COUNTERPARTY CREDIT RISK AND THE CREDIT DEFAULT SWAP MARKET

Navneet Arora
Priyank Gandhi
Francis A. Longstaff

Abstract. Counterparty credit risk has become one of the highest-profile risks facing participants in the financial markets. Despite this, relatively little is known about how counterparty credit risk is actually priced. We examine this issue using an extensive proprietary data set of contemporaneous CDS transaction prices and quotes by 14 different CDS dealers selling credit protection on the same underlying firm. This unique cross-sectional data set allows us to identify directly how dealers' credit risk affects the prices of these controversial credit derivatives. We find that counterparty credit risk is significantly priced in the CDS market. The magnitude of the effect, however, is relatively modest and is consistent with a market structure in which participants require collateralization of swap liabilities by counterparties. The pricing of counterparty credit risk became much more significant after the Lehman default at both the market level and at the level of individual CDS dealers. Furthermore, there is some evidence of strategic behavior by CDS dealers with the best credit. Surprisingly, we find that counterparty credit risk is not priced in the CDS spreads for financial firms in the sample, but is priced for the nonfinancial firms. This may suggest that the market expects large CDS dealers to be treated as too large to fail when other major financial firms begin to default.

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Navneet Arora is with Blackrock. Priyank Gandhi is with the UCLA Anderson School. Francis A. Longstaff is with the UCLA Anderson School and the NBER.
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1. INTRODUCTION

During the past several years, counterparty credit risk has emerged as one of the most-important factors driving financial markets and contributing to the global credit crisis. Concerns about counterparty credit risk were significantly heightened in early 2008 by the collapse of Bear Stearns, but then skyrocketed later in the year when Lehman Brothers declared Chapter 11 bankruptcy and defaulted on its debt and swap obligations.[1] Fears of systemic defaults were so extreme in the aftermath of the Lehman bankruptcy that Euro-denominated CDS contracts on the U.S. Treasury were quoted at spreads as high as 100 basis points.

Despite the significance of counterparty credit risk in the financial markets, however, there has been relatively little empirical research about how it affects the prices of contracts and derivatives in which counterparties may default. This is particularly true for the $57.3 trillion notional credit default swap (CDS) market in which defaultable counterparties sell credit protection (essentially insurance) to other counterparties.[2] The CDS markets have been the focus of much attention recently because it was AIG's massive losses on credit default swap positions that led to the Treasury's $182.5 billion bailout of AIG. Furthermore, concerns about the extent of counterparty credit risk in the CDS market underlie recent proposals to create a central clearinghouse for CDS transactions.[3]

This paper uses a unique proprietary data set to examine how counterparty credit risk affects the pricing of CDS contracts. Specifically, this data set includes contemporaneous CDS transaction prices and quotations provided by 14 large CDS dealers for selling protection on the same set of underlying reference firms. Thus, we can use this cross-sectional data to measure directly how a CDS dealer's counterparty credit risk affects the prices at which the dealer can sell credit protection. A key aspect of the data set is that it includes most of 2008, a period during which fears of counterparty defaults in the CDS market reached historical highs. Thus, this data set provides an ideal sample for studying the effects of counterparty credit

[1]Lehman Brothers filed for Chapter 11 bankruptcy on September 15, 2008. During the same month, American International Group (AIG), Merrill Lynch, Fannie Mae, and Freddie Mac also failed or were placed under conservatorship by the U.S. government.

[2]The size of the CDS market as of June 30, 2008 comes from estimates reported by the Bank for International Settlements.

[3]For example, see the speech by Federal Reserve Board Chairman Ben S. Bernanke at the Council on Foreign Relations on March 10, 2009. For an in-depth discussion of the economics of CDS clearinghouse mechanisms, see Duffie and Zhu (2009).

risk on prices in derivatives markets.

Six key results emerge from the empirical analysis. First, we find that there is a significant relation between the credit risk of the dealer and the prices at which the dealer can sell credit protection. As would be expected, the higher the dealer's credit risk, the lower is the price that the dealer can charge for selling credit protection. This confirms that prices in the CDS market respond rationally to the perceived counterparty risk of dealers selling credit protection.

Second, although there is a significant relation between dealer credit risk and the cost of credit protection, we show that the effect on CDS spreads is relatively small. In particular, an increase in the dealer's credit spread of 645 basis points only translates into a one-basis-point decline on average in the dealer's spread for selling credit protection. This small effect is an order of magnitude smaller than what would be expected if swap liabilities were uncollateralized. In contrast, the size of the pricing effect is very consistent with the standard practice among dealers of having their counterparties fully collateralize swap liabilities.

Third, because the Lehman bankruptcy in September 2008 was such a major counterparty credit event in the financial markets, we examine how the pricing of counterparty credit risk was affected by this event. We find that while counterparty credit risk was priced prior to the Lehman bankruptcy, the pricing of counterparty credit risk became much more significant and was adopted by many more CDS dealers after the Lehman bankruptcy. This result is consistent with the widely-held industry view that the Lehman default highlighted the importance of a number of counterparty credit risks that had been largely ignored previously, such as the risk of posted collateral not being segregated or even being rehypothecated, leaving some counterparties with only an unsecured general claim on the bankruptcy estate.

Fourth, we explore whether geography/legal jurisdiction plays a role in the pricing of counterparty credit risk. We find that non-U.S. CDS dealers were less likely to price counterparty credit risk after the Lehman default. This is particularly surprising since U.S. legal protections for clients and counterparties of U.S. dealers (such as hedge funds using the dealer as a prime broker) are generally viewed as being stronger. This result could be consistent with a scenario in which legal and banking reforms in the wake of the financial crisis were expected to be more severe in Europe than in the U.S.

Fifth, we examine whether the CDS dealers with the best credit in the market are able to sell credit protection at a premium during periods of financial distress. This could occur, for example, if there was a "flight to quality" in the credit protection market. We find that the three strongest CDS dealers in the market began to offer credit protection at prices that no longer reflected their counterparty credit risk after the Lehman bankruptcy. Thus, there is some evidence that CDS dealers behave strategically by taking into account their competitive position in the industry while selling credit protection.

Sixth, we study whether the pricing of counterparty credit varies across industries. In theory, the default correlation between the firm underlying the CDS contract and the CDS dealer selling protection on that firm should affect the pricing. Clearly, to take an extreme example, no investor would be willing to buy credit protection on Citigroup from Citigroup itself. Similarly, to take a less extreme example, we might expect the pricing of CDS dealers' credit risk to be more evident in selling credit protection on other financial firms. Surprisingly, we find that counterparty credit risk is priced in the CDS spreads of all firms in the sample except for the financials. One possible explanation for this perplexing result is that the market might anticipate that large CDS dealers could become too large to fail if, but only if, the large financial firms in the CDX index were in danger of defaulting. Since the CDX index includes many large insurers and industrial financing firms such as AIG and GE Capital, this interpretation is very consistent with the actual behavior of the Treasury and its efforts via the TARP program to stabilize the large Wall Street firms making markets in CDS contracts in the wake of the huge losses by AIG and the auto industry.

These results also have many important implications for current proposals to regulate the CDS market. As one example, they argue that market participants may view current CDS risk mitigation techniques such as the overcollateralization of swap liabilities and bilateral netting as largely successful in addressing counterparty credit risk concerns. Thus, proposals to create a central CDS exchange, may not actually be effective in reducing counterparty credit risk further.

This paper contributes to an extensive literature on the effect of counterparty credit risk on derivatives valuation. Important research in this area includes Cooper and Mello (1991), Sorensen and Bollier (1994), Duffie and Huang (1996), Jarrow and Yu (2001), Hull and White (2001), Longstaff (2004, 2009), and many others. The paper most closely related to our paper is Duffie and Zhu (2009) who study whether the introduction of a central clearing counterparty into the CDS market could improve on existing credit mitigation mechanisms such as bilateral netting. They show that a central clearing counterparty might actually increase the amount of credit risk in the market. Thus, our empirical results support and complement the theoretical analysis provided in Duffie and Zhu.

The remainder of this paper is organized as follows. Section 2 provides a brief introduction to the CDS market. Section 3 discusses counterparty credit risk in the context of the CDS markets. Section 4 describes the data. Section 5 examines the effects of dealers' credit risk on spreads in the CDS market. Section 6 summarizes the results and presents concluding remarks.

2. THE CREDIT DEFAULT SWAP MARKET

In this section, we briefly review the basic features of a typical CDS contract. We then discuss the institutional structure of the CDS market.

2.1 CDS Contracts

A CDS contract is best thought of as a simple insurance contract on the event that a specific firm or entity defaults on its debt. As an example, imagine that counterparty A buys credit protection on Amgen from counterparty B by paying a fixed spread of, say, 225 basis points per year for a term of five years. If Amgen does not default during this period of time, then B does not make any payments to A. If there is a default by Amgen, however, then B pays A the difference between the par value of the bond and the post-default value (typically determined by a simple auction mechanism) of a specific Amgen bond. In essence, the protection buyer is able to put the bond back to the protection buyer in the event of a default. Thus, the CDS contract "insures" counterparty A against the loss of value associated with default by Amgen.[4]

2.2 The Structure of the CDS Market

Like interest rate swaps and other fixed income derivatives, CDS contracts are traded in the over-the-counter market between large financial institutions. During the past 10 years, CDS contracts have become one of the largest financial products in the fixed income markets. As of June 30, 2008, the total notional amount of CDS contracts outstanding was $57.325 trillion. Of this notional, $33.083 trillion is with dealers, $13.683 trillion with banks, $0.398 trillion with insurance companies, $9.215 trillion with other financial institutions, and $0.944 trillion with nonfinancial customers.[5]

Early in the development of the CDS market, participants recognized the advantages of having a standardized process for initiating, documenting, and closing out CDS contracts. The chartering of the International Swap and Derivatives Association (ISDA) in 1985 led to the development of a common framework which could then be used by institutions as a uniform basis for their swap and derivative transactions with each other. Currently, ISDA has 830 member institutions. These institutions include virtually every participant in the swap and derivatives markets.

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[4]For a detailed description of the characteristics of CDS contracts, see Longstaff, Mithal, and Neis (2005).

[5]Data obtained from Table 4 of *OTC Derivatives Market Activity for the First Half of 2008*, Bank for International Settlements.

As the central organization of the privately-negotiated derivatives industry, ISDA performs many functions such as producing legal opinions on the enforceability of netting and collateral arrangements, advancing the understanding and treatment of derivatives and risk management from public policy and regulator capital perspectives, and developing uniform standards and guidelines for the derivatives industry.[6]

3. COUNTERPARTY CREDIT RISK

In this section, we first review some of the sources of counterparty credit risk in the CDS market. We then discuss ways in which the industry has attempted to mitigate the risk of losses stemming from the default of a counterparty to a CDS contract.

3.1 Sources of Counterparty Credit Risk

There are at least three ways in which a participant in the CDS market may suffer losses when their counterparty enters into financial distress. First, consider the case in which a market participant buys credit protection on a reference firm from a protection seller. If the reference firm underlying the CDS contract defaults, the protection buyer is then owed a payment from the counterparty. If the default was unanticipated, however, then the protection seller could suddenly be faced with a large loss. If the loss was severe enough, then the protection seller could potentially be driven into financial distress. Thus, the protection buyer might not receive the promised protection payment.

Second, even if the reference firm underlying the CDS contract does not default, a participant in the CDS market could still experience a substantial loss in the event that the counterparty to the contract entered financial distress. The reason for this is that while CDS contracts initially have value of zero when they are executed, their mark-to-market value may diverge significantly from zero over time as credit spreads evolve. Specifically, consider the case where counterparty A has an uncollateralized mark-to-market liability of X to counterparty B. If counterparty A were to enter bankruptcy, thereby canceling the CDS contract and making the liability immediately due and payable, then counterparty B's only recourse would be to attempt to collect its receivable of X from the bankruptcy estate. As such, counterparty B would become a general unsecured creditor of counterparty A. Given that the debt and swap liabilities of Lehman Brothers were settled at only 8.625 cents on the dollar, this could result in counterparty B suffering substantial losses

[6]This discussion draws on the information about ISDA provided on its website www.isda.org.

from the default of counterparty A.[7]

A third way in which a market participant could suffer losses through the bankruptcy of a counterparty is through the collateral channel. Specifically, consider the case where counterparty A posts collateral with counterparty B, say because counterparty B is counterparty A's prime broker. Now imagine that the collateral is either not segregated from counterparty B's general assets (as was very typical prior to the Lehman default), or that counterparty B rehypothecates counterparty A's collateral (also very common prior to the Lehman default). In this context, a rehypothecation of collateral is the situation in which counterparty B transfers counterparty A's collateral to a third party (without transferring title to the collateral) in order to obtain a loan from the third party. Buhlman and Lane (2009) argue that under certain circumstances, the rehypothecated securities become part of the bankruptcy estate. Thus, if counterparty B filed for bankruptcy after rehypothecating counterparty A's collateral, or if counterparty A's collateral was not legally segregated, then counterparty A would become a general unsecured creditor of counterparty B for the amount of the collateral, again resulting in large potential losses. An even more precarious situation would be when the rehypothecated collateral itself was seized and sold by the third party in response to counterparty B's default on the loan obtained using the rehypothecated securities as collateral. Observe that because of this collateral channel, counterparty A could suffer significant credit losses from counterparty B's bankruptcy, even if counterparty B does not actually have a mark-to-market liability to counterparty A stemming from the CDS contract.

3.2 Mitigating Counterparty Credit Risk

One of the most important ways in which the CDS market attempts to mitigate counterparty credit risk is through the market infrastructure provided by ISDA. In particular, ISDA has developed specific legal frameworks for standardized master agreements, credit support annexes, and auction, close-out, credit support, and novation protocols. These ISDA frameworks are widely used by market participants and serve to significantly reduce the potential losses arising from the default of a counterparty in a swap or derivative contract.[8]

Master agreements are encompassing contracts between two counterparties that

[7] The settlement amount was based on the October 10, 2008 Lehman Brothers credit auction administered by Creditex and Markit and participated in by 14 major Wall Street dealers. See the Lehman auction protocol and auction results provided by ISDA.

[8] Bliss and Kaufman (2006) provide an excellent discussion of the role of ISDA and of netting, collateral, and closeout provisions in mitigating systemic credit risk.

detail all aspects of how swap and derivative contracts are to be executed, confirmed, documented, settled, etc. Once signed, all subsequent swaps and derivative transactions become part of the original master swap agreement, thereby eliminating the need to have separate contracts for each transaction. An important advantage of this structure is that it allows all contracts between two counterparties to be netted in the event of a default by one of the counterparties. This netting feature implies that when default occurs, the market value of all contracts between counterparties A and B are aggregated into a net amount, leaving one of the two counterparties with a net liability to the other. Without this feature, counterparties might have incentives to demand payment on contracts on which they have a receivable, but repudiate contracts on which they have a liability to the defaulting counterparty.

Credit support annexes are standardized agreements between counterparties governing how credit risk mitigation mechanisms are to be structured. For example, a specific type of credit risk mitigation mechanism is the use of margin calls in which counterparty A demands collateral from counterparty B to cover the amount of counterparty B's net liability to counterparty A. The credit support annex specifies details such as the nature and type of collateral to be provided, the minimum collateral transfer amount, how the collateral amount is to be calculated, etc.

ISDA protocols specify exactly how changes to master swap agreements and credit support annexes can be modified. These types of modifications are needed from time to time to reflect changes in the nature of the markets. For example, the increasing tendency among market participants to close out positions through novation rather than by offsetting positions motivated the development of the 2006 ISDA Novation Protocol II. Similarly, the creation of a standardized auction mechanism for settling CDS contracts on defaulting firms motivated the creation of the 2005-2009 ISDA auction protocols and the 2009 ISDA close-out amount protocol.

An important second way in which counterparty credit risk is minimized is through the use of collateralization. Recall that the value of a CDS contract can diverge significantly from zero as the credit risk of the reference firm underlying the contract varies over time. As a result, each counterparty could have a significant mark-to-market liability to the other at some point during the life of the contract. In light of the potential credit risk, full collateralization of CDS liabilities has become the market standard. For example, the ISDA Margin Survey 2009 reports that 74 percent of CDS contracts executed during 2008 were subject to collateral agreements and that the estimated amount of collateral in use at the end of 2008 was approximately $4.0 trillion. Typically, collateral is posted in the form of cash or government securities. Participants in the Margin Survey indicate that approximately 80 percent of the ISDA credit support agreements are bilateral, implying two-way transfers of collateral between counterparties. Of the 20 largest respondents to the survey (all large CDS dealers), 50 percent of their collateral agreements are with hedge funds and institutional investors, 15 percent are with corporations, 13 percent are with banks, and 21 percent are with others.

The data set used in this study represents the CDS spreads at which the largest Wall Street dealers actually sell, or are willing to sell, credit protection. Both discussions with CDS traders and margin survey evidence indicate that the standard practice by these dealers is to require full collateralization of swap liabilities by both counterparties to a CDS contract. In fact, the CDS traders we spoke with reported that the large Wall Street dealers they trade with typically require that their non-dealer counterparties overcollateralize their CDS liabilities slightly. This is consistent with the ISDA Margin Survey 2009 that documents that the 20 largest firms accounted for 93 percent of all collateral received, but only 89 percent of all collateral delivered, suggesting that there was a net inflow of collateral to the largest CDS dealers. Furthermore, the degree of overcollateralization required can vary over time. As an example, one reason for the liquidity problems at AIG that led to emergency loans by the Federal Reserve was that AIG would have been required to post additional collateral to CDS counterparties if AIG's credit rating had downgraded further.[9]

At first glance, the market standard of full collateralization seems to suggest that there may be little risk of a loss from the default of a Wall Street credit protection seller. This follows since the protection buyer holds collateral in the amount of the protection seller's CDS liability. In actuality, however, the Wall Street practice of requiring non-dealer protection buyers to slightly overcollateralize their liabilities actually creates a subtle counterparty credit risk. To illustrate this, imagine that a protection buyer has a mark-to-market liability to the protection seller of \$15 per \$100 notional amount. Furthermore, imagine that the protection seller requires the protection buyer to post \$17 in collateral. Now consider what occurs if the protection seller defaults. The bankruptcy estate of the protection seller uses \$15 of the protection buyer's collateral to offset the \$15 mark-to-market liability. Rather than returning the additional \$2 of collateral, however, this additional capital becomes part of the bankruptcy estate. This implies that the protection buyer is now an unsecured creditor in the amount of the \$2 excess collateral. Thus, in this situation, the protection buyer could suffer a significant loss even though the buyer actually owed the defaulting counterparty on the CDS contract.

This scenario is far from hypothetical. In actuality, a number of firms experienced major losses on swap contracts in the wake of the Lehman bankruptcy because of their net exposure (swap liability and offsetting collateral) to Lehman.[10]

[9]For example, see the speech by Federal Reserve Chairman Ben S. Bernanke before the Committee on Financial Services, U.S. House of Representatives, on March 24, 2009.

[10]From the October 7, 2008 Financial Times: "The exact amount of any claim is

4. THE DATA

Fixed-income securities and contracts are traded primarily in over-the-counter markets. For example, Treasury bonds, agency bonds, sovereign debt, corporate bonds, mortgage-backed securities, bank loans, corporate bonds, interest rate swaps, and CDS contracts are all traded in over-the-counter markets. Because to the inherent decentralized nature of these markets, however, actual transaction prices are difficult to observe. This is why most of the empirical research in the financial literature about fixed-income markets has typically been based on the quotation data available to participants in these markets.

We were fortunate to be given access to an extensive proprietary data set of CDS prices by one of the largest fixed-income asset management firms in the financial markets. A unique feature of this data set is that it contains both actual CDS transaction prices for contracts entered into by this firm as well as *actionable* quotations provided to the firm by a variety of CDS dealers. These quotations are actionable in the sense that the dealers are keenly aware that the firm expects to be able to trade (and often does) at the prices quoted by the dealers (and there are implicit sanctions imposed on dealers who do not honor their quotations). Thus, these quotations should more closely represent actual market prices than the indicative quotes typically used in the fixed-income literature.

In this paper, we study the spreads associated with contracts in which 14 major CDS dealers sell five-year credit protection to the fixed-income asset management firm on the 125 individual firms in the widely-followed CDX index. The sample period for the study is March 31, 2008 to January 20, 2009. This period covers the turbulent Fall 2008 period in which Fannie Mae, Freddie Mac, Lehman Brothers, AIG, etc. entered into financial distress and counterparty credit fears reached their peak. Thus, this sample period is ideally suited for studying the effects of counterparty credit risk on financial markets.

The transactions data in the sample are taken from a file recording the spreads on actual CDS contracts executed by the firm in which the firm is buying credit protection. There are a roughly one thousand transactions in this file. The average transaction size is $6.5 million and the average maturity of these contracts is 4.9 years. All 14 of the major CDS dealers to be studied in this paper are included in this file. Thus, all 14 of these dealers sold credit protection to the asset-management firm during the sample period. Of these transactions, however, most involve either

determined by the difference between the value of the collateral and the cost of replacing the contract. . . . Moreover, many counterparties to Lehman who believe it owes them money have joined the ranks of unsecured creditors."

firms that are not in the CDX index, or contracts with maturities significantly different from five years. Screening out these trades results in a sample of several hundred observations.

To augment the sample, we also include quotes provided directly to the firm by the CDS dealers selling protection on the firms in the CDX index. As described above, these quotes represent firm offers to sell protection and there can be sanctions for dealers who fail to honor their quotes. For example, if the asset management firm finds that a dealer is often not willing to execute new trades (or unwind existing trades) at quoted prices, then that dealer could be dropped from the list of dealers that the firm's traders are willing to do business with. Given the large size of the asset management firm providing the data, the major CDS dealers included in the study have strong incentives to provide actionable quotes.

There are a number of clear indications that the dealers respond to these incentives and provide reliable quotes. First, the dealers included in the study frequently update their quotes throughout the trading day. The total number of quotations records in the data set for firms in the CDX index is 673,060. This implies an average of 2.19 quotations per day per dealer for each of the firms in the sample. Thus, quotes are clearly being refreshed throughout the trading day. Second, we compare the actual prices from our sample of transactions with the quotation in the market (if available) on the day that the transaction is executed. On average, the transaction prices and the quotes are within a basis point or two of each other, representing a difference of only about one to two percent.[11] Third, the fact that all 14 of the CDS dealers sold protection to the asset-management firm during the sample period suggests that each was active in providing competitive and actionable quotes during this period.

As mentioned, dealers frequently update their quotations throughout the day to insure that they are current. Since our objective is to study whether the cross sectional dispersion in dealer prices is related to counterparty credit risk, it is important that we focus on dealer prices that are as close to contemporaneous as possible. To this end, we extract quotes from the data set in the following way. First, we select 11:30 AM as the reference time. For each of the 14 CDS dealers, we then include the quote with time stamp nearest to 11:30 AM, but within 15 minutes (from 11:15 to 11:45 AM). In many cases, of course, there may not be a quote within this 30-minute period. Thus, we will generally have fewer than 14 prices or quotes available for each firm each day. For a firm to be included in the sample for a particular day, we require that there be two or more prices or quotes

[11]This comparison is necessarily a little noisy since the transaction prices are not time stamped within the day, and we are comparing them to quotes available in the market at roughly 11:30 A.M.

for that firm. We repeat this process for all days and firms in the sample.

This algorithm results in a set of 13,383 observation vectors of synchronous prices or quotations by multiple CDS dealers for selling protection on a common underlying reference firm. Since there are 212 trading days in the sample period, this implies that we have data for multiple CDS dealers for an average of 63.13 firms each day. Table 1 presents summary statistics for the data. As shown, the number of synchronous quotes ranges from two to nine. On average, an observation includes 3.073 dealer quotes for the reference firm for that day. Table 1 also shows that the variation in the quotes provided by the various dealers is relatively modest. For most of the observations, the range of CDS quotations is only on the order of two to three basis points, and the median range is three basis points.

In addition to the prices and quotes provided by the dealers selling protection, we also need a measure of the counterparty credit risk of the dealers themselves. To this end, we obtain daily midmarket five-year CDS quotes referencing each of the 14 major CDS dealers in the study. The midmarket spreads for these CDS contracts are obtained from the Bloomberg system and reflect the market's perception of the counterparty credit risk of the dealers selling credit protection to the asset management firm.

Table 2 reports summary statistics for the CDS spreads for these dealers. As shown, the average CDS spread ranges from a low of 59.40 basis points for BNP Paribas to a high of 355.10 basis points for Morgan Stanley. Note that CDS data for Lehman Brothers and Merrill Lynch are included in the data set even though these firms either went bankrupt or merged during the sample period. The reason for including these firms is that both were actively making markets in selling credit protection through much of the sample period. Thus, their spreads may be particularly informative about the impact of perceived counterparty credit risk on CDS spreads.

5. EMPIRICAL ANALYSIS

In this section, we begin by briefly describing the methodology used in the empirical analysis. We then test whether counterparty credit risk is reflected in the prices of CDS contracts. Next, we examine whether there are differences across CDS dealers in terms of how they price their own credit risk. We also explore whether there are differences in how counterparty credit risk is priced based on geography/legal jurisdiction. We examine whether the CDS dealers with the best credit take advantage of their strong competitive position when pricing counterparty credit risk. Finally, we study whether the pricing of counterparty credit risk by dealers varies by industry as would be implied by a correlation-based credit model.

5.1 Methodology

For each reference firm and for each date t in the sample, we have simultaneous prices from multiple CDS dealers for selling five-year credit protection on that firm. Thus, we can test directly whether counterparty credit risk is priced by a straightforward regression of the price of protection sold or quoted by a dealer for a reference firm on the price of protection for the dealer itself providing that quotation. In this panel regression framework, we allow for reference-firm-specific date fixed effects. Specifically, we estimate the following regression

$$CDS_{i,j,t} \;=\; \alpha' \, F_{i,t} \; + \beta \, \text{Spread}_{j,t-1} \;+\; \epsilon_{i,j,t}, \tag{1}$$

where $CDS_{i,j,t}$ denotes the CDS spread for credit protection on reference firm i sold or quoted by dealer j at date t, α is a vector of regression coefficients, $F_{i,t}$ is a fixed-effects vector with value one for firm i at date t, and zero for all other elements, and $\text{Spread}_{j,t-1}$ is the CDS spread for dealer j as of the end of the previous day.[12] Under the null hypothesis that counterparty credit risk is not priced, the slope coefficient β is zero. The t-statistics for β reported in the tables are based on the White (1980) heteroskedastic-consistent estimate of the covariance matrix.

As shown in Table 1, there are a total of 13,383 observation vectors in the sample. On average, each observation vector consists of 3.073 distinct quotations for selling credit protection on the reference firm, giving a total of 41,122 observations collectively. Thus, there are 339.85 observations on average for each of the 121 reference firms in the sample.

5.2 Is Counterparty Credit Risk Priced?

Although a formal model of the relation between a dealer's credit risk and the price at which the dealer could sell credit protection could be developed, the underlying economics of the transaction makes it clear that there should be a negative relation between the two. Specifically, as the credit risk of a protection seller increases, the value of the protection being sold is diminished and market participants would not be willing to pay as much for it. Thus, if counterparty credit risk is priced in the market, the slope coefficient β in the regressions should be negative.

Table 3 reports the regression results. The slope coefficient β is -0.001548 with

[12] We use the dealer's spread as of $t-1$ rather than t since the dealer data is as of the end of the day while the *CDS* quotation data is taken from a narrow timeframe centered at 11:30 A.M. Thus, using the dealer's spread as of the end of day $t-1$ avoids using *ex post* data in the regression.

a t-statistic of -7.31. Thus, the empirical results strongly support the hypothesis that counterparty credit risk is priced in the CDS market. Furthermore, the sign of the coefficient is negative, consistent with the economic intuition.

5.3 Why is the Effect so Small?

Although statistically very significant, the slope coefficient is relatively small in economic terms. In particular, the value of -0.001548 implies that the credit spread of a CDS dealer would have to increase by nearly 645 basis points to result in a one-basis-point decline in the price of credit protection. As shown in Table 2, credit protection on most of CDS dealers in the sample never even reached 645 basis during the period under study. These results are consistent with the results in Table 1 suggesting that the cross-sectional variation in the dealers' quotes for selling credit protection on a specific reference firm is only on the order of several basis points.

A number of papers have explored the theoretical magnitude of counterparty credit risk on the pricing of interest rate swaps. Important examples of this literature include Cooper and Mello (1991), Sorensen and Bollier (1994), and Duffie and Huang (1996). Typically, these papers find that since the notional amount is not exchanged in an interest rate swap, the effect of counterparty credit risk on an interest rate swap is very small, often only a basis point or two.

Unlike an interest rate swap, however, a CDS contract could involve a very large payment by the protection seller to the protection buyer. For example, sellers of protection on Lehman Brothers were required to pay $91.375 per $100 notional to settle their obligations to protection buyers. Thus, the results from the interest rate swap literature may not necessarily be directly applicable to the CDS market.

A few recent papers have focused on the theoretical impact of counterparty credit risk on the pricing of CDS contracts. Important examples of these papers include Jarrow and Yu (2001), Hull and White (2001), Brigo and Pallavicini (2006), Kraft and Steffensen (2007), Segoviano and Singh (2008), and Blanchet-Scalliet and Patras (2008). In general, estimates of the size of the effect of counterparty credit risk in this literature tend to be orders of magnitude larger than those in the literature for interest rate swaps. For example, estimates of the potential size of the pricing effect range from 7 basis points in Kraft and Steffensen to more than 20 basis points in Hull and White, depending on assumptions about the default correlations of the protection seller and the underlying reference firm. Thus, this literature tends to imply counterparty credit risk pricing effects many times larger than those we find in the data.

It is crucial to recognize, however, that this literature focuses almost exclusively on the case in which CDS contract liabilities are not collateralized. As was discussed earlier, the standard market practice during the sample period would be to require full collateralization by both counterparties to a CDS contract. This would be particularly true for CDS contracts in which one counterparty was a large Wall Street CDS dealer.

In theory, full collateralization of CDS contract liabilities would appear to imply that there should be no pricing of counterparty credit risk in CDS contracts. In reality, however, there are several reasons why there might still be a small pricing effect even if counterparties require full collateralization. First, as became clear after the Lehman bankruptcy, counterparties who post collateral in excess of their liabilities risk becoming unsecured creditors of a defaulting counterparty for the amount of the excess collateral. As discussed earlier, however, Wall Street CDS dealers often require a small amount of overcollateralization from their counterparties (typically on the order of several percent) thus creating the possibility of a slight credit loss (ironically, however, only when the counterparty owes the bankrupt firm money). Second, the Lehman bankruptcy also showed that there were a number of legal pitfalls that many market participants had not previously appreciated. These include the risk of unsegregated margin accounts or the disposition of rehypothecated collateral.

In summary, the size of the counterparty pricing effect in the CDS market appears much too small to be explained by models that abstract from the collateralization of CDS contracts. Rather, the small size of the pricing effect appears more consistent with the standard market practice of full collateralization, or even overcollateralization, of CDS contract liabilities.

5.4 Did Pricing of Counterparty Credit Risk Change?

The discussion above suggests that the Lehman bankruptcy event may have forced market participants to reevaluate the risks inherent in even fully collateralized counterparty relationships. If so, then the pricing of counterparty credit after the Lehman bankruptcy might differ from the pricing in the CDS market previous to the bankruptcy. To explore this possibility, we split the sample into the pre-Lehman and post-Lehman periods, and estimate the regression separately for each. Table 3 also reports the results from these regressions.

The results show that counterparty credit risk is significantly priced in both the pre-Lehman and post-Lehman periods. Interestingly, however, the effect seems to be much stronger in the post-Lehman period. In particular, the slope coefficient for the pre-Lehman period is -0.000991, while the slope coefficient for the post-Lehman period of -0.001704 is almost twice as large. These two values imply that an increase in the CDS dealer's credit spread of 1009.08 and 586.85 basis points, respectively, map into a one-basis-point decrease in the price at which the dealer can sell credit protection.

How should these results be interpreted? One possibility is that prior to the Lehman bankruptcy, the market viewed the practice of collateralization as largely effective in mitigating counterparty credit risk. Subsequently, however, the market underwent a regime shift as it realized that even Lehman was not too large to fail and that there were numerous legal pitfalls inherent in even a collateralized counterparty relationship.

5.5 Are there Differences Across Dealers?

An interesting issue that our data set allows us to explore is whether there are differences across dealers in how counterparty credit risk is priced. In theory, one might expect that counterparty credit risk would be priced symmetrically across dealers. In reality, however, there are important differences in the microstructure and legal framework of the CDS market that could introduce asymmetries into the pricing of counterparty credit risk.

To test for cross sectional differences across dealers, we estimate the following extended panel regression specification, again with fixed effects for each date for each firm

$$CDS_{i,j,t} \;=\; \alpha' \, F_{i,t} \; + \beta' \, I \; \text{Spread}_{j,t-1} \;+\; \epsilon_{i,j,t}, \tag{2}$$

where β is now a vector of slope coefficients, and I is a vector of indicators where element I_j takes value one for dealer j and zero otherwise. As before, we estimate the regression for the full sample as well as the pre-Lehman and post-Lehman subperiods.

Before reporting the results, we first need to explain that under the terms by which we were given access to the data, we cannot provide information that identifies specific dealers. Thus, we are not able to attach specific dealer names to the regression coefficients we estimate. Despite this handicap, however, the regression results still have the potential to provide interesting insights into the pricing of counterparty credit risk. Table 4 reports the regression results. The results are listed for each dealer, where a number from 1 to 14 has been randomly assigned. Thus, there is no relation between the ordering of dealers in Table 2 and those in this table.

As shown, there are clearly cross-sectional differences in how counterparty credit risk is priced. Of the 14 CDS dealers, eight have statistically significant coefficients. Five of these have negative signs, consistent with economic intuition. On the other hand, there are three CDS dealers with significant positive coefficients, which is clearly a puzzling result.

The magnitudes of the significant coefficients vary widely across dealers. The largest in absolute magnitude has a value of -0.012882, implying that the price of credit protection sold by this dealer decreases by a basis point for every 77.6 basis points that the dealer's CDS spread increases. The absolute magnitude of the other coefficients are generally much smaller and are consistent with those reported in Table 3.

Turning to the subperiod results, Table 4 shows that only two dealers had significant coefficients during the pre-Lehman period. Both of these significant coefficients are negative. In the post-Lehman period, the number of dealers with significant coefficients increases to seven, five of which are negative. Thus, the results indicate that there was a definite increase in the number of dealers pricing their own counterparty credit risk in the aftermath of the Lehman default. In other words, the shock of the Lehman bankruptcy resulted in a significant change in the way that many CDS dealers do business. Interestingly, one of the anonymous 14 dealers in the sample had a very significant negative coefficient during the pre-Lehman period, but drops out of the sample during the post-Lehman period.

5.6 Does Geography/Legal Jurisdiction Matter?

One of the important lessons of the recent crisis in the financial markets is that the underlying nature of counterparty credit risk itself could vary across legal jurisdictions. In particular, U.S. law provides much stronger protection to clients of prime brokers in regards to the rehypothecation of collateral than does the U.K. A recent paper by Singh and Aitken (2009) explains that how the Securities Act of 1933, the Securities Exchange Act of 1934, and the Securities Investor Protection Act of 1970 offer U.S. investors protections not available in the U.K. They argue that because of these statutory protections, customers of Lehman Brothers Inc. (U.S.) may be treated more advantageously than the customers of Lehman Brothers International (Europe). The dealers headquartered in the U.S. are Bank of America, Citigroup, Goldman Sachs, JP Morgan, Lehman, Merrill Lynch, and Morgan Stanley. Thus, the sample is fairly evenly split between U.S. and non-U.S. dealers.

To examine whether legal jurisdiction matters, we estimate the following regression specification

$$CDS_{i,j,t} \ = \ \alpha' \ F_{i,t} \ + \beta' \ I \ \text{Spread}_{j,t-1} \ + \ \epsilon_{i,j,t}, \tag{3}$$

where I is vector of two indicator variables, one for U.S. dealers and the other for non-U.S. dealers. The regression is estimated for the full sample and for the two pre-Lehman and post-Lehman subperiods. The regression results are reported in Table 5.

The results are surprising. Counterparty credit risk is significantly negatively priced in the CDS spreads provided by U.S. dealers during the full period, the pre-Lehman period, and the post-Lehman period. The values of the coefficients for these dealers are very similar across all three of these sample periods.

In contrast, counterparty credit risk is significantly priced by the non-U.S. dealers during the pre-Lehman period. During the post-Lehman period, however, the dummy variable for the non-U.S. dealers is no longer significant. Thus, the regression results are essentially the reverse of what we would have expected since the pricing of counterparty credit risk appears to be the most significant in the U.S. where legal protections are the strongest for financial institutions buying credit protection. One possible interpretation of these counterintuitive results might be that legal and banking reforms in Europe in the wake of the Lehman bankruptcy were anticipated to be much more comprehensive than those that might be enacted in the U.S. of the Lehman bankruptcy.

5.7 Do Dealers Behave Strategically?

An interesting additional issue to explore is whether the CDS dealers in the sample act strategically in terms of their offers to sell credit protection. For example, many market participants wanted to buy credit protection during the financial crisis, but were very concerned about the counterparty credit risk of the protection sellers. In this situation, there might have been a "flight to quality" by protection buyers. If so, then the strongest CDS dealers in the market might find that they were able to sell credit protection at a premium, or at least, not need to discount their own credit as much as would otherwise be the case.

To explore the possibility that the top CDS dealers might be strategically adjusting their offers in response to their competitive position, we reestimate the regressions with the following specification

$$CDS_{i,j,t} \; = \; \alpha' \; F_{i,t} \; + \beta' \; I \; \text{Spread}_{j,t-1} \; + \; \epsilon_{i,j,t}, \tag{4}$$

where I is now a vector of two dummy variables, where I_1 takes value one if dealer j has one of the three lowest credit spreads among the dealers in the sample at date $t-1$, and zero otherwise, and vice versa for I_2. The results from this regression are reported in Table 6.

The results are very intriguing. The dummy variables for top three CDS dealers and the other CDS dealers are significant and negative for the overall period as well as for the pre-Lehman period. In fact, the pricing of counterparty credit risk seems to be more pronounced for the top three dealers; the coefficient for the top three dealers is more than double that for the other dealers for the overall period as well as for the pre-Lehman period.

This pattern, however, changes after the Lehman bankruptcy. The coefficient for the top three dealers actually changes signs and becomes positive during the post-Lehman period, although it is not statistically significant. Thus, the top three dealers completely change their approach to pricing their counterparty credit risk after the crisis. Prior to the crisis, they price their counterparty credit risk more aggressively than the others; after the crisis, they no longer price their counterparty credit risk, while the other firms become more aggressive in pricing theirs. This evidence is consistent with the interpretation that the top CDS dealers behaved strategically with respect to their competitive advantage in a post-Lehman market dominated by concerns about counterparty credit risk. Note that since many of the strongest credits among CDS dealers after the Lehman crisis were European, this finding may help explain the puzzling results in the previous section.

5.8 Are there Differences Across Firms?

A number of recent papers have emphasized the role that the default correlation between the protection seller and the reference firm should play in determining CDS spreads. To illustrate the importance of correlation, let us take it to an extreme and imagine that Citigroup is willing to sell credit protection against the event that Citigroup itself defaults. Clearly, no one would be willing to pay Citigroup for this credit protection.[13] Similarly, a financial institution selling credit protection on another financial institution might not be able to charge as much for selling credit protection as a nonfinancial seller might.[14]

To explore the effects of correlation on the price of credit protection, we do the following. First, we classify the firms in the CDX index that are in our sample into one of five broad industry categories: consumer, energy, financials, industrials, and technology. We then reestimate the regressions using the following specification

$$CDS_{i,j,t} \ = \ \alpha' \ F_{i,t} \ + \beta' \ I \ \text{Spread}_{j,t-1} \ + \ \epsilon_{i,j,t}, \tag{5}$$

where I is now a vector of indicator variables for the various industries represented by the firms in the CDX index. As before, we estimate the regression for the full sample as well as for the pre-Lehman and post-Lehman periods. The regression results are reported in Table 7.

As shown, counterparty credit risk is priced consistently in each regression

[13] It is interesting to note, however, that a number of European banks sell credit protection on the iTraxx index which includes these banks as index components.

[14] Examples of recent papers discussing the role of correlation in the pricing of CDS contracts include Hull and White (2001), Jarrow and Yu (2001), Longstaff, Mithal, and Neis (2005), Yu (2007), and many others.

for the energy, industrial, and technology firms in the sample. Specifically, the slope coefficients for the dummy variables for firms in these three industries are significantly negative and comparable in magnitude for the full period, the pre-Lehman period, and the post-Lehman period. The coefficients for the energy and technology regressions for the full period are very similar in magnitude, and are about twice as large as the coefficient for the industrial firms. Thus, the results suggest that there are important differences across industries in how CDS dealers price counterparty credit risk.

The results for the consumer sector are mixed. Counterparty credit risk is significantly priced over the full period, but this seems to be due to a strong relationship coming from the post-Lehman period. In particular, counterparty credit risk is not priced during the pre-Lehman period for the firms in this sector. The magnitude of the significant coefficients, however, are not as large as those for the energy and technology sectors.

The most puzzling and counterintuitive results, however, are those for the financial sector. As described above, the correlation argument suggests that the counterparty credit risk for the CDS dealers should be most evident when they are selling protection on firms in the financial industry. In sharp contrast to this intuition, however, the results show that the CDS dealers' counterparty credit risk is not priced in the spreads of CDS contracts on financial firms in any of the three periods. Thus, far from being the most sensitive to counterparty credit risk, financial firms in the CDX index are the only category in the sample for which counterparty credit risk is not priced.

What factors might help account for this perplexing result? First of all, the financial firms in the CDX index consist primarily of insurance firms, industrial lenders, consumer finance firms, and real estate companies. Thus, it is possible that the default risk of these firms in the CDX index may actually be much less correlated with that of the CDS dealers than one might expect based on their designation as financials. Second, counterparty credit risk might not be priced in the cost of selling protection on the large financial firms in the CDX index if the market believed that the CDS dealers would become too big to fail when these large financial firms in the CDX index became vulnerable to default. Thus, this possibility suggests that there might be a state contingent aspect to a CDS dealer becoming too large to fail. CDS dealers might be allowed to fail when industrials or energy firms are defaulting, but not when the overall financial sector is distressed. Given that some of the large financial firms in the CDX index include AIG and GE Capital, this hypothesis is clearly consistent with recent government policy interventions in the financial markets during the recent crises on Wall Street.

6. CONCLUSION

We examine the extent to which the credit risk of a dealer offering to sell credit protection is reflected in the prices at which the dealer can sell protection. We find strong evidence that counterparty credit risk is priced in the market; the higher the credit risk of a dealer, the lower is the price at which the dealer can sell credit protection in the market. The magnitude of the effect, however, is fairly small. In particular, an increase in the credit spread of a dealer of about 645 basis points maps into only a one-basis-point decline in the price of credit protection.

The price of counterparty credit risk appears to be too small to be explained by models that assume that CDS liabilities are unsecured. The pricing of counterparty credit risk, however, seems consistent with the standard market practice of requiring full collateralization, or even the overcollateralization of CDS liabilities. This view appears supported by the evidence that counterparty credit risk was more significantly priced after the Lehman default which industry sources say revealed potential weaknesses with existing collateral protocols and/or legal protections.

These results are also informative about how financial institutions respond to major shocks. We find that many firms began to price their counterparty credit risk after the Lehman bankruptcy. There is evidence, however, that the top credit-quality dealers behaved strategically in light of their strong competitive position. Curiously, CDS dealers in the U.S. appear to have behaved differently than those in Europe and Asia. Furthermore, CDS dealers seem to adjust their pricing of counterparty risk based on the industry to which the underlying firm belongs. The effect, however, is the reverse of what might be expected by a standard default correlation model. Thus, the results pose a puzzle that may require the introduction of a formal model of the too-large-to-fail phenomenon among large CDS dealers in order to reconcile the findings.

These results also have implications for current proposals about restructuring derivatives markets. For example, since market participants appear to price counterparty credit risk as it were only a relatively minor concern, this suggests that attempts to mitigate counterparty credit risk through alternative approaches, such as the creation of a central clearinghouse for CDS contracts, may not be as effective as might be anticipated. This implication parallels and complements the conclusions in the recent paper by Duffie and Zhu (2009).

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Table 1

The Distribution of Dealer Prices and Quotes. This table provides summary statistics for the distribution of dealer prices or quotes for CDS contracts referencing the firms in the CDX index. The panel on the left summarizes the distribution in terms of the number of dealer spreads on a given day for a CDS contract referencing a specific firm. The panel on the right summarizes the distribution in terms of the range of dealer spreads (R measured in basis points) on a given day for a CDS contract on a specific reference firm. Only days on which two or more simultaneous prices or quotes are available for a specific firm are included in the sample as an observation. The sample period is March 31, 2008 to January 20, 2009.

Number of Quotes	Observations	Percentage	Range of Quotes	Observations	Percentage
2	4907	36.66	0	1175	8.78
3	4518	33.78	$0 < R \leq 1$	1952	14.59
4	2566	19.17	$1 < R \leq 2$	2298	17.17
5	1012	7.56	$2 < R \leq 3$	1925	14.38
6	267	1.99	$3 < R \leq 4$	1065	7.96
7	84	0.62	$4 < R \leq 5$	1800	13.44
8	21	0.16	$5 < R \leq 10$	2209	16.51
9	8	0.06	$10 < R \leq 20$	748	5.59
			$20 < R$	211	1.58
Total	13383	100.00	Total	13383	100.00

Table 2

Summary Statistics for CDS Contracts Referencing Dealers. This table provides summary statistics for the CDS spreads (in basis points) for contracts referencing the dealers listed below. The spreads are based on daily observations obtained from the Bloomberg system. N denotes the number of days on which Bloomberg quotes are available for the indicated dealer. The sample period is March 31, 2008 to January 20, 2009.

Dealer	Mean	Standard Deviation	Minimum	Median	Maximum	N
Barclays	122.65	43.33	53.27	122.17	261.12	212
BNP Paribas	59.40	13.29	34.24	59.08	107.21	212
Bank of America	121.60	35.77	61.97	119.75	206.85	209
Citigroup	180.67	71.13	87.55	162.90	460.54	207
Credit Suisse	111.66	37.20	57.59	101.40	194.22	212
Deutsche Bank	96.88	29.70	51.92	90.11	172.00	212
Goldman Sachs	230.58	110.62	79.83	232.69	545.14	177
HSBC	75.41	21.94	41.84	67.59	128.30	212
JP Morgan	110.86	27.96	62.54	107.68	196.34	209
Lehman	291.79	89.01	154.04	285.12	641.91	84
Merrill Lynch	243.19	71.34	114.35	218.43	472.72	193
Morgan Stanley	355.10	236.22	108.06	244.98	1360.00	187
Royal Bank of Scotland	116.45	45.16	55.17	110.69	304.89	212
UBS	139.09	56.81	55.45	126.24	320.80	212

Table 3

Results from the Regression of CDS Spreads on the CDS Spread of the Corresponding Dealer. This table reports the results from the regression of CDS prices or quotations for the firms in the CDX Index on the CDS spread of the dealer providing the CDS price or quotation. The regression includes a separate fixed effect dummy variable for each date for each firm. The Full Period is March 31, 2008 to January 20, 2009; the Pre-Lehman Period is March 31, 2008 to September 14, 2008; the Post-Lehman Period is September 15, 2008 to January 20, 2009. The t-statistics are based on the White (1980) heteroskedasticity-consistent estimate of the covariance matrix. The superscript ** denotes significance at the five-percent level; the superscript * denotes significance at the ten-percent level.

$$CDS_{i,j,t} \ = \ \alpha' \ F_{i,t} \ + \ \beta \ \text{Spread}_{j,t-1} \ + \ \epsilon_{i,j,t}$$

	Full Period		Pre-Lehman Period		Post-Lehman Period	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
Spread	−0.001548	−7.31**	−0.000991	−3.73**	−0.001704	−6.53**
N		41122		32178		8944

Table 4

Results from Regression of CDS Spreads on the CDS Spread of the Corresponding Dealer Interacted with Dummy Variables for the Individual Dealers. This table reports the results from the regression of CDS prices or quotations for the firms in the CDX Index on the CDS spread of the dealer providing the CDS price or quotation interacted with a vector of dummy variables I where element I_j takes value one if the CDS spread for the firm is provided by the j-th dealer, and zero otherwise. The regression includes a separate fixed effect dummy variable for each date for each firm. The Full Period is March 31, 2008 to January 20, 2009; the Pre-Lehman Period is March 31, 2008 to September 14, 2008; the Post-Lehman Period is September 15, 2008 to January 20, 2009. The t-statistics are based on the White (1980) heteroskedasticity-consistent estimate of the covariance matrix. The superscript ** denotes significance at the five-percent level; the superscript * denotes significance at the ten-percent level.

$$CDS_{i,j,t} \;=\; \alpha' \, F_{i,t} \;+\; \beta' \, I \; \text{Spread}_{j,t-1} \;+\; \epsilon_{i,j,t}$$

Dummy Variable	Full Period		Pre-Lehman Period		Post-Lehman Period	
	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
Dealer_1	−0.012882	−4.40**	−0.004550	−0.61	−0.015631	−4.17**
Dealer_2	0.006164	2.02**	0.008208	1.70*	−0.010393	−1.80*
Dealer_3	−0.000120	−0.10	−0.001286	−0.66	−0.003488	−1.09
Dealer_4	−0.000248	−0.32	0.001306	0.89	−0.004139	−2.35**
Dealer_5	0.000289	0.19	−0.003737	−1.59	−0.001028	−0.27
Dealer_6	−0.001480	−1.36	−0.004499	−1.84*	0.000530	0.15
Dealer_7	−0.001470	−2.73**	−0.003037	−2.07**	−0.002475	−2.24**
Dealer_8	0.005068	1.45	0.002752	0.63	0.004207	0.24
Dealer_9	0.004099	3.26**	−0.001414	−0.67	0.008266	2.25**
Dealer_{10}	−0.002929	−7.06**	−0.003439	−4.76**	−−−	−−−
Dealer_{11}	−0.001210	−3.12**	−0.000656	−0.86	−0.004595	−3.45**
Dealer_{12}	−0.000989	−3.13**	−0.001447	−1.52	−0.001681	−3.00**
Dealer_{13}	0.004032	3.58**	0.000975	0.38	0.002114	1.01
Dealer_{14}	0.000706	0.48	−0.003079	−1.57	0.018040	2.11**
N		41122		32178		8944

Table 5

Results from Regression of CDS Spreads on the CDS Spread of the Corresponding Dealer Interacted with Dummy Variables for U.S. and Non-U.S. Dealers This table reports the results from the regression of CDS prices or quotations for the firms in the CDX Index on the CDS spread of the dealer providing the CDS price or quotation interacted with a vector of dummy variables I where element I_1 takes value one if the CDS spread for the firm is provided by a U.S. dealer and zero otherwise, while element I_2 takes value one if the CDS spread for the firm is provided by a non-U.S. dealer and zero otherwise. The regression includes a separate fixed effect dummy variable for each date for each firm. The Full Period is March 31, 2008 to January 20, 2009; the Pre-Lehman Period is March 31, 2008 to September 14, 2008; the Post-Lehman Period is September 15, 2008 to January 20, 2009. The t-statistics are based on the White (1980) heteroskedasticity-consistent estimate of the covariance matrix. The superscript ** denotes significance at the five-percent level; the superscript * denotes significance at the ten-percent level.

$$CDS_{i,j,t} \ = \ \alpha' \ F_{i,t} \ + \ \beta' \ I \ \text{Spread}_{j,t-1} \ + \ \epsilon_{i,j,t}$$

Dummy Variable	Full Period		Pre-Lehman Period		Post-Lehman Period	
	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
U.S. Dealer	−0.001417	−5.93**	−0.001344	−4.12**	−0.001363	−4.78**
Non-U.S. Dealer	−0.000572	−0.83	−0.002450	−3.01**	0.001765	1.64
N		41122		32178		8944

Table 6

Results from Regression of CDS Spreads on the CDS Spread of the Corresponding Dealer Interacted with Dummy Variables for the Three Highest Credit-Quality Dealers and for the Remaining Dealers This table reports the results from the regression of CDS prices or quotations for the firms in the CDX Index on the CDS spread of the dealer providing the CDS price or quotation interacted with a vector of dummy variables I where element I_1 takes value one if the CDS spread for the firm is provided by a dealer with one of the three lowest credit spreads for that day, and zero otherwise, and vice versa for element I_2. The regression includes a separate fixed effect dummy variable for each date for each firm. The Full Period is March 31, 2008 to January 20, 2009; the Pre-Lehman Period is March 31, 2008 to September 14, 2008; the Post-Lehman Period is September 15, 2008 to January 20, 2009. The t-statistics are based on the White (1980) heteroskedasticity-consistent estimate of the covariance matrix. The superscript ** denotes significance at the five-percent level; the superscript * denotes significance at the ten-percent level.

$$CDS_{i,j,t} \;=\; \alpha' \, F_{i,t} \;+\; \beta' \, I \; \text{Spread}_{j,t-1} \;+\; \epsilon_{i,j,t}$$

Dummy Variable	Full Period		Pre-Lehman Period		Post-Lehman Period	
	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
In Top Three	−0.002909	−2.99**	−0.003322	−3.12**	0.001570	0.60
Remaining Dealers	−0.001600	−7.25**	−0.001262	−4.35**	−0.001660	−6.26**
N		41122		32178		8944

Table 7

Results from Regression of CDS Spreads on the CDS Spread of the Corresponding Dealer Interacted with Dummy Variables for the Industry This table reports the results from the regression of CDS prices or quotations for the firms in the CDX Index on the CDS spread of the dealer providing the CDS price or quotation interacted with a vector of dummy variables I where element I_k takes value one if the firm whose CDS spread is the dependent variable in the regression is in industry k and zero otherwise. The regression includes a separate fixed effect dummy variable for each date for each firm. The Full Period is March 31, 2008 to January 20, 2009; the Pre-Lehman Period is March 31, 2008 to September 14, 2008; the Post-Lehman Period is September 15, 2008 to January 20, 2009. The t-statistics are based on the White (1980) heteroskedasticity-consistent estimate of the covariance matrix. The superscript ** denotes significance at the five-percent level; the superscript * denotes significance at the ten-percent level.

$$CDS_{i,j,t} \;=\; \alpha' \, F_{i,t} \;+\; \beta' \, I \; \text{Spread}_{j,t-1} \;+\; \epsilon_{i,j,t}$$

Dummy Variable	Full Period		Pre-Lehman Period		Post-Lehman Period	
	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
Consumer	−0.001161	−4.83**	−0.000015	−0.04	−0.001734	−5.45**
Energy	−0.002313	−4.17**	−0.002253	−5.14**	−0.002332	−3.27**
Financial	0.001097	0.77	−0.000910	−0.67	0.002272	1.08
Industrial	−0.001324	−3.61**	−0.001245	−2.42**	−0.001341	−3.11**
Technology	−0.002553	−5.41**	−0.003173	−4.69**	−0.002499	−4.90**
N		41122		32178		8944