P. and M. Oehmke (2011). Credit Default Swaps and the Empty Creditor Problem. *Review of Financial Studies* 24(8), 2617–2655.
- Dick-Nielsen, J. (2009). Liquidity Biases in TRACE. *The Journal of Fixed Income* 19(2), 43–55.
- Duffie, D. (1999, January). Credit Swap Valuation. *Financial Analysts Journal* 55(1), 73–86.
- Duffie, D. (2010). Presidential Address: Asset Price Dynamics with Slow-Moving Capital. *The Journal of Finance* 65(4), 1237–1267.
- Duffie, D. (2012). Market Making Under the Proposed Volcker Rule. *Rock Center for Corporate Governance at Stanford University Working Paper* (106).
- Fontana, A. (2011). The Negative CDS-Bond Basis and Convergence Trading during the 2007/09 Financial Crisis. *Working Paper*.
- Franzone, F. and A. Plazzi (2013, July). Do Hedge Funds Provide Liquidity? Evidence From Their Trades. *Working Paper*.
- Gârleanu, N. and L. H. Pedersen (2011). Margin-based Asset Pricing and Deviations from the Law of One Price. *Review of Financial Studies* 24(6), 1980–2022.

- Houweling, P. and A. C. F. Vorst (2002). An empirical comparison of default swap pricing models. Technical report, Erasmus Research Institute of Management (ERIM).
- Kim, G. H. (2013, March). Credit Default Swaps, Strategic Default, and the Cost of Corporate Debt. *Working Paper, University of Warwick*.
- Longstaff, F. A., S. Mithal, and E. Neis (2005). Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit Default Swap Market. *The Journal of Finance* 60(5), 2213–2253.
- Mitchell, M. and T. Pulvino (2012). Arbitrage Crashes and the Speed of Capital. *Journal of Financial Economics* 104(3), 469–490.
- Morgan, J. P. (2009, February). Bond-CDS Basis Handbook. *Europe Credit Derivatives Research*.
- Saretto, A. and H. E. Tookes (2013). Corporate Leverage, Debt Maturity, and Credit Supply: The Role of Credit Default Swaps. *Review of Financial Studies* 26(5), 1190–1247.
- Schultz, P. (2001). Corporate Bond Trading Costs: A Peek Behind the Curtain. *The Journal of Finance* 56(2), 677–698.
- Shachar, O. (2013, August). Exposing The Exposed: Intermediation Capacity in the CDS Market. *Working Paper*.
- Shleifer, A. and R. Vishny (1997). The Limits of Arbitrage. *Journal of Finance* 52(1), 28–55.
- Subrahmanyam, M. G., T. D. Yongjun, and S. Q. Wang (2012). Does the Tail Wag the Dog? The Effect of Credit Default Swaps on Credit Risk. *Working Paper*.

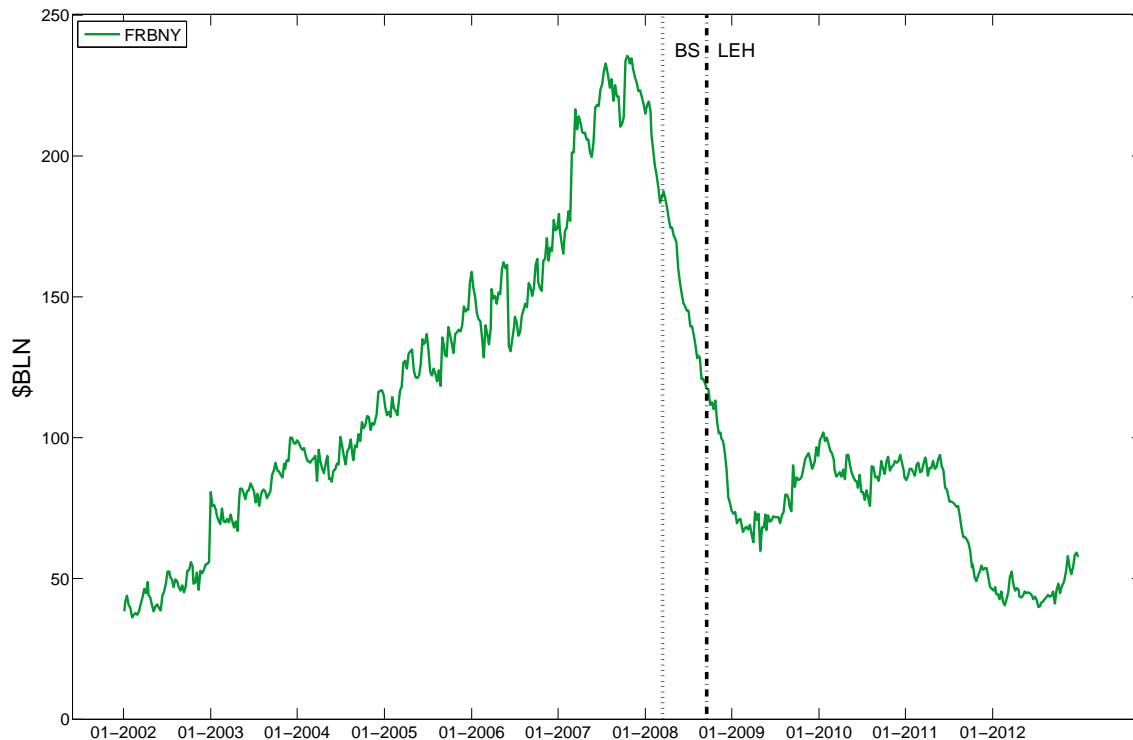


Figure 1: Aggregate Long-Term Corporate Securities Position of Primary Dealers

This figure shows primary dealers' aggregate position in long-term (i.e. with maturity greater than 1-year) corporate securities as reported in the Federal Reserve Bank of New York weekly survey. The debt securities that must be reported by the primary dealers, include: bonds, notes, debentures; covered bonds; debt issued under the FDIC's Temporary Liquidity Guarantee Program Debt Guarantee Program; CMOs and REMICs (including residuals) issued by entities other than federal agencies and GSEs, even if the collateral for the CMO or REMIC consists of GNMA pass-through securities, FHLMC participation certificates, or FNMA pass-through securities; stripped securities (both the IO and PO components) issued by entities other than federal agencies and GSEs, even if the securities that have been stripped consist of GNMA pass-through securities, FHLMC participation certificates, or FNMA pass-through securities; commercial paper; and privately placed securities (e.g., 144a securities). In April 3rd 2013, the Federal Reserve Bank of New York started collecting primary dealers' holdings of non-federal agency and GSE-issued MBS as a distinct asset class instead of in the corporate securities category. If the proportion of these non-federal agency and GSE-issued MBS securities has remained unchanged since the crisis in the primary dealers' portfolios, it would imply that the "de-leveraging" was less extreme than the magnitude in this figure.



Figure 2: Aggregate Corporate Bond Position

This figure plots FINRA member dealers' aggregate position in corporate bonds with maturity greater than 1-year as constructed from trades that are reported in TRACE. The pattern over time should contrast with Figure 1, while keeping in mind that the universe of dealers and the universe of securities underlying these figures are different. Figure 1 is based on primary dealers who report on their corporate securities, including corporate bonds, whereas Figure 2 is based on dealers who are FINRA members and include only corporate bonds.

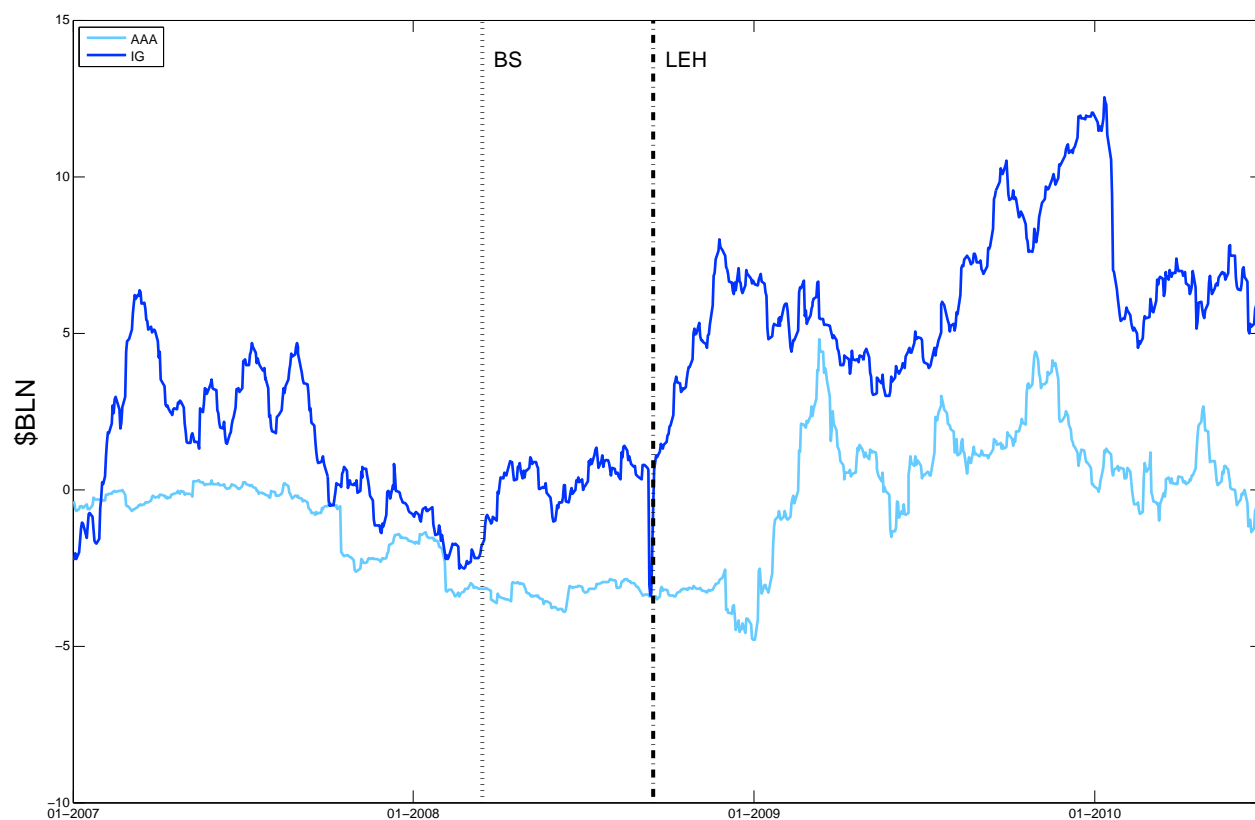


Figure 3: Dealers' Bond Inventory Across Ratings

The aggregate position in corporate bonds with maturity greater than 1-year of dealers as constructed trades reported TRACE is decomposed in this figure based on ratings . Dealers' inventory of AAA corporate bonds is in light blue, and dealers' inventory of non-AAA investment grade corporate bonds is in dark blue. We focus on investment grade corporate bonds in this figure as they are regarded as safe-haven at times of upheaval.

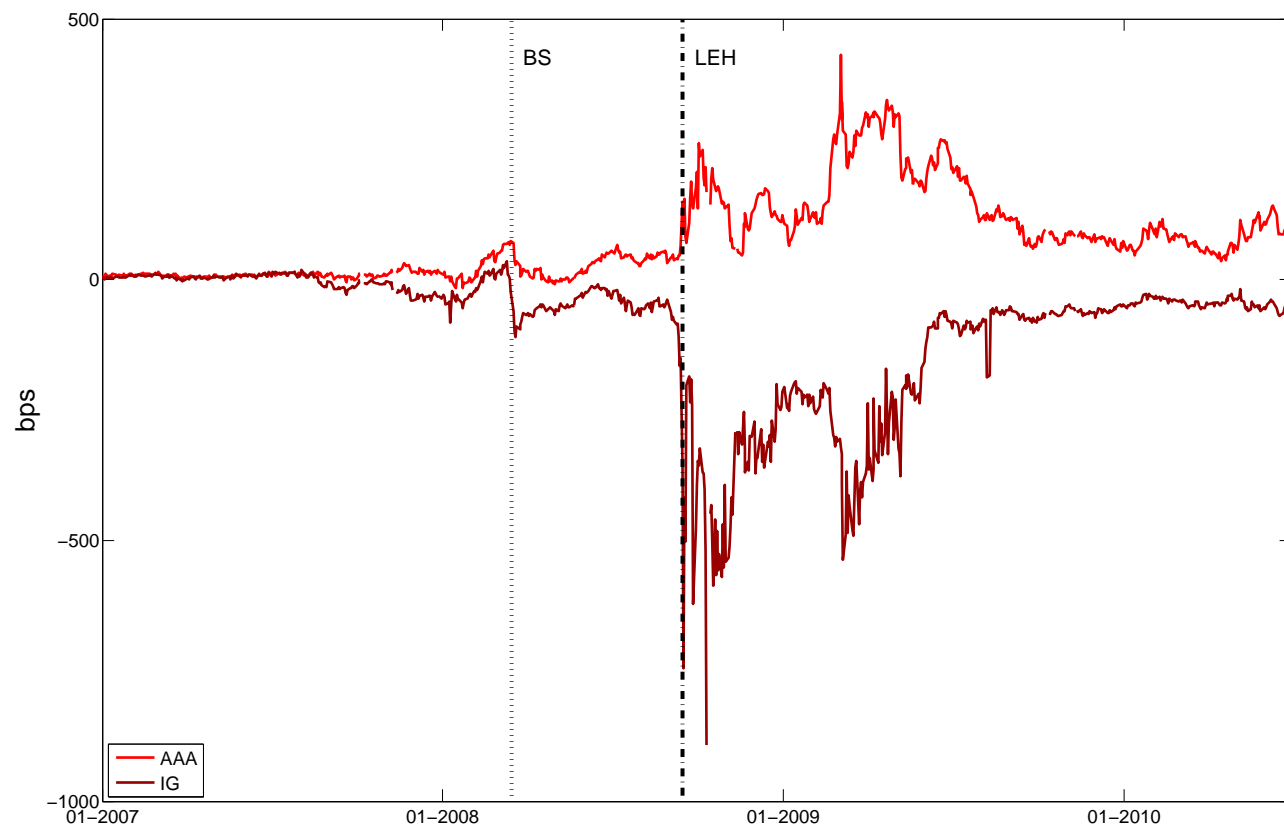


Figure 4: CDS-Corporate Bond Basis

This figure depicts CDS-Corporate bond basis for AAA and non-AAA investment grade bonds. We focus on investment grade corporate bonds in this figure as they are regarded as safe-haven at times of upheaval.

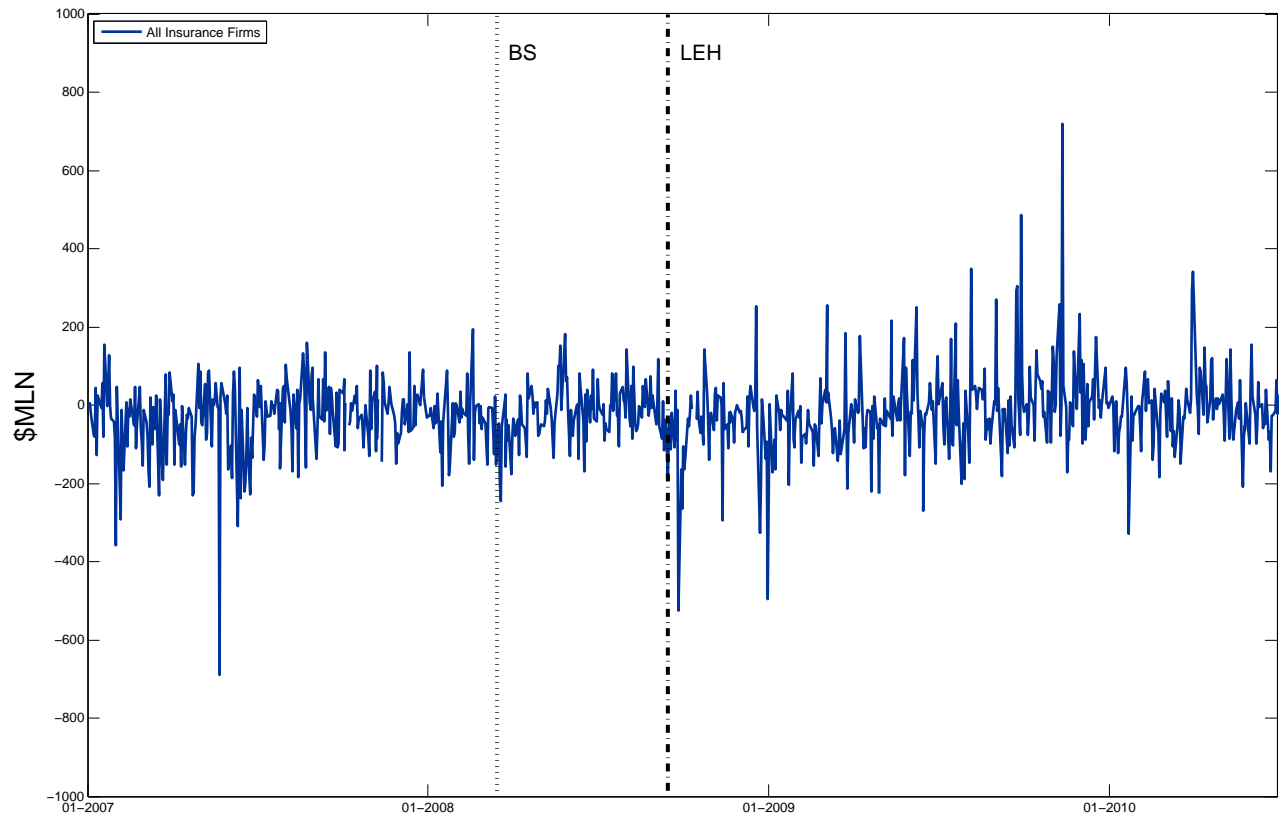


Figure 5: Flows by Insurance Companies

This figure shows aggregate corporate bond daily net flows by US insurance companies, as reported to National Association of Insurance Commissioners (NAIC). Insurance companies are required to report their bond trades to NAIC, and the dataset contains actual transactions of insurance companies on more than 79,000 unique issues for almost 8,000 issuers from 1994 onwards.

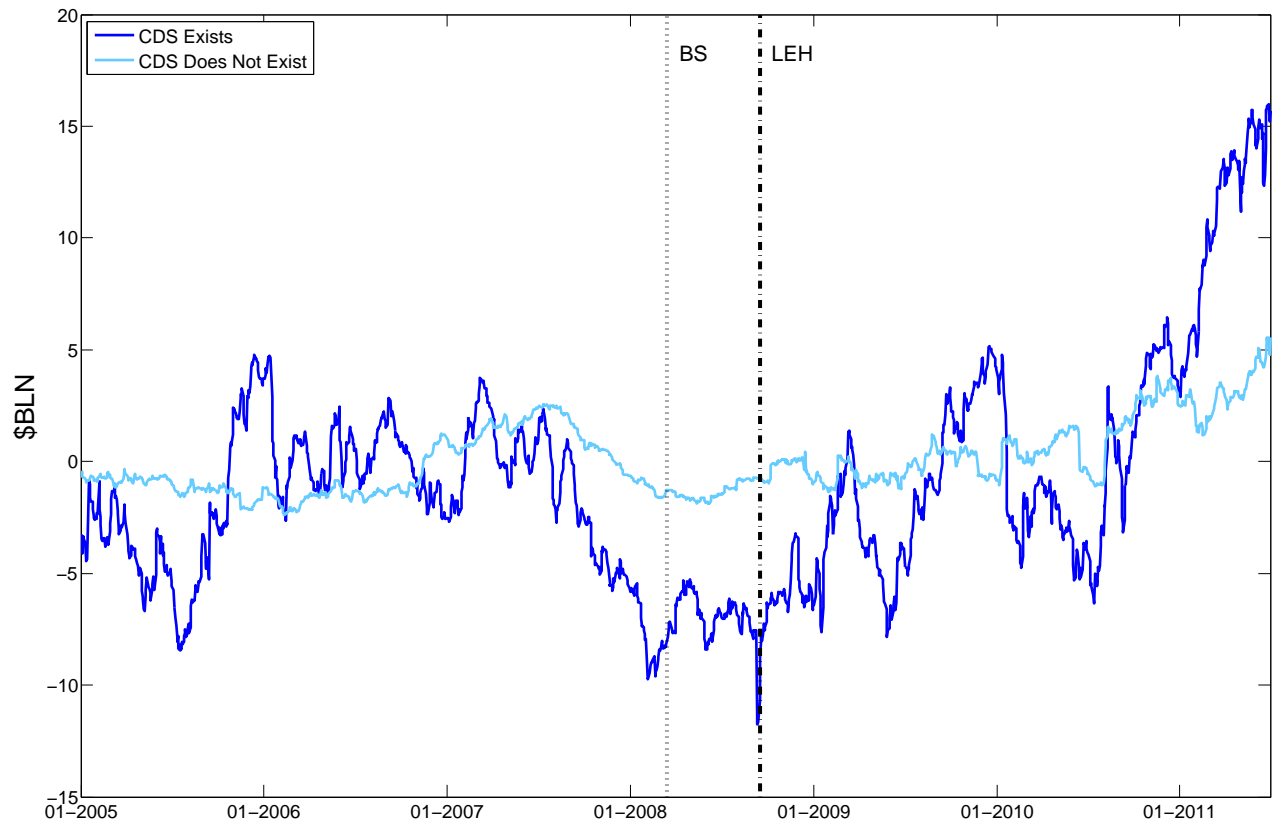


Figure 6: Inventory of Corporate Bonds With Available CDS vs. Corporate Bond Without Available CDS

This figure shows the aggregate inventory of corporate bonds held by dealers, who report their trades in TRACE. The figure contrasts the inventory of corporate bonds with available CDS and the inventory of corporate bonds without available CDS. The availability of a CDS is determined by the existence of a quote in Markit.

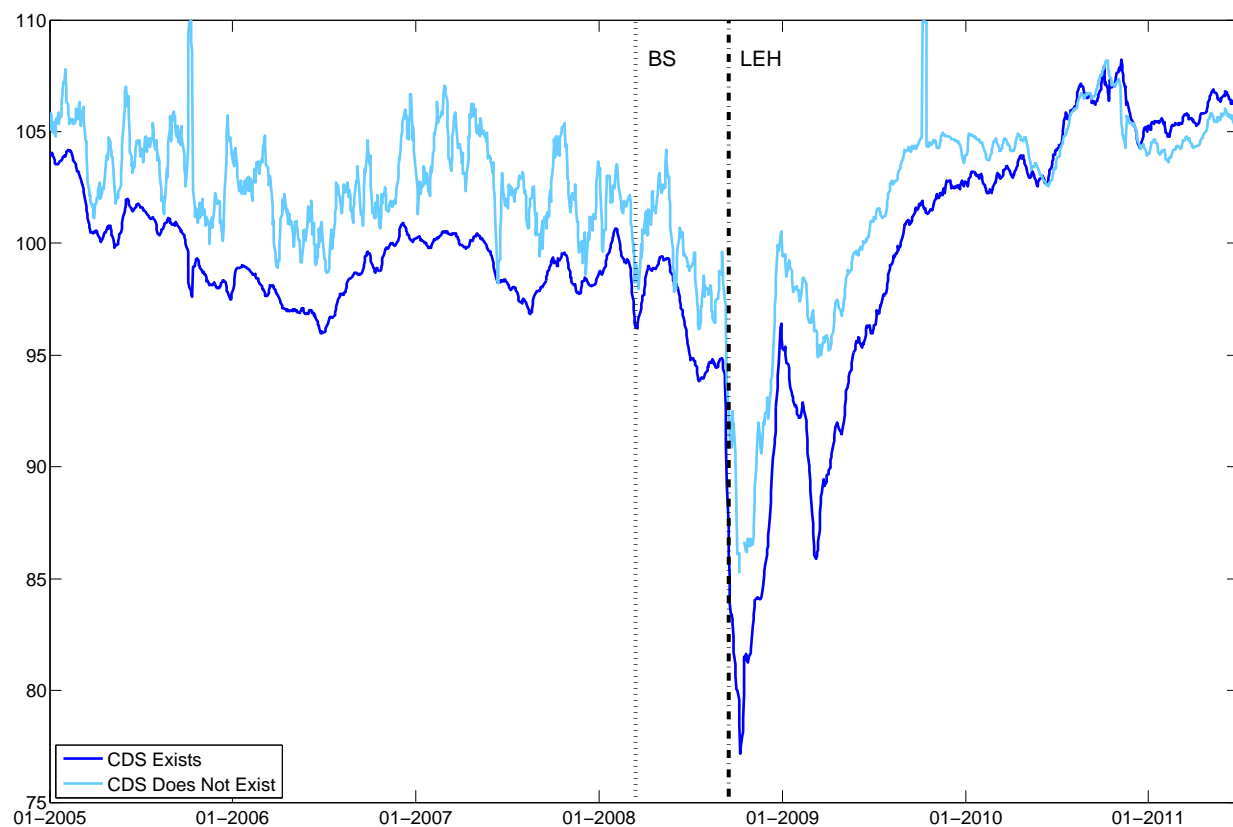


Figure 7: Prices of Corporate Bonds With CDS vs. Corporate Bonds Without Available CDS

This figure shows the prices of corporate bonds held by dealers, who report their trades in TRACE. The figure contrasts the inventory of corporate bonds with available CDS and the inventory of corporate bonds without available CDS. The availability of a CDS is determined by the existence of a quote in Markit.

Table 1
Summary Statistics

This table provides summary statistics for the following three periods: *Crisis 1* from July 2007 to Sep 14 2008, *Crisis 2* from Sep 15 2008 to Feb 28, 2009, and *Crisis 3* from March 2009 to June 2009. *basis*($\equiv p_{CSD} - p(\text{CS})$) is the CDS-corporate bond basis. $p(\text{CDS})$ is the CDS spreads and $p(\text{CS})$ is the par-equivalent credit spread. $Q(\text{CDS}, \text{buy})$ and $Q(\text{CDS}, \text{sell})$ are daily quantities bought and sold by dealers in the CDS market, respectively. $Q(\text{CS}, \text{buy})$ and $Q(\text{CS}, \text{sell})$ are daily quantities bought and sold by dealers in the corporate bond market, respectively.

AAA									
	Crisis 1			Crisis2			Crisis3		
	Mean	Stdev	N	Mean	Stdev	N	Mean	Stdev	N
basis	28.63	39.57	7,362	148.25	130.93	3,023	234.36	160.61	4,160
$p(\text{CDS})$	90.25	49.23	7,362	411.91	137.54	3,023	455.69	235.94	4,160
$p(\text{CS})$	61.62	45.64	7,362	263.62	146.89	3,023	216.48	250.30	4,160
$Q(\text{CDS}, \text{buy})$	47.04	55.09	6,418	100.21	130.46	2,585	43.52	62.01	3,733
$Q(\text{CDS}, \text{sell})$	27.43	33.92	6,332	72.83	95.39	2,450	41.62	63.74	3,567
$Q(\text{CS}, \text{buy})$	3.35	10.17	7,362	5.85	17.51	3,023	8.12	22.75	4,160
$Q(\text{CS}, \text{sell})$	3.66	10.39	7,362	5.86	16.02	3,023	8.21	19.14	4,160
Investment Grade exc. AAA									
	Crisis 1			Crisis2			Crisis3		
	Mean	Stdev	N	Mean	Stdev	N	Mean	Stdev	N
basis	-31.44	155.77	50,188	-406.50	1,195.50	15,572	-229.03	705.38	19,321
$p(\text{CDS})$	146.84	166.12	50,188	362.65	425.39	15,572	382.76	389.83	19,321
$p(\text{CS})$	177.48	250.85	50,188	768.71	1,469.33	15,572	606.04	941.19	19,321
$Q(\text{CDS}, \text{buy})$	53.63	82.59	39,156	53.97	103.25	12,808	32.09	61.21	15,960
$Q(\text{CDS}, \text{sell})$	59.80	86.28	34,268	61.13	93.85	10,578	38.07	67.91	13,908
$Q(\text{CS}, \text{buy})$	3.02	8.94	50,188	3.84	11.02	15,572	3.27	8.29	19,321
$Q(\text{CS}, \text{sell})$	3.16	8.69	50,188	3.75	10.49	15,572	3.42	9.78	19,321
High Yield									
	Crisis 1			Crisis2			Crisis3		
	Mean	Stdev	N	Mean	Stdev	N	Mean	Stdev	N
basis	-57.29	497.60	6,460	-2,245.28	2,044.84	1,926	-1,285.54	2,914.87	2,809
$p(\text{CDS})$	748.21	439.11	6,460	2,801.74	2,378.70	1,926	2,168.42	2,799.52	2,809
$p(\text{CS})$	805.08	786.63	6,460	7,451.68	7,733.52	1,926	4,612.08	6,875.91	2,809
$Q(\text{CDS}, \text{buy})$	42.18	63.38	3,059	35.09	41.35	799	14.69	28.13	1,400
$Q(\text{CDS}, \text{sell})$	40.34	56.56	2,987	34.39	33.85	794	19.29	31.99	1,058
$Q(\text{CS}, \text{buy})$	3.74	8.40	6,460	5.14	16.48	1,926	3.45	7.18	2,809
$Q(\text{CS}, \text{sell})$	4.05	9.40	6,460	5.07	15.42	1,926	3.52	7.65	2,809

Table 2
Dealer trades and price changes

This table provides the estimation results of the following regressions:

$$\begin{aligned}\Delta p(\text{CDS}, t) &= c_1 + \alpha_1 \text{basis}(t-1) + \beta_1 Q(\text{CDS}, t) + \text{ctrls} + \varepsilon_{1t} \\ \Delta p(\text{CS}, t) &= c_2 + \alpha_2 \text{basis}(t-1) + \gamma_2 Q(\text{Bond}, t) + \text{ctrls} + \varepsilon_{2t} \\ \Delta \text{basis}(t) &= c_3 + \alpha_3 \text{basis}(t-1) + \beta_3 Q(\text{CDS}, t) + \gamma_3 (-Q(\text{Bond}, t)) + \text{ctrls} + \varepsilon_{3t}\end{aligned}$$

where $p(\text{CDS}, t)$ and $p(\text{CS}, t)$ are CDS and par-equivalent credit spreads, respectively, and basis_t is $p(\text{CDS}, t) - p(\text{CS}, t)$. The control variables ctrls include: the lagged basis, $\text{basis}(t-1)$; lagged changes in CDS and PECS; changes in VIX, $\text{VIX}(t)$; changes in repo spread, repo , which is the difference between 3-month general collateral repo rate and T-bill rate; changes in overnight index swap (OIS) spreads, OIS, which is Libor minus OIS rates; aggregate stock returns on primary dealers $\text{CP}^{\text{equity}}$; and, changes in average CDS spreads of primary dealers CP^{CDS} . The sample sub-periods are: *Crisis 1* from July 2007 to Sep 14 2008, *Crisis 2* from Sep 15 2008 to Feb 28, 2009, and *Crisis 3* from March 2009 to June 2009. The numbers in parentheses are Newey-West standard errors.

	Crisis 1			Crisis 2			Crisis 3		
	Dependent Variables			Dependent Variables			Dependent Variables		
$q(\text{CS})$	$\Delta p(\text{CS}, t)$	$\Delta p(\text{CDS}, t)$	Δbasis_t	$\Delta p(\text{CS}, t)$	$\Delta p(\text{CDS}, t)$	Δbasis_t	$\Delta p(\text{CS}, t)$	$\Delta p(\text{CDS}, t)$	Δbasis_t
	-2.49*** (0.43)		-2.58*** (0.44)	-5.96*** (1.48)		-5.78*** (1.41)	-3.22*** (0.94)		-2.96*** (0.90)
$q(\text{CDS})$		0.02 (0.21)	-0.49 (0.54)		-1.79 (1.25)			-1.70*** (0.64)	
$\text{basis}(t-1)$	0.03*** (0.01)	0.00 (0.00)	-0.02*** (0.01)	0.00 (0.00)	0.00 (0.00)	-0.01*** (0.00)	0.01*** (0.00)	-0.00 (0.00)	-0.01*** (0.00)
$\Delta p(\text{CDS}, t-1)$	0.70*** (0.10)	0.17*** (0.04)	-0.55*** (0.10)	0.73*** (0.12)	0.10* (0.06)	-0.58*** (0.09)	0.49*** (0.10)	0.14*** (0.05)	-0.39*** (0.08)
$\Delta p(\text{CS}, t-1)$	-0.15*** (0.03)	0.02*** (0.01)	0.17*** (0.02)	-0.15*** (0.03)	0.02* (0.01)	0.17*** (0.03)	-0.14*** (0.02)	0.02*** (0.01)	0.17*** (0.02)
$\Delta \text{VIX}(t)$	0.06 (0.33)	0.73** (0.28)	0.68** (0.35)	0.52 (0.66)	0.93** (0.40)	0.70* (0.41)	-2.15*** (0.60)	-0.77*** (0.29)	0.74 (0.59)
$\Delta \text{repo}(t)$	2.25 (3.56)	2.98 (2.17)	1.98 (2.81)	-16.37 (11.85)	-15.53*** (5.14)	1.92 (11.40)	16.97 (37.78)	57.26*** (17.29)	16.56 (27.85)
Δois_t	-4.46 (3.01)	8.10*** (1.79)	9.15*** (3.36)	15.71 (9.88)	18.39** (8.62)	4.28 (11.37)	17.49 (59.40)	-27.88 (30.03)	-41.92 (67.22)
$\text{CP}^{\text{equity}}$	-63.86* (36.07)	-27.52** (12.78)	59.82** (29.51)	-5.56 (7.10)	5.57 (3.89)	18.22* (9.38)	-91.22*** (33.64)	-79.97*** (11.83)	3.91 (28.18)
CP^{CDS}	57.10*** (15.24)	84.21*** (14.27)	23.48** (10.13)	179.28*** (26.54)	117.02*** (15.22)	-95.46*** (27.94)	102.96*** (24.38)	151.40*** (13.82)	24.40 (21.39)
R^2	0.085	0.237	0.061	0.089	0.231	0.062	0.050	0.214	0.043
N	64,287	47,321	64,287	21,065	15,726	21,065	28,009	20,908	28,009
									20,908

Table 3
Positive basis vs. Negative basis (buy and sell separately)

This table provides the estimation results of the following regressions for the positive lagged basis ($\text{basis}(t-1) > 0$) and negative lagged basis cases ($\text{basis}(t-1) < 0$) separately:

$$\Delta \text{basis}(t) = c_3 + \alpha_3 \text{basis}(t-1) + \beta_1 Q(\text{CDS}, \text{buy}, t) + \beta_2 Q(\text{CDS}, \text{sell}, t) + \gamma_1 (-Q(\text{Bond}, t)^{\text{buy}}) + \gamma_2 (-Q(\text{CDS}, \text{sell}, t)) + \text{ctrls} + \varepsilon_t$$

where basis_t is $p(\text{CDS}, t) - p(\text{CS}, t)$ and $p(\text{CDS}, t)$ and $p(\text{CS}, t)$ are CDS and par-equivalent credit spreads, respectively. The buy and sell CDS volumes ($p(\text{CDS}, t)^{\text{buy}}$ and $p(\text{CDS}, t)^{\text{sell}}$) are defined as $Q(\text{CDS}, \text{buy}, t) \equiv Q(\text{CDS}, t)1_{Q(\text{CDS}, t) > 0}$ and $Q(\text{CDS}, \text{sell}, t) \equiv Q(\text{CDS}, t)1_{Q(\text{CDS}, t) < 0}$. The buy and sell bond volumes are defined similarly: $Q(\text{Bond}, t)^{\text{buy}} \equiv Q(\text{Bond}, t)1_{Q(\text{Bond}, t) > 0}$ and $Q(\text{Bond}, t)^{\text{sell}} \equiv Q(\text{Bond}, t)1_{Q(\text{Bond}, t) < 0}$. The control variables ctrls include: the lagged basis, $\text{basis}(t-1)$; lagged changes in CDS and PECS; changes in VIX, VIX(t); changes in repo spread, repo , which is the difference between 3-month general collateral repo rate and T-bill rate; changes in overnight index swap (OIS) spreads, OIS, which is Libor minus OIS rates; aggregate stock returns on primary dealers $\text{CP}^{\text{equity}}$; and, changes in average CDS spreads of primary dealers CP^{CDS} . The sample sub-periods are: *Crisis 1* from July 2007 to Sep 14 2008, *Crisis 2* from Sep 15 2008 to Feb 28, 2009, and *Crisis 3* from March 2009 to June 2009. The numbers in parentheses are Newey-West standard errors.

	Crisis 1		Crisis 2		Crisis 3	
	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$
$Q(\text{CS})1_{\text{buy}}$	-5.83*** (1.15)	-2.72*** (0.50)	-3.98* (2.30)	-4.19* (2.45)	-0.12 (0.60)	-7.56*** (1.83)
$Q(\text{CS})1_{\text{sell}}$	-1.51*** (0.54)	-1.51** (0.73)	-0.73 (1.05)	-0.32 (0.95)	-1.16** (0.59)	-5.96*** (2.16)
$Q(\text{CDS})1_{\text{buy}}$	-2.79* (1.66)	-0.06 (0.87)	-7.62*** (1.72)	-0.02*** (2.00)	3.40 (3.25)	(2.25) (1.45)
$Q(\text{CDS})1_{\text{sell}}$	0.86 (0.58)	1.03** (0.52)	-3.62 (4.13)	-0.98 (1.99)	-14.50* (8.69)	5.08* (2.67)
$\text{basis}(t-1)$	-0.04*** (0.01)	-0.02** (0.01)	-0.02 (0.03)	-0.01** (0.00)	-0.04*** (0.01)	-0.01*** (0.00)
$\Delta p(\text{CDS}, t-1)$	-0.43*** (0.08)	-0.62*** (0.13)	-0.48** (0.19)	-0.51** (0.21)	-0.01 (0.16)	-0.49*** (0.10)
$\Delta p(\text{CS}, t-1)$	0.25*** (0.03)	0.15*** (0.03)	0.14 (0.10)	0.18*** (0.03)	0.31*** (0.03)	0.16*** (0.02)
$\Delta \text{VIX}(t)$	0.91** (0.40)	0.32 (0.46)	0.66 (0.42)	0.74* (0.45)	2.00* (1.09)	2.10*** (0.70)
$\Delta \text{repo}(t)$	5.42* (2.93)	-3.10 (5.12)	-6.88 (7.25)	-8.60 (9.56)	40.51 (48.91)	20.09 (39.83)
Δois_t	7.59 (5.89)	12.15*** (4.33)	19.24 (17.64)	32.17 (22.34)	-18.29 (34.89)	-41.95 (85.91)
$\text{CP}^{\text{equity}}$	84.05*** (32.66)	32.55 (40.18)	-15.62*** (5.62)	-18.00** (7.77)	48.16 (53.26)	-5.55 (33.28)
CP^{CDS}	50.03*** (9.95)	57.78*** (13.52)	-2.84 (28.24)	-11.31 (33.20)	133.92*** (19.18)	-20.72 (24.63)
R^2	0.087	0.055	0.051	0.064	0.124	0.045
N	26,406	37,881	3,919	3,095	7,605	20,404
					6,158	14,750

Table 4
Liquidity Provision when basis is large

This table provides the estimation results of the following regressions for the positive lagged basis ($\text{basis}(t-1) > 0$) and negative lagged basis cases ($\text{basis}(t-1) < 0$) separately:

$$\begin{aligned}\Delta \text{basis}(t) &= \beta_1 Q(\text{CDS}, \text{buy}, t) + \beta_2 Q(\text{CDS}, \text{buy}, t) \cdot |\text{basis}(t-1)| + \beta_3 Q(\text{CDS}, \text{sell}, t) + \beta_4 Q(\text{CDS}, \text{sell}, t) \cdot |\text{basis}(t-1)| \\ &+ \gamma_1 Q(\text{Bond}, t)^{\text{buy}} + \gamma_2 Q(\text{Bond}, t)^{\text{buy}} \cdot |\text{basis}(t-1)| + \gamma_3 Q(\text{CDS}, \text{sell}, t) + \gamma_4 Q(\text{CDS}, \text{sell}, t) \cdot |\text{basis}(t-1)| \\ &+ \alpha_3 \text{basis}(t-1) + c_3 + \varepsilon_{3t}\end{aligned}$$

where basis_t is $p(\text{CDS}, t) - p(\text{CS}, t)$ and $p(\text{CDS}, t)$ and $p(\text{CS}, t)$ are CDS and par-equivalent credit spreads, respectively. The buy and sell CDS volumes ($p(\text{CDS}, t)^{\text{buy}}$ and $p(\text{CDS}, t)^{\text{sell}}$) are defined as $Q(\text{CDS}, \text{buy}, t) \equiv Q(\text{CDS}, t)1_{Q(\text{CDS}, t) > 0}$ and $Q(\text{CDS}, t)1_{Q(\text{CDS}, t) < 0}$. The buy and sell bond volumes are defined similarly: $Q(\text{Bond}, t)^{\text{buy}} \equiv Q(\text{Bond}, t)1_{Q(\text{Bond}, t) > 0}$ and $Q(\text{Bond}, t)^{\text{sell}} \equiv Q(\text{Bond}, t)1_{Q(\text{Bond}, t) < 0}$. The control variables *ctrls* include: the lagged basis, $\text{basis}(t-1)$; lagged changes in CDS and PECS; changes in VIX, $\text{VIX}(t)$; changes in repo spread, *repo*, which is the difference between 3-month general collateral repo rate and T-bill rate; changes in overnight index swap (OIS) spreads, OIS, which is Libor minus OIS rates; aggregate stock returns on primary dealers $\text{CP}^{\text{equity}}$; and, changes in average CDS spreads of primary dealers CP^{CDS} . The coefficients on the control variables are not reported here to save space. The sample sub-periods are: *Crisis 1* from July 2007 to Sep 14 2008, *Crisis 2* from Sep 15 2008 to Feb 28, 2009, and *Crisis 3* from March 2009 to June 2009. The numbers in parentheses are Newey-West standard errors.

	Crisis 1		Crisis 2		Crisis 3					
	basis($t-1$) > 0	basis($t-1$) < 0	basis($t-1$) > 0	basis($t-1$) < 0	basis($t-1$) > 0	basis($t-1$) < 0				
$Q(\text{CS})1_{\text{buy}}$	-5.09*** (1.25)	-2.63*** (0.91)	-5.00*** (0.71)	-5.48*** (0.60)	-9.46** (4.18)	-10.53*** (4.59)	-4.39*** (1.61)	-5.25** (2.08)	-6.19** (2.55)	-0.76 (1.55)
$Q(\text{CS})1_{\text{buy}} \text{basis}(t-1) $	-17.34 (35.26)	-95.79*** (26.63)	41.74*** (9.17)	54.84*** (7.96)	24.82** (11.73)	27.29** (12.65)	2.10 (8.81)	13.65*** (4.12)	-4.43 (10.11)	-26.11*** (7.56)
$Q(\text{CS})1_{\text{sell}}$	-0.11 (0.46)	0.66 (0.43)	1.22*** (0.35)	0.82 (0.56)	-2.20 (3.46)	-1.86 (3.65)	1.34 (2.76)	0.25 (0.76)	0.72 (0.89)	11.74*** (3.84)
$Q(\text{CS})1_{\text{sell}} \text{basis}(t-1) $	-36.54*** (10.64)	-60.84*** (17.16)	-39.51*** (7.15)	-28.87*** (10.75)	6.90 (12.43)	7.14 (13.31)	-18.38* (10.48)	-5.13** (2.15)	-5.66*** (2.02)	-47.41** (21.70)
$Q(\text{CDS})1_{\text{buy}}$		-0.39 (0.75)		-2.21*** (0.57)		-8.46* (4.41)		(5.80) (5.13)	5.96 (6.19)	(25.56) (5.66)
$Q(\text{CDS})1_{\text{buy}} \text{basis}(t-1) $		-57.07 (38.45)		49.60** (21.20)		7.07 (25.57)		91.11** (35.73)	-7.09 (26.41)	23.62 (19.24)
$Q(\text{CDS})1_{\text{sell}}$		0.46 (0.74)		0.60 (0.62)		5.70 (13.36)		5.05** (2.52)	13.82** (6.41)	9.13 (5.74)
$Q(\text{CDS})1_{\text{sell}} \text{basis}(t-1) $		9.35 (31.98)		8.32 (13.76)		-80.42 (100.53)		-25.32*** (9.49)	-130.47** (61.72)	-9.91 (16.63)
R^2	0.088	0.096	0.067	0.065	0.052	0.065	0.068	0.096	0.138	0.077
N	26,406	19,842	37,881	27,479	3,919	3,095	17,146	12,631	7,605	14,750

Table 5
Liquidity Provision across Ratings

This table provides the estimation results of the following regressions for the positive lagged basis ($\text{basis}(t-1) > 0$) and negative lagged basis cases ($\text{basis}(t-1) < 0$) separately:

$$\Delta \text{basis}(t) = c_3 + \alpha_3 \text{basis}(t-1) + \beta_1 Q(\text{CDS, buy}, t) + \beta_2 Q(\text{CDS, sell}, t) + \gamma_1 (-Q(\text{Bond}, t)^{\text{buy}}) + \gamma_2 (-Q(\text{CDS, sell}, t)) + \text{ctrls} + \varepsilon_t$$

where basis_t is $p(\text{CDS}, t) - p(\text{CS}, t)$ and $p(\text{CDS}, t)$ and $p(\text{CS}, t)$ are CDS and par-equivalent credit spreads, respectively. The buy and sell CDS volumes ($p(\text{CDS}, t)^{\text{buy}}$ and $p(\text{CDS}, t)^{\text{sell}}$) are defined as $Q(\text{CDS, buy}, t) \equiv Q(\text{CDS}, t)1_{Q(\text{CDS}, t) \geq 0}$ and $Q(\text{CDS, sell}, t) \equiv Q(\text{CDS}, t)1_{Q(\text{CDS}, t) < 0}$. The buy and sell bond volumes are defined similarly: $Q(\text{Bond}, t)^{\text{buy}} \equiv Q(\text{Bond}, t)1_{Q(\text{Bond}, t) \geq 0}$ and $Q(\text{Bond}, t)^{\text{sell}} \equiv Q(\text{Bond}, t)1_{Q(\text{Bond}, t) < 0}$. The control variables ctrls include: the lagged basis, $\text{basis}(t-1)$; lagged changes in CDS and PECS; changes in VIX, $\text{VIX}(t)$; changes in repo spread, repo , which is the difference between 3-month general collateral repo rate and T-bill rate; changes in overnight index swap (OIS) spreads, OIS, which is Libor minus OIS rates; aggregate stock returns on primary dealers $\text{CP}^{\text{equity}}$; and, changes in average CDS spreads of primary dealers CP^{CDS} . The coefficients on the control variables are not reported here to save space. The sample sub-periods are: *Crisis 1* from July 2007 to Sep 14 2008, *Crisis 2* from Sep 15 2008 to Feb 28, 2009, and *Crisis 3* from March 2009 to June 2009. The numbers in parentheses are Newey-West standard errors.

	AAA					
	Crisis 1		Crisis 2		Crisis 3	
	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$
$Q(\text{CS})1_{\text{buy}}$	-3.47*** (0.72)	-1.58*** (0.35)	-2.27** (0.95)	-2.45** (1.09)	0.05 (0.37)	-2.04** (0.87)
$Q(\text{CS})1_{\text{sell}}$	0.36 (0.39)	0.21 (0.16)	0.52 (0.77)	-0.57 (0.64)	-0.40 (0.33)	1.11 (1.09)
$Q(\text{CDS})1_{\text{buy}}$	-0.13 (0.21)	-0.93** (0.37)	-7.26*** (1.48)	5.29*** (1.78)	4.11*** (1.31)	4.49** (1.95)
$Q(\text{CDS})1_{\text{sell}}$	-1.10 (0.73)	-0.23 (0.65)	-0.99 (1.87)	0.70 (5.03)	-15.84*** (4.30)	-12.77*** (3.96)
	Investment Grade exc. AAA					
	Crisis 1		Crisis 2		Crisis 3	
	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$
$Q(\text{CS})1_{\text{buy}}$	-6.53*** (1.06)	-2.87*** (0.52)	-68.76*** (22.17)	-12.95*** (2.50)	-17.77*** (6.11)	-7.25*** (1.45)
$Q(\text{CS})1_{\text{sell}}$	-0.82 (0.52)	-0.22 (0.26)	-35.49** (14.83)	-3.22 (2.19)	0.14 (1.13)	-4.46** (1.76)
$Q(\text{CDS})1_{\text{buy}}$	-4.69*** (0.93)	0.37 (0.73)	-13.78*** (4.85)	0.60 (1.62)	-4.38 (4.52)	-0.97 (1.80)
$Q(\text{CDS})1_{\text{sell}}$	1.30*** (0.44)	0.89** (0.39)	25.53 (17.52)	-1.37 (1.40)	0.81 (4.98)	5.36*** (1.75)
	High Yield					
	Crisis 1		Crisis 2		Crisis 3	
	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$
$Q(\text{CS})1_{\text{buy}}$	-3.68** (1.76)	-6.91*** (2.07)	-94.83*** (19.41)	-9.41 (29.06)	-217.65 (281.11)	-15.21 (11.99)
$Q(\text{CS})1_{\text{sell}}$	-2.70* (1.63)	-4.00** (1.90)	38.54* (22.69)	-47.72** (22.53)	-55.16 (308.87)	-46.62*** (15.75)
$Q(\text{CDS})1_{\text{buy}}$	-0.80 (1.72)	-0.32 (4.02)	-27.61 (53.51)	-20.50 (42.74)	-76.82 (491.28)	-1.65 (25.34)
$Q(\text{CDS})1_{\text{sell}}$	-2.27* (1.30)	0.29 (2.06)	-100.56** (44.70)	38.03 (29.71)	-32.37 (294.47)	55.22* (33.27)

Table 6
Liquidity Demand by Insurance Company

This table provides the estimation results of the following regressions for the positive lagged basis ($\text{basis}(t-1) > 0$) and negative lagged basis cases ($\text{basis}(t-1) < 0$) separately:

$$\Delta \text{basis}(t) = c_3 + \alpha_3 \text{basis}(t-1) + \beta_1 Q(\text{CDS, buy}, t) + \beta_2 Q(\text{CDS, sell}, t) + \gamma_1 (-Q(\text{Bond}, t)^{\text{buy}}) + \gamma_2 (-Q(\text{CDS, sell}, t)) + \text{ctrls} + \varepsilon_t$$

where basis_t is $p(\text{CDS}, t) - p(\text{CS}, t)$ and $p(\text{CDS}, t)$ and $p(\text{CS}, t)$ are CDS and par-equivalent credit spreads, respectively. The buy and sell CDS volumes by insurance companies ($p(\text{CDS}, t)^{\text{buy}}$ and $p(\text{CDS}, t)^{\text{sell}}$) are defined as $Q(\text{CDS, buy}, t) \equiv Q(\text{CDS}, t)1_{Q(\text{CDS}, t) > 0}$ and $Q(\text{CDS, sell}, t) \equiv Q(\text{CDS}, t)1_{Q(\text{CDS}, t) < 0}$. The buy and sell bond volumes are defined similarly: $Q(\text{Bond}, t)^{\text{buy}} \equiv Q(\text{Bond}, t)1_{Q(\text{Bond}, t) > 0}$ and $Q(\text{Bond}, t)^{\text{sell}} \equiv Q(\text{Bond}, t)1_{Q(\text{Bond}, t) < 0}$. The control variables ctrls include: the lagged basis, $\text{basis}(t-1)$; lagged changes in CDS and PECS; changes in VIX, $\text{VIX}(t)$; changes in repo spread, repo , which is the difference between 3-month general collateral repo rate and T-bill rate; changes in overnight index swap (OIS) spreads, OIS , which is Libor minus OIS rates; aggregate stock returns on primary dealers $\text{CP}^{\text{equity}}$; and, changes in average CDS spreads of primary dealers CP^{CDS} . The coefficients on the control variables are not reported here to save space. The sample sub-periods are: *Crisis 1* from July 2007 to Sep 14 2008, *Crisis 2* from Sep 15 2008 to Feb 28, 2009, and *Crisis 3* from March 2009 to June 2009. We further divide the sample based on credit ratings of bonds: AAA, investment grades excluding AAA, and high yield bonds. The numbers in parentheses are Newey-West standard errors.

	Crisis 1		Crisis 2		Crisis 3	
	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$	$\text{basis}(t-1) > 0$	$\text{basis}(t-1) < 0$
$Q(\text{CS})1_{\text{buy}}$	-2.90 (2.32)	-0.37 (0.55)	-6.15 (3.84)	1.35 (4.46)	0.55 (1.66)	0.58 (1.57)
$Q(\text{CS})1_{\text{sell}}$	3.80*** (1.10)	5.83*** (1.75)	-2.79 (4.93)	7.09 (6.73)	6.81** (2.75)	0.05 (5.68)
$Q(\text{CDS})1_{\text{buy}}$	1.54* (0.87)	3.20 (2.28)	-3.00 (2.60)	0.62 (1.45)	0.04 (2.77)	-3.12 (7.37)
$Q(\text{CDS})1_{\text{sell}}$	-1.54 (1.23)	-2.89 (3.11)	63.12 (38.85)	0.86 (3.94)	35.23** (14.18)	6.96 (7.64)
$\text{basis}(t-1)$	-0.06** (0.03)	-0.14*** (0.03)	0.15* (0.08)	-0.03* (0.02)	0.04 (0.03)	-0.04*** (0.01)
$\Delta p(\text{CDS}, t-1)$	-0.53*** (0.13)	-0.88*** (0.17)	-0.06 (0.40)	-1.00*** (0.17)	0.43 (0.32)	-0.54*** (0.19)
$\Delta p(\text{CS}, t-1)$	0.31*** (0.09)	-0.03 (0.06)	-0.01 (0.28)	0.30*** (0.07)	0.27 (0.17)	0.17** (0.08)
$\Delta \text{VIX}(t)$	0.84 (0.60)	0.58 (0.81)	2.94 (2.29)	-1.19 (0.89)	1.62 (2.08)	0.23 (2.78)
$\Delta \text{repo}(t)$	1.18 (4.97)	7.14 (11.28)	65.99 (44.62)	69.84** (30.80)	102.46 (80.65)	-20.54 (136.89)
Δoist	18.19 (11.35)	29.88*** (10.46)	-83.51 (78.30)	-41.54 (42.42)	-53.90 (135.47)	-235.78 (168.25)
$\text{CP}^{\text{equity}}$	27.39 (48.27)	44.51 (68.99)	-1.07 (128.85)	-26.46 (30.68)	-32.58 (78.42)	-99.25 (94.84)
CP^{CDS}	74.27*** (15.79)	16.39 (25.29)	-66.68 (47.93)	-86.86* (48.51)	166.10*** (35.72)	32.18 (39.84)
R^2	0.196	0.271	0.093	0.188	0.167	0.075
N	1,891	2,884	323	1,153	683	1,469

Table 7
Returns of Corporate Bonds with Available CDS vs. Unavailable CDS After
Lehman Brothers' Collapse

This table provides the regression results of the following model:

$$\text{Ret}(t) = c_1 + \beta_1 \text{CDS}^{\text{exists}} + \beta_2 \text{basis}(\text{Aug})\text{Mat5Y}(\text{Aug}) + \text{Controls} + \varepsilon_t$$

where $\text{Ret}(t)$ is the monthly corporate bond returns constructed from TRACE, $\text{CDS}^{\text{exists}}$ is an indicator variable that takes the value of one if the bond has a CDS contract available in Markit prior to September 2009 and zero otherwise, $\text{basis}(\text{Aug})$ is the CDS-bond basis at the end of August 2008, and $\text{Mat5Y}(\text{Aug})$ is an indicator variable that takes the value of one if the maturity of the bond at the end of August 2008 is between 4.5 and 5.5 years and zero otherwise. $\text{Ret}(eq, t)$ is the corresponding stock returns of the bond. The control variables *ctrls* include: changes in VIX, VIX; and changes in the repo spread, *repo*, the difference between 3-month general collateral repo rate and T-bill rate. The numbers in parenthesis are White robust standard errors. The sample period is September and October of 2008.

	Bond Return				Proxy Basis			
$\text{CDS}^{\text{exists}}$	-0.07*** (0.02)		-0.07*** (0.02)	-0.11*** (0.04)	-0.11** (0.05)		-0.12** (0.05)	-0.04 (0.03)
$\text{basis}(\text{Aug})\text{Mat5Y}(\text{Aug})$		3.09*** (0.94)	2.72*** (0.97)	-1.04 (1.74)		10.51** (4.95)	11.33** (5.00)	95.40 (78.99)
$\text{Ret}(\text{equity}, t)$				0.02 (0.01)				-0.01 (0.01)
$\Delta \text{Vol}(t)$				-0.53*** (0.17)				-0.26 (0.47)
time-to-maturity				-0.00 (0.00)				0.01 (0.01)
$\Delta \text{VIX}(t)$				0.00 (0.00)				0.00 (0.00)
$\Delta \text{repo}(t)$				-0.03* (0.01)				0.03 (0.04)
R^2	0.081	0.068	0.081	0.172	0.071	0.057	0.071	0.129
N	1,166	1,161	1,161	721	163	160	160	95
Rating Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8
Returns of Corporate Bonds with Available CDS vs. Unavailable CDS After
Lehman Brothers' Collapse: Month-by-Month

This table provides the regression results of the following model for each month from August 2008 to December of 2008:

$$\text{Ret}(t) = c_1 + \beta_1 \text{CDS}^{\text{exists}} + \beta_2 \text{basis}(\text{Aug})\text{Mat5Y}(\text{Aug}) + \text{Controls} + \varepsilon_t$$

where $\text{Ret}(t)$ is the monthly corporate bond returns constructed from TRACE, $\text{CDS}^{\text{exists}}$ is an indicator variable that takes the value of one if the bond has a CDS contract available in Markit prior to September 2009 and zero otherwise, $\text{basis}(\text{Aug})$ is the CDS-bond basis at the end of August 2008, and $\text{Mat5Y}(\text{Aug})$ is an indicator variable that takes the value of one if the maturity of the bond at the end of August 2008 is between 4.5 and 5.5 years and zero otherwise. $\text{Ret}(eq, t)$ is the corresponding stock returns of the bond. The control variables $ctrls$ include: changes in VIX, VIX; and changes in the repo spread, $repo$, the difference between 3-month general collateral repo rate and T-bill rate. The numbers in parenthesis are White robust standard errors.

	Bond Return				
	Aug	Sep	Oct	Nov	Dec
$\text{CDS}^{\text{exists}}$	-0.01 (0.01)	0.07 (0.07)	-0.36** (0.15)	-0.01 (0.02)	0.02 (0.02)
$\text{basis}(\text{Aug})\text{Mat5Y}(\text{Aug})$	-3.13** (1.27)	-5.35 (6.13)	2.75 (6.48)	1.87 (1.95)	3.54 (3.10)
$\text{Ret}(\text{equity}, t)$	0.01*** (0.00)	-0.03*** (0.01)	0.03*** (0.00)	-0.00 (0.00)	0.00 (0.00)
$\Delta \text{Vol}(t)$	0.21** (0.10)	-0.62*** (0.19)	0.38 (0.30)	-0.35* (0.20)	-0.39* (0.21)
time-to-maturity	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00*** (0.00)
$\Delta \text{VIX}(t)$	-0.00** (0.00)	-0.00 (0.00)	-0.00* (0.00)	-0.00** (0.00)	-0.00 (0.00)
$\Delta \text{repo}(t)$	0.03 (0.04)	0.06** (0.03)	0.06*** (0.02)	-0.10** (0.05)	0.02 (0.03)
R^2	0.096	0.288	0.410	0.454	0.168
N	400	347	374	369	274
Rating Dummy	Yes	Yes	Yes	Yes	Yes