Liquidity, Liquidity Spillover, and Credit Default Swap Spreads *

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ABSTRACT

This paper presents the first systematic study of the effects of liquidity in the credit default swap (CDS) market and liquidity spillover from other markets on CDS spreads. The liquidity effect in the CDS market is more significant than generally believed. We estimate an illiquidity premium of 9.4 basis points in CDS spreads, on par with the Treasury bond liquidity premium and the nondefault component of corporate bond yield spreads. we also find substantial liquidity spillover from bond, stock and option markets to the CDS market. As the CDS market liquidity improves over time, the liquidity and liquidity spillover effects become less significant in more recent periods. These results provide a new perspective for a better understanding of the CDS markets and previous findings on CDS spreads.

Preliminary. Comments Welcome!

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ABSTRACT

This paper presents the first systematic study of the effects of liquidity in the credit default swap (CDS) market and liquidity spillover from other markets on CDS spreads. The liquidity effect in the CDS market is more significant than generally believed. We estimate an illiquidity premium of 9.4 basis points in CDS spreads, on par with the Treasury bond liquidity premium and the nondefault component of corporate bond yield spreads. we also find substantial liquidity spillover from bond, stock and option markets to the CDS market. As the CDS market liquidity improves over time, the liquidity and liquidity spillover effects become less significant in more recent periods. These results provide a new perspective for a better understanding of the CDS markets and previous findings on CDS spreads.

JEL Classification: G12; G13; E43; E44

Keywords: Credit Default Swaps; Credit Spreads; Liquidity; Liquidity Spillover

I. Introduction

The liquidity effects for traditional securities, such as stocks and bonds, have been studied extensively in the literature.[1] Several recent papers have also explored the role of liquidity in pricing equity options.[2] However, much remains unknown about the liquidity effects for a variety of derivative securities. One of these derivative contracts is credit default swaps (CDS) which is the most popular credit derivative security. The CDS market has grown rapidly in the past decade. Much of this development has been driven by the demand from banks and insurance companies to hedge their underlying bond exposures and by the need for more liquid instruments for speculation on credit risk by hedge funds and investment banks' proprietary trading desks. In this paper, we carry out a first systematic study on the liquidity effect on the pricing of CDS contracts in this market.

It is important to study, both qualitatively and quantitatively, the liquidity effects in credit derivatives. First, credit derivatives are over-the-counter (OTC) contracts with zero net supply. Both parties, the buyer and the seller, negotiate the terms of the contract. Therefore, the role of liquidity in pricing of these securities may be different from that for stock and bonds.[3] Second, a better understanding of derivatives in general, and credit derivatives in particular, is instrumental (Stulz (2004)). Trading in credit derivatives can have a market-wide impact, as demonstrated by the recent GM/Ford credit debacle. Regulators pay close attention to credit derivatives markets.[4] Up until now, however, recent studies of CDS prices have largely ignored the potential liquidity effects.

Liquidity effects can potentially help resolve several empirical anomalies. First, even though the CDS market has grown rapidly, the usage of CDS by banks is surprisingly low given its obvious hedging advantages. Minton, Stulz, and Williamson (2005) find that only 19 out of 345 large banks use credit derivatives. They argue that "the use of credit derivatives by banks is limited because adverse selection and moral hazard problems make the market for credit derivatives illiquid for the typical credit exposure of banks." In other words, liquidity is most scarce when it is most needed. Second, there are gaps in explaining CDS prices without accounting for liquidity effects.

[1]See Amihud, Mendelson, and Pedersen (2005) for an excellent review.

[2]Bollen and Whaley (2004), Cetin, Jarrow, Protter, and Warachka (2005), and Garleanu, Pedersen, and Poteshman (2006) illustrate the effect of supply/demand imbalance on equity option prices. Brenner, Eldor, and Hauser (2001) find a significant illiquidity discount in the prices of non-tradable currency options compared to their exchange-traded counterparts.

[3]See Jarrow (2005), Jarrow and Protter (2005), and Amihud, Mendelson, and Pedersen (2005) for more discussions on the liquidity role in option pricing. Duffie, Garleanu, and Pedersen (2005, 2006) study asset valuation and liquidity in OTC markets.

[4]See, "Wall Street Is Cleaning Derivatives Mess" *Wall Street Journal*, February 16, 2006 and "Credit Derivatives And Their Risks Are on the Table", *Wall Street Journal*, September 15, 2005.

Saita (2006) finds that the market price of default risk is too high based on CDS prices. Blanco, Brennan, and Marsh (2005) find that 19 of the 33 reference entities in their sample have average CDS spreads larger than their corresponding corporate bond yield spreads. This would be unlikely if CDS spreads contain no illiquidity premium and reflect only credit risk. Pan and Singleton (2005) find that, without considering the liquidity effect in the CDS market, the recovery rate implied by the term structure of sovereign CDS spreads is significantly lower than generally observed. They also show that pricing errors are particularly large for short-term (1-year) CDS contracts and suggest a second factor which may be related to liquidity in these contracts due to trading pressure. Berndt *et al* (2005) find that there is on average approximately 33 basis points in CDS spreads that are not accounted for by default risk measured by the Moody's KMV's EDF indicator.

From an information-theoretic point of view, with possible informed trading in the CDS market (e.g., Acharya and Johnson (2005)), asymmetric information and associated risk of adverse selection will lead to widened bid-ask spreads in this market and hence increase liquidity costs of trading. Parlour and Plantin (2005) show that liquidity effect can arise endogenously in credit derivative market when banks are net protection buyers. The presence of banks in the CDS market creates two effects: First, it introduces more information asymmetry because banks are likely to have better access to the private information about an issuer. Second, it may lower information quality because banks may monitor the firms less if monitoring is more costly than credit protection from CDS contracts, less information will be generated when banks monitor less. This second effect, i.e., incomplete information characterized by the lack of transparency, has been shown to affect corporate bond yield spreads by Duffie and Lando (2001) and Yu (2005a). This effect may also affect CDS spreads as demand, and consequently liquidity, can diminish for CDS contracts of firms with an opaque information environment.

We first investigate how liquidity in the CDS market affects CDS spreads. We use three different measures to proxy for the liquidity in the market. The first measure is the total number of quotes and trades per month (NQT) for each contract. Because a majority of trades in credit default swaps are initiated by buyers in order to obtain protection on credit risk, dealers are often the main liquidity providers in the market by providing such insurance and holding large portfolios of swaps. Therefore, a high level of NQT may actually imply high demand for credit protection and hence worsening marginal liquidity in the market. This intuition is corroborated by the second measure we use, order imbalance, which is constructed by using the Lee-Ready (1991) algorithm to assign a trade direction for each quote or transaction. The order imbalance has a correlation coefficient of 0.57 with NQT. The third measure is the bid-ask spread, which captures the cost for dealers to provide liquidity to the market.

We find that, controlling for fundamental determinants of credit spreads, CDS spreads are significantly positively related to NQT. Because NQT is positively correlated with the trade imbalance and hence decreases in marginal liquidity, this implies that the liquidity effect in the CDS market is driven by the buying pressure. This result is consistent with the implication of Parlour and Plantin (2005) and similar to those in previous studies on option markets. The buying pressure pushes CDS spreads higher, and the buying pressure from informed traders would increase the spreads even more.[5] We estimate that the implied illiquidty premium is about 9.3 basis points, on par with the 5-year Treasury illiquidity premium of 9.99 basis points estimated by Longstaff (2004) and the average size of the non-default component of corporate bond spreads (8.6 basis points) estimated by Longstaff, Mithal, and Neis (2005) using swap curves. We also find that the order imbalance measure and the bid-ask spread provide the same qualitative result. These findings represent the first systematic evidence that demonstrates the importance of liquidity consideration in the CDS market.

Holders of corporate bonds averse to default risk may want to enter CDS contracts for credit protection if selling the bonds is too costly due to illiquidity in the corporate bond market.[6] The illiquidity in the bond market can also affect the hedging capability of dealers in the CDS market and hence increase the premium embedded in CDS spreads. Therefore, when the underlying bonds have poor liquidity, *ceteris paribus*, the corresponding CDS spreads should be higher. We examine the effect of this liquidity spillover from the bond market to the CDS market on CDS spreads. Following the suggestion by Edwards, Harris and Piwowar (2005), we measure the liquidity of a corporate bond by its age, maturity and issue size. Consistent with the existence of liquidity spillover from the corporate bond market to the CDS market, we find that CDS spreads are lower for bonds with a large issue size and higher for longer-term bonds. However, we don't find a significant effect for the vintage of a bond.

One trading strategy that has become popular with hedge funds and investment banks in recent years is capital structure arbitrage, which exploits potential relative price inefficiencies among equity and debt instruments of the same firm (see, e.g., Yu (2005b)). The development of the CDS market helps fuel the deployment of this strategy by providing a more efficient way to trade in credit risk than the corporate bond market. In order to implement their strategies, credit traders often trade credit default swaps simultaneously with corresponding equity securities. Then the price formation

[5]BBA (2004) find that banks are net buyers of CDS, they buy 51% of the credit protection but only sell 38%. Banks are also likely to be more informed about the quality of issuers.

[6]There are other reasons that bondholders cannot sell the bonds. For example, a bond underwriter may agree to hold the bonds they underwrite for a certain length of time. Holders of convertible bonds may not want to sell the bonds because they like the convertibility portion of the security. Many of them, however, may want to obtain credit protection by entering into CDS contracts.

in the CDS market depends on the liquidity of equity markets. For example, if an investor wants to build a portfolio with both stocks and CDS contracts because of her private information, she may not trade CDS contracts at all if her stock or stock option positions are too costly to build. Given that hedge funds tend to be liquidity providers in the CDS market, as is evidenced by the huge losses they suffered during the GM/Ford credit debacle in May, 2005, liquidity in other markets will allow them to execute their trades in the CDS market and thus reduce CDS spreads.

We test this hypothesis of liquidity spillover from equity and equity option markets to the CDS market. We use the Amihud (2002) measure to gauge the illiquidity of the corresponding stock. Option liquidity is measured by bid-ask spread, trading volume and open interest. We find that controlling for fundamental determinants and NQT, the effect of stock illiquidity on CDS spreads is significantly positive. Moreover, our empirical results indicate that, *ceteris paribus*, CDS spreads are lower if the underlying firm's stock options have a higher trading volume, or a narrower bid-ask spread. In the multivariate regression, an option's open interest has a significantly positive effect on CDS spreads as it captures the unique effect of divergence in opinion once the trading volume controls for the market activity in the underlying option.

In addition, we document improving liquidity in the CDS market over time, as the market has undergone tremendous growth and maturation. We show that the average trading cost, measured by the average bid-ask spread, has decreased significantly over time. We also illustrate that the explanatory power of liquidity measures for CDS spreads, proxied by R^2s of the regression of CDS spreads on these liquidity measures, have declined from a very high level (~ 0.8) to a recent level of around 0.3. This observation of time variation of the liquidity effect may provide a perspective for understanding the result in Berndt *et al* (2005), which shows that the default risk premium estimated based on CDS spreads has decreased by almost 50% from the third quarter of 2002 to late 2003. This time variation in the credit risk premium may be consistent with a constant default risk premium and a reduction in the illiquidity premium, as the CDS market has become more liquid in recent years.

To our best knowledge, our study is the first to focus on the liquidity and liquidity spillover in the CDS market, although the liquidity effect has been extensively studied for the corporate bond market.[7] Ericsson and Renault (2005) and Chen, Lesmond, and Wei (2005) have analyzed the liquidity effect in corporate bond yield spreads. Regarding liquidity spillover, Odders-White and Ready (2006) show that credit ratings are related to equity market liquidity. Moreover, Newman

[7] The relevance of liquidity for derivative securities is discussed by Jarrow (2005) and Jarrow and Protter (2005). Important contributions are also made by Cetin, Jarrow, Protter, and Warachka (2005) on incorporating liquidity risk into option pricing.

and Rierson (2004) demonstrate liquidity spillover in the Euro Telecom industry.

Our unique contribution in this paper is to provide empirical evidence to illustrate the significant effect of liquidity in the CDS market on CDS spreads which supports the consideration of a liquidity factor in order to account for unexplained discrepancies in CDS spreads, documented in Berndt *et al* (2005), Blanco, Brennan, and Marsh (2005), and Pan and Singleton (2005). We further show that there are significant liquidity spillovers from other markets into the CDS market, demonstrating the integration among these markets and the important role of liquidity in such market integration. A good understanding of the CDS market structure is important for financial market stability.[8] Duffee and Zhou (2001) raise some concerns on the usage of CDS contracts. Our study should help shed more light on the CDS market and its interaction with other markets and inform on policy implications.

The rest of this paper is organized as follows. Section II provides some background information on the CDS market and describes the CDS data used for this study. Section III discusses the control variables and the econometric method used for our empirical analysis. Section IV demonstrates the liquidity effects in the CDS market. Section V presents evidence of liquidity spillover effects from bond, stock and option markets to the CDS market on CDS spreads. Section VI illustrates the time variation in the liquidity effect. Section VII concludes.

II. Credit Default Swaps (CDS): Background and Data

A. The CDS Market

Credit derivatives markets have been growing rapidly. The notional amount traded in global credit derivatives markets had increased from \$180 billion in 1997 to \$5 trillion in 2004 and is expected to rise to \$8.2 trillion by the end of 2006, according to a new report, based on a survey among 30 market leaders, published by the British Bankers' Association (BBA). Increased market liquidity, improved standardization of contracts and trading procedures, and a greater understanding by clients have all been instrumental in the rapid growth of global markets in credit derivatives. Most credit derivatives are unfunded, i.e., they do not require up-front capital investment. Banks, securities houses and insurance companies constitute the majority of market participants. Recently, hedge funds have emerged to be an important player in credit derivatives markets.

[8]This is underscored by the recent concern expressed by the president of the New York Federal Reserve Bank which convened a meeting of major CDS dealers to discuss the proper functioning of the market.

Nearly half of the instruments traded in the credit derivative market are related to credit default swap contracts. Credit default swaps are over-the-counter contracts for credit protection. CDS contracts were developed by banks in order to reduce their credit risk exposure and better satisfy regulatory requirements. In a CDS contract, the two parties, the protection buyer and seller, agree to swap the credit risk of a bond issuer or loan debtor ("reference entity"). Credit protection buyer pays a periodic fee (as a percentage of the face value of the debt), usually called CDS premium or spread, to the protection seller until the contract matures or a credit event occurs, in which case the protection buyer delivers defaulted bonds or loans ("reference issue") to the seller in exchange for the face value of the issue in cash ("physical settlement"), or the protection seller directly pays the difference between market value and face value of the reference issue to the protection buyer ("cash settlement"). Credit event and deliverable obligations are specified in the contract. Credit events generally include bankruptcy, failure to pay, and restructuring. Along with the development of the CDS market, International Swaps and Derivatives Association (ISDA) has given definitions to four types of restructuring: full restructuring; modified restructuring (only bonds with maturity shorter than 30 months can be delivered); modified-modified restructuring (restructured obligations with maturity shorter than 60 months and other obligations with maturity shorter than 30 months can be delivered); and no restructuring.

The typical maturity of a CDS contract is five years. The typical notional amount is $10-20 million for investment grade credits and $2-5 millions for high yield credits. CDS trading is concentrated in London and New York, each accounting for about 40% of the total market. Most transactions (86%) use physical settlement, according to the 2003/2004 Credit Derivatives Report by the British Bankers' Association.

B. Default Risk and CDS Spreads: Models and Evidence

CDS spreads are the compensation for providing insurance for default risk of the underlying firm (called "reference entity" or "name"). Theoretical determination of CDS spreads is similar to corporate bond pricing in terms of capturing the risk of default and the potential loss upon default.

There are two approaches generally used for credit risk modelling. The structural approach, i.e., the Merton (1974)-type models, describes default as the first-passage of firm value below a threshold. The reduced-form approach, originated by Jarrow and Turnbull (1995), attributes default to some exogenous inaccessible intensity process, which is applied to value credit default swaps in Duffie (1999). The fundamental difference between structural and reduced form models lies in the information set available to the modeler. In structural models, the modeler has perfect information regarding the firm's asset value, while this restriction is not imposed on reduced form models. Structural models converge to reduced form models when this perfect information assumption is relaxed (Duffie and Lando (2001), and Guo, Jarrow, and Zeng (2005)). The relationship between these two approaches is discussed in detail by Jarrow and Protter (2004).

Current empirical evidence indicates that both structural and reduced form models perform reasonably in explaining CDS spreads. Berndt *et al* (2005) find that default probabilities, measured by Moody's KMV's Expected Default Frequencies (EDF), can account for a large portion of CDS spreads. Ericsson, Jacobs, and Oviedo (2005) show that factors suggested by structural models are important determinants of CDS spreads. Moreover, Ericsson, Reneby, and Wang (2005) demonstrate that CDS spreads are less affected by significant liquidity premia contained in the credit spreads measured from corporate bond yields. On the other hand, Houweling and Vorst (2005) show that CDS spreads can be well explained by simple reduced form models. While reduced form models render modelling convenience, Arora, Bohn, and Zhu (2005) find that reduced form models do not outperform structural model when predicting the probability of default and the CDS spreads.

A critical factor in credit risk portfolio management is default correlations. Das, Duffie, Kapadia, and Saita (2005) and Zhang (2005) demonstrate contagion as a default trigger. Recovery rate plays another important role in CDS pricing. We believe a study on liquidity and liquidity spillover in the CDS market will shed more light on credit contagion and recovery process and improve our understanding of CDS pricing.

C. CDS Data

Our dataset is from a major CDS broker and spans from June 1997 to April 2005, representing the largest CDS database so far. It has information on all the intraday quotes and trades, including transaction time, reference entity (bond issuer), seniority of the reference issue, maturity, notional amount and currency denomination of a CDS contract, restructuring code, and the quote or trade price. In this study, we focus on CDS contracts for non-Sovereign U.S. bond issuers denominated in U.S. dollars with reference issues ranked senior and CDS maturities between 4.5 and 5.5 years. Monthly data are obtained by averaging over the month. All together, in our sample there are 10697 issuer-month CDS spread observations.

Average CDS spreads are plotted in Figure 1. There is a significant time-series variation in average CDS spreads. CDS spreads peaked in the second half of year 2002 due to the credit market turbulence at the time. CDS spreads subsequently declined afterwards possibly due to (1) improving macroeconomic conditions that lead to lower market-wide credit risk; (2) more dominance of high quality issuers in the market; (3) increased competition in the market such that CDS sellers could not overprice the CDS contracts.

Figure 2 plots the monthly total number of quotes and trades in our data sample. It shows that there was little trading prior to 1999, because our data provider was one of the handful earliest market participants. The shrinking trading activity in our data sample since 2003 reflects the increasing competition from other dealers and new entrants in this market, as a new player emerges every several months. It is widely perceived that the market is much more competitive and liquid than the early stage of the market.

Table 1 provides the year-by-year summary statistics for our data sample. In our sample, average CDS spreads over the entire sample is 125.73 basis points. The majority of CDS contracts are for A and BBB bonds. Two observations from the summary table are noteworthy. First, The average spread for AAA bonds is about 35 basis points, which is still much higher than predicted value by most structural models. Second, CDS spreads for AAA bonds are not always smaller than CDS spreads for AA bonds, which suggests that CDS spreads may contain components other than credit risk. Other factors such as liquidity may also at work. Alternatively, CDS spreads may react to news more promptly than credit ratings. As shown by Hull, Predescu, and White (2004) and Norden and Weber (2004), the CDS market anticipates rating announcements, especially negative rating events. For AAA bonds, the only possible rating change is downgrade. Therefore, the market could incorporate information before rating agencies adjust the ratings.

III. Control Variables and Empirical Methodology

The purpose of our study is to examine the effects of liquidity and liqudity spillover on CDS spreads. To isolate the effects of liquidity and liquidity spillover, we control for other fundamental determinants of CDS spreads and adopt an appropriate econometric framework.

A. Fundamental Determinants of Credit Spreads

We identify the set of credit risk factors that are commonly studied in the literature (see, among others, Collin-Dufresne, Goldstein, and Martin (2001), Campbell and Taskler (2003) and Eom, Helwege, and Huang (2004)). Those factors affect credit spreads either through default probabilities or through expected recovery rates. Although most theoretical models assume a constant recovery rate, empirical evidence has shown that recovery rate varies across industries and with time. It is necessary to control for those factors in order to isolate the unique effects of liquidity and liquidity spillover that are not due to their correlations with fundamental factors.

The Merton (1974) model suggests leverage ratio and asset volatility as important cross-sectional determinants of default probabilities. Leland (2004) argues that in order to better match historical default probabilities, a jump component is needed for the asset value process. Driessen (2005) estimates a reduced form model and uncovers a significant jump risk premium. Therefore, our first set of credit risk factors should include leverage, asset volatility, and jump component in asset value. In theory, credit spreads should increase with leverage, asset volatility, and jump magnitude.

We measure leverage using book value of debt and market value of equity, as following:

$$\text{Leverage} = \frac{\text{Book Value of Debt}}{\text{Market Value of Equity} + \text{Book Value of Debt}}. \tag{1}$$

This is the measure customarily used in the literature. The market value of equity is calculated as stock price multiplied by number of shares outstanding. The book value of debt is the sum of short-term debt (Compustat quarterly file data item 45) and long-term debt (item 51). Debt level is only available at quarterly frequency. Following Collin-Dufresne, Goldstein, and Martin (2001), we use linear interpolation to obtain monthly debt levels based on quarterly data.[9] When this interpolation results in a negative debt level, we keep the previous debt level.

Asset volatility is not directly observable. In a simplified framework, asset volatility should be proportional to stock volatility. Therefore, we use instead stock return volatility measured by the average monthly at-the-money stock option implied volatility calculated based on option data from OptionMetrics. Option implied volatility measures total equity volatility, including idiosyncratic volatility. Campbell and Taskler (2003) show that idiosyncratic volatility can explain as much cross-sectional variation in credit spreads as can credit ratings. Cremers, Driessen, Maenhout, and Weinbaum (2005) argue that option prices contain information for credit spreads. These results further bolster the use of stock volatility as one of the fundamental control variables.

Asset value jump size is proxied by the monthly average slope of option implied volatility curve. Specifically, it is the difference between the implied volatility measured at the strike-to-spot ratio of 0.9 and the implied volatility measured at money. The idea is that the skewness of the volatility curve is mainly caused by jump component. Similar measures of jump size are used by

[9]All of our results are not affected by this interpolation. Using quarterly leverage produces almost identical results.

Collin-Dufresne, Goldstein, and Martin (2001), and Cremers, Driessen, Maenhout, and Weinbaum (2005).

Although credit rating does not directly enter into any structural credit risk model, we include credit rating for two reasons. First, credit rating has been shown to affect credit spreads even after controlling for leverage, volatility, and other factors. Second, Molina (2005) shows that, when leverage ratio is endogenized, the effect of leverage on credit risk is much larger than in the case of exogeneous leverage choice. Leverage ratio could also be chosen to target a certain credit rating (Kisgen (2005)). Therefore, credit rating should have additional explanatory power as part of fundamental control variables. Credit rating is included in our CDS database. Missing values are filled in by the data in Compustat and the Fixed Income Securities Database (FISD). Letter ratings are converted into numerical values as 37 minus the numerical number in Compustat, with AAA corresponding to 35, AA+ to 33, and D to 10. etc.

Lastly, we control for a firm's equity size and book-to-market equity ratio. Size and book-to-market ratio have long been argued to be associated with firm distress. Campbell, Hilscher, and Szilagyi (2005) show that book-to-market ratio and firm size are strong predictors of long-run default probability.

B. Empirical Methodology

We conduct regression analysis to examine the effects of fundamental determinants on CDS spreads. We are primarily interested in the cross-sectional relation. Our dataset is a pooled time-series and cross-section unbalanced panel. Extra care needs to be taken to analyze such a panel dataset. Fama and French (2002) have expressed their concern about obtaining robust econometric inferences from panel data by stating that "the most serious problem in the empirical leverage literature is understated standard errors that cloud inferences." Two types of correlations need to be considered in panel data: (1) Observations from the same issuer cannot be treated as independent to each other, therefore we need to control for the issuer effect; (2) Firms in the aggregate may be affected by the same macroeconomic conditions, therefore we need to control for the time effect. Petersen (2005) provides a detailed analysis on the performance of various approaches in this setting. He shows that when the firm effect exists, adjusting for firm clustering is the preferred approach,[10] while when the time effect exists, Fama-MacBeth should be applied. When both firm and time effects are present, one may consider controlling time effect parametrically using time dummies

[10]Petersen (2005) verifies that the bootstrapping method employed by Kayhan and Titman (2004) performed equally well.

with firm clustering.

Petersen (2005) states that "when the standard errors clustered by firm are much larger than the White standard errors (three to four times larger), this indicates the presence of a firm effect in the data. When the standard errors clustered by time are much larger than the White standard errors, this indicates the presence of a time effect in the data." Using this diagnosis, we find both firm and (relatively weaker) time effects in our panel data. Hence, we follow Petersen's suggestion and conduct our empirical analysis by adjusting for issuer clustering and controlling for the time effect by adding monthly time dummies. Because of the presence of time dummies, we do not include any other macroeconomic variables in our regression analysis.[11]

IV. Liquidity and CDS Spreads

The notion that liquidity affects asset prices and hence returns is generally accepted since the seminal work of Amihud and Mendelson (1986), although the magnitude of the liquidity effect in asset markets is still being hotly debated. The contractual nature of credit default swaps makes liquidity or convenience yield a less serious concern. As argued by Longstaff, Mithal, and Neis (2005), CDS provides researchers with "a near-ideal way of directly measuring the size of the default component in corporate spread." However, like in any other markets, CDS market participants are not symmetrically informed. Liquidity costs induced by information asymmetry may affect CDS spreads. The magnitude and the significance of this liquidity effect is the empirical issue that we attempt to address here.

A. CDS Liquidity Proxies

Liquidity is an elusive concept. Often liquidity has several distinctive dimensions. It is difficult to find a single summary measure for liquidity. Therefore, our objective is to find multiple proxies for liquidity to ensure the robustness of our findings. We use three measures for CDS liquidity: number of quotes and trades per month as a measure of trading activity; order imbalance; and bid-ask spread.

[11]We have also entertained other approaches to obtain robust cross-sectional results. We first consider firm fixed effect rather than issuer clustering. For the second alternative approach we first calculate the time-series average for each issuer then we run one cross-sectional regression. In this way we suppress any time-series variations. Lastly we run cross-sectional regression for each month. The average coefficient and t values are then calculated by aggregating over all the months. This is the Fama-MacBeth approach which provides the most conservative results. All results are consistent with our issuer clustering-adjusted results.

Our first and primary measure of CDS market liquidity is from market trading activity, the number of quotes and trades within a given month (NQT). Without identifying the trade direction or calculating order imbalance, it is hard to tell whether high trading activity reflects more liquidity or the lopsided demand which would indicate illiquidty. Because CDS contracts provide protection against default risk, which is a downside event, it is arguable that demand for protection may be particularly high when a firm's financial condition deteriorates. Therefore, active trading may be linked to high order imbalance and less liquidity.

In order to formally verify the conjecture that CDS trading activity could be a measure for order imbalance, we use the Lee and Ready (1991) algorithm to assign trade direction. The Lee and Ready algorithm classifies a trade as buyer initiated if the trade price is above the mid point between the bid and ask prices and seller initiated if the trade price is below the mid price. Random direction is assigned if trade occurs at the mid price. We find that the order imbalance measure so calculated has a correlation coefficient of 0.57 with NQT, thus indicating that NQT is more related to marginal illiquidity. In our test, we use this order imbalance measure as another measure of CDS illiquidity.

Even though credit protection buyers and sellers agree on the terms of a contract, a buy-side initiated trade may entail a different rate than a sell-side initiated trade. We call this difference in the CDS spread for the same issue in the same day a bid-ask spread, although technically it is not in the same sense of the bid-ask spread for an equity trade paid to a market maker. We argue that this "bid-ask spread" can measure the degree of the divergence of opinions or of the information asymmetry in the underlying issuer and reflect the level of trade imbalance in the contract. We use the percentage bid-ask spread (bid-ask spread divided by mid quote or trade price) to get a unitless measure. A high bid-ask spread is associated with low liquidity.

B. Empirical Evidence

Table II reports the regression analysis on the effect of CDS liquidity on CDS spreads. We carry out our analysis using four different specifications. In specification (1), NQT is used as the illiquidity measure. After controlling for other credit risk and recovery factors, CDS spreads are significantly and positively associated with NQT. Given the sample standard deviation of 58.11 for NQT, a one standard deviation increase in NQT is associated with an increase of $58.11 \times 0.09 = 5.2$ basis points in CDS spreads. The economic significance of this illiquidity effect can be further seen by multiplying this 5.2 basis points to the current market nominal amount of CDS of $12.43 trillion (ISDA 2005 Mid-Year Market Survey), resulting in a change of total CDS premium of $6.5 billion.

Given the sample mean of 25.89 for NQT, the estimated average liquidity premium is 2.3 basis points, with a plausible range from 0 to 10.5 basis points,[12] comparable to the 9.99 basis points for the 5-year Treasury bond liquidity premium estimated by Longstaff (2004).

In this regression model, all other fundamental control variables have the expected signs except for market capitalization, because the positive coefficient implies that, all else equal, larger firms tend to have larger CDS spreads. This is, however, consistent with the shareholders advantage story of Garlappi, Shu, and Yan (2005) that is built on the model of strategic debt service by Fan and Sundaresan (2000): controlling for credit risk, firms with more shareholder bargaining power (i.e., larger firms) will have higher credit spreads. It may also be consistent with the possibility that large firms may have more debt outstanding held by investors who require more credit protection, hence increase CDS spreads.

We obtain similar results using order imbalance (specification 2) and percentage bid-ask spread (specification 3) as illiquidity measures, albeit at lower significance levels. Our results on percentage bid-ask spreads are in contrast to the results in Acharya and Johnson (2005). They find an insignificant *negative* relation between CDS bid-ask spread and CDS spreads using a set of "benchmark" CDS contracts which are arguably the most liquid CDS contracts. In our study, we use market quote and trade data for all CDS contracts.[13] In specification (4) of Table II, we calculate the combined liquidity premium, given the average percentage CDS bid-ask spread of 0.23, at 12.29 basis points. A more conservative estimate of total liquidity premium is 9.3 basis points by adding separately the liquidity premium due to NQT (2.3 basis points) and the liquidity premium due to the CDS bid-ask spread (7.0 basis points). These results show that CDS liquidity affects significantly CDS spreads. In the following analysis we will focus on the NQT measure because it has the most data availability.

The liquidity effect may interact with credit risk. It is plausible that the magnitude of the illiquidity premium may vary across rating groups. For example, for high quality CDS names, their default probability is negligible, few investors are interested in such credit protections. Therefore liquidity premium may be large for high credit-quality names than for low credit-quality names. We separate the data by rating groups and examine the effect of NQT within each group. Regression results are presented in Table III. We consider four rating groups (AA, A, BBB, and BB) due to data availability. A pattern emerges from the coefficient estimates of NQT, which monotonically decrease from AA (0.26) to A (0.18) to BBB (0.16). The coefficient estimate is insignificant for the

[12]The upper bound is estimated by using the regression coefficient that is one standard deviation from its point estimate multiplying an NQT value that is also one standard deviation from its mean.

[13]Their sample is probably more homogenous as evidenced by the insignificant effect of leverage on CDS spreads.

BB (junk) group. Ericsson and Renault (2005) show that the liquidity effect is more pronounced for lower credit-quality name in corporate bond market. The difference in the liquidity effects between bond and CDS markets could be driven by bond investors hedging needs using CDS contracts.[14]

Both Table II and Table III indicate that CDS spreads are well explained by credit risk, recovery risk, and liquidity. Regression R^2's are around 60% in Table II. Moreover, Lower credit quality CDS spreads are better explained than higher credit-quality CDS. In Table III, the R^2 for BBB bonds is substantially higher (0.562) than A's (0.312) even though the BBB group has more observations (4002) than A group (3176). This result provides indirect evidence that other factors are in place for high credit-quality CDS contracts.

V. Liquidity Spillover and CDS Spreads

CDS contracts are often traded jointly with other securities. It is likely that liquidity, or illiquidity, of other markets could spill over to the CDS market. CDS contracts are used for two purposes: hedging and speculation. Bondholders may want to buy protections against default for the bonds in their portfolios when unloading the bonds are too costly due to bond market illiquidity. Some investors may also prefer bond-type securities to equity-type securities, and they will choose CDS contracts over bonds if the bond market is illiquid. Those hedgers are mostly protection buyers. Their trading in the CDS market will increase order imbalance and reduce liquidity. Therefore bond market illiquidity could potentially affect CDS spreads by affecting CDS liquidity. Speculators, such as capital structure arbitrageurs, trade CDS contracts jointly with equity-like securities such as stocks or stock options. In this case, stock (or stock option) liquidity is complement to CDS liquidity and will directly affect CDS spreads. Furthermore, the effect of CDS liquidity will be even stronger when the second channel is blocked as arbitrageurs are generally liquidity providers. They both buy and sell protections. In this section we examine the impact of liquidity spillover from bond, stock, and option markets on CDS spreads.

[14]Other things to notice in Table III is that jump risk is only significant for lower credit-quality names. Leverage is *positively* related to CDS spreads for AA bonds. The book-to-market ratio is positively related to CDS spreads for AA names but negative for BBB names.

A. Liquidity Spillover from the Corporate Bond Market

A.1. Bond Liquidity Proxies

Edwards, Harris, and Piwowar (2004) argue that age, maturity, and amount outstanding are good measures of bond liquidity. Amount outstanding measures the availability of a bond. Recently issued or new bonds may be more liquid because they attract more of investors' attention. Bonds with shorter maturity may be more liquid because investors for long bonds may prefer the cash flow from the coupon payments, therefore not trade the bonds.[15] Because CDS contracts are written on certain bond classes (e.g., senior unsecured) rather than a specific bond issue, we use the average age of bonds by an issuer, the average maturity of bonds by an issuer, and the total amount of bonds outstanding by an issuer to measure the liquidity of the bonds by this issuer. The data is from the Fixed Income Securities Database (FISD).

A.2. Results

Table IV provides evidence of liquidity spillover from the bond market to the CDS market. From specification (2), we can see that CDS spreads are higher when the reference issue has longer maturity (a one standard deviation move in maturity is associated with a change of 6.7 basis points in CDS spreads). Specification (3) shows issuers with more bond outstanding have lower CDS spreads (a one standard deviation move in bond principal outstanding is associated with a change of 5.7 basis points in CDS spreads). The effect of bond age (specification (1)) is, however, insignificant. This lack of significance may be explained by the effect of familiarity: CDS investors are more familiar with issuers with older bonds, this effect offsets the liquidity spillover from older bonds.

From all four specifications we can see that, after including bond market liquidity proxies, both the magnitude of coefficient and statistical significance for NQT are reduced. The coefficient estimate decreases from 0.09 (in Table II model (1)) to 0.05. t values decrease from 2.55 to about 1.70. This result shows that if two firms have similar bond issues, CDS liquidity should not have a significant impact on CDS spreads. This liquidity spillover effect is consistent with the credit hedging scenario.

[15]Another potential measure of bond liquidity is coupon rate. Bonds with high coupon may be less liquid because they are mostly held in the portfolios of investors who prefer the coupon payments. This measure would not be adequate in our case, however, because we would have used the average coupon per issuer because of the nature of CDS contracts.

B. Liquidity Spillover from the Stock Market

B.1. Stock Liquidity Proxy

Firm i's stock liquidity in month m is proxied by the Amihud measure as monthly average absolute return over volume:

$$\text{Illiquidity}_{im} = \frac{1}{D_{im}} \sum_{d=1}^{D_{im}} \frac{|r_{id}|}{\text{Volume}_{id}}, \tag{2}$$

where D_{im} is the number of days in month m for firm i, r_{id} is day d's return, and Volume_{id} is day d's volume. This measure actually measures illiquidity rather than liquidity. Hasbrouck (2005) argues that the Amihud measure is among the best liquidity proxies that can be constructed from low frequency data and are highly correlated with proxies constructed using transaction data. He suggests a modified version of the Amihud measure to smooth over extreme values, which is

$$\text{Illiquidity}_{im} = \frac{1}{D_{im}} \sum_{d=1}^{D_{im}} \sqrt{\frac{|r_{id}|}{\text{Volume}_{id}}}. \tag{3}$$

This is the version we adopt in this paper. We use data from CRSP to construct this stock illiquidity measure.

B.2. Results

Table V presents the analysis on liquidity spillover from the stock market to the CDS market. It shows that CDS spreads are higher when the reference entity's stock is less liquid. The economic significance is remarkable: a one standard deviation (0.033) increase in stock illiquidity is associated with an increase of 39.6 basis points in CDS spreads. Furthermore, including stock illiquidity slightly increases the coefficient estimate and statistical significance of CDS illiquidity (NQT). Therefore, liquidity spillover from the stock market to the CDS market is more likely through a direct impact of stock illiquidity on CDS spreads. This result is also consistent with the capital structure arbitrage scenario in that in order to successfully implement an arbitrage strategy, liquidities in both stock and CDS markets are critical.

C. Liquidity Spillover from the Stock Option Market

C.1. Option Liquidity Proxies

Option liquidity is measured by bid-ask spread, trading volume, and open interest. Options are standard securities. The bid-ask spread measures trading costs that compensate market makers for the risk of adverse selection and hedge costs. Trading volume measures market activity that may or may not be due to private information or difference in opinion, because of the hedging role of these equity options. Open interest provides key information regarding both market activity and differential information of an option. When options have a large open interest, it means they have a large number of buyers and sellers, and an active secondary market will also increase the odds of getting option orders filled at good prices. So, all else being equal, the bigger the open interest, the easier it will be to trade that option at a reasonable spread between the bid and the ask.

C.2. Results

Table VI presents evidence of liquidity spillover from the option market to the CDS market. The overall finding is similar to that in the previous section on liquidity spillover from the stock market to the CDS market. This is expected as stocks and options are close substitutes in capital structure arbitrage, therefore they should play similar roles. First, option trading volume is negatively significantly associated with CDS spreads. The economic significance is also notable: a one standard deviation (1.95) increase in option volume (in log) is associated with a decrease of 8.4 basis points in CDS spreads. Option bid-ask spread is insignificant because it measures more of trading costs than liquidity. Option open interest is insignificant by itself but significantly *positive* when included with option volume, very likely due to multicollinearity between trading volume and open interest (the correlation between volume (in log) and open interest (in log) is 0.94). Also, including option illiquidity proxies slightly increases the coefficient estimate and statistical significance of NQT, consistent with the capital structure arbitrage scenario as we discussed in the previous subsection.

VI. Time Variation in the CDS Liquidity

The CDS market is still at its early stage compared to other derivative markets. Given its rapid growth, we should observe some time variation in the liquidity effects as the market becomes more mature and efficient. We expect the market to be more liquid and more integrated with other markets over time.

Our first evidence of improving liquidity in the CDS market is from CDS market trading costs. As shown in Figure 3, the average bid-ask spread in the market has decreased significantly, from the high of around 50 basis points before year 2003 to around 10 basis points more recently.[16] Because the set of issuers change over time, we also plot the percentage bid-ask spread (bid-ask spread divided by mid quote) in Figure 4, we still observe some evidence that the average percentage bid-ask spread has declined, although there is a sharp increase in year 2005.

We also investigate the time variation in the explanatory power of liquidity for CDS spreads. In each month, we regress CDS spreads on liquidity proxies only in the cross-section. We do not include other determinants of CDS spreads in order to capture the pure explanatory power from liquidity proxies. We expect the explanatory power of liquidity (both own market liquidity and other market liquidity) to decrease as the market develops. Figure 5 plots the time-series of R^2s from the regression of CDS spreads on all liquidity proxies. The overall evidence shows that the explanatory power of liquidity has decreased since the beginning of year 2000. At the beginning of the market, liquidity and liquidity spillover explain around 60 percent of the cross-sectional variations in CDS spreads. In more recent times, the R^2 has dropped to the 30 percent level. Admittedly, it is difficult to judge the statistical significance of the magnitude of this decrease without a formal test. On average, liquidity seems to explain around 40% of the cross-sectional variations in CDS spreads.

VII. Conclusions

Information is key to price formation. Information asymmetry and informational opacity are pervasive in financial markets and directly affects the liquidity of the underlying securities. In this paper we show that liquidity in the CDS market itself and liquidity spillover from other markets are also significant factors for CDS spreads. We find both CDS market liquidity and liquidity spillover from bond, stock and option markets explain a substantial portion of credit spreads. We estimate a liquidity premium of 9.3 basis points in CDS spreads, on par with Treasury bond liquidity premium and nondefault component of corporate bond yield spreads. Liquidity proxies alone explain around 40% of the cross-sectional variations in credit spreads. We also document some evidence that the effect of liquidity on CDS spreads varies over time as the CDS market becomes more mature and

[16]The low bid-ask spread at the very beginning of the period may be driven by higher quality of issuers. It is conceivable that only high quality issuers were selected to be traded at the experimental stage of a market.

efficient and more integrated with other financial markets.

This study demonstrates that liquidity concern should also be on the list of "unresolved issues" in the pricing of CDS contracts discussed by Turnbull (2005). Our findings highlight the need of a CDS pricing model that explicitly takes liquidity premium into account. In the imperfectly liquid CDS market, the supply curve for CDS contracts may be a function of order flows, along the line of Cetin, Jarrow, Protter, and Warachka (2005) on option pricing with illiquidity. Further research on this subject is certainly needed.

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Table I
CDS Data Summary Statistics

This table reports pooled time-series and cross-sectional year-by-year summary statistics of monthly average CDS spreads in basis points from June 1997 to April 2005. Data is from a major CDS broker. This sample selects only non-sovereign US bond issuers denominated in US dollars with reference issue ranked senior unsecured and maturity around five years. Intradaily quotes and trades are aggregated to obtain monthly average CDS spreads.

		Rating Groups						
		AAA	AA	A	BBB	BB	B	NR
1997	N	4	6	20	13	5	1	–
	Mean	23.50	24.00	40.17	37.50	71.00	120.00	–
	Stdev	10.79	18.53	41.68	11.69	38.79	–	–
1998	N	6	39	119	49	11	–	6
	Mean	38.44	38.35	33.84	54.52	73.41	–	44.11
	Stdev	25.63	32.56	18.66	40.75	47.03	–	14.89
1999	N	9	73	238	139	12	–	17
	Mean	38.95	30.15	34.64	70.99	59.82	–	49.08
	Stdev	23.54	15.67	17.30	44.79	18.06	–	28.06
2000	N	15	83	326	377	56	15	14
	Mean	57.27	42.26	55.28	130.60	220.07	388.27	166.59
	Stdev	31.13	30.25	38.98	109.80	125.95	125.36	171.75
2001	N	24	139	523	625	116	28	16
	Mean	42.68	53.78	84.42	172.40	376.51	596.90	216.47
	Stdev	27.47	37.61	49.93	106.72	151.04	243.97	151.63
2002	N	39	151	808	1106	176	20	33
	Mean	67.82	67.88	101.83	213.63	481.41	642.20	250.38
	Stdev	51.95	58.34	77.13	172.56	236.02	322.55	254.37
2003	N	58	82	776	1220	220	75	15
	Mean	35.08	30.15	59.06	126.62	362.32	573.91	129.83
	Stdev	33.45	25.19	56.24	104.33	183.34	293.44	87.59
2004	N	51	98	491	965	245	61	211
	Mean	15.19	24.97	40.79	73.32	182.46	329.81	116.33
	Stdev	9.14	8.91	38.84	47.14	111.57	170.76	116.10
2005	N	8	18	98	285	91	19	185
	Mean	11.82	18.90	30.07	48.16	102.15	236.40	79.04
	Stdev	3.80	7.37	46.53	38.56	55.14	92.62	80.32

Table II
CDS Illiquidity and CDS Spreads

This table shows the effects of CDS illiquidity on CDS spreads. Shown in the table are panel regression results. The dependent variable is monthly average CDS spreads. Monthly dummies (not shown) are also included in the regressions. OIV is at-the-money option-implied volatility. Jump is the difference implied volatility between at the money option and in-the-money option. NQT is number of quotes and trades within the month for the reference issue. Order imbalance is the absolute difference between number of buyer initiated quote or trade and seller-initiated quote or trade. % B/A is the percentage CDS bid-ask spread. Issuer-clustering is adjusted to obtain robust t-values.

	(1)		(2)		(3)		(4)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	419.22	7.19	416.98	7.15	533.08	7.81	536.97	7.90
OIV	492.25	14.59	496.13	14.92	509.40	13.12	502.14	12.68
Jump	734.24	4.07	734.07	4.03	624.69	3.03	620.95	3.07
Credit Rating	-23.67	-12.16	-23.67	-12.14	-25.52	-11.37	-25.69	-11.51
Leverage	83.19	5.02	83.44	5.01	84.89	4.25	87.15	4.46
B/M	0.00	-12.00	0.00	-12.06	16.94	1.39	16.08	1.34
Market Cap	32.11	4.86	32.58	4.87	41.58	5.01	41.11	5.08
NQT	0.09	2.55					0.11	3.60
Order Imbalance			0.57	1.58			-0.01	-0.06
% B/A					30.52	1.80	41.10	2.56
N	8704		8704		6138		6138	
Cluster	497		497		440		440	
Adj-R^2	0.598		0.597		0.613		0.615	
F	29.52		28.97		18.31		22.57	

Table III
Illiquidity and Credit Risk

This table shows the effects of CDS illiquidity on CDS spreads by credit ratings. Shown in the table are panel regression results. The dependent variable is monthly average CDS spreads. Monthly dummies (not shown) are also included in the regressions. OIV is at-the-money option-implied volatility. Jump is the difference implied volatility between at the money option and in-the-money option. NQT is number of quotes and trades within the month for the reference issue. Issuer-clustering is adjusted to obtain robust t-values.

	AA		A		BBB		BB	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	-45.40	-4.48	-29.55	-2.51	-194.05	-12.60	-162.62	-2.56
OIV	196.32	4.49	156.07	5.00	563.30	11.61	499.87	7.24
Jump	-653.40	-1.16	342.40	1.25	750.61	3.84	1017.39	1.96
Leverage	-39.31	-2.72	-9.36	-0.85	176.22	7.95	193.58	2.71
B/M	66.27	6.73	29.65	1.82	0.00	-10.88	0.74	0.04
Market Cap	-4.39	-0.12	-2.94	-0.51	-25.36	-0.88	-88.84	-0.77
NQT	0.26	1.87	0.18	3.55	0.16	4.00	0.20	1.09
N	611		3176		4002		639	
Cluster	38		188		269		111	
Adj-R^2	0.446		0.312		0.562		0.561	
F	6.51		16.01		55.56		12.03	

Table IV
Illiquidity Spillover from Bond Market to CDS Market

This table shows the effects of illiquidity spillover from bond market to CDS market on CDS spreads. Shown in the table are panel regression results. The dependent variable is monthly average CDS spreads. Monthly dummies (not shown) are also included in the regressions. OIV is at-the-money option-implied volatility. Jump is the difference implied volatility between at the money option and in-the-money option. NQT is number of quotes and trades within the month for the reference issue. Bond age (maturity) is the average age (maturity) of all bonds outstanding for the reference entity. Bond Amt is the total principal amount of bond outstanding for the reference entity. Issuer-clustering is adjusted to obtain robust t-values.

	(1)		(2)		(3)		(4)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	507.96	8.21	500.21	8.52	349.40	5.96	511.95	8.74
OIV	523.51	12.61	527.06	12.86	526.94	12.78	524.20	12.83
Jump	610.15	3.80	573.50	3.48	635.17	3.80	574.56	3.52
Credit Rating	-21.99	-10.65	-22.58	-11.31	-21.48	-10.85	-22.60	-11.39
Leverage	62.63	3.34	65.80	3.76	73.60	3.79	73.23	3.91
B/M	10.28	0.80	9.61	0.76	6.68	0.54	8.89	0.70
Market Cap	33.73	3.21	38.35	3.72	35.03	5.05	44.40	4.35
NQT	0.05	1.73	0.05	1.71	0.06	2.13	0.05	1.65
Bond Age	-1.53	-1.16					-1.78	-1.37
Bond Maturity			0.98	2.17			0.92	2.01
Bond Amt					-0.33	-2.06	-0.36	-1.97
N	7401		7401		7540		7401	
Cluster	403		403		406		403	
Adj-R^2	0.594		0.596		0.597		0.598	
F	26.81		40.23		26.26		29.72	

Table V
Illiquidity Spillover from Stock Market to CDS Market

This table shows the effects of illiquidity spillover from stock market to CDS market on CDS spreads. Shown in the table are panel regression results. The dependent variable is monthly average CDS spreads. Monthly dummies (not shown) are also included in the regressions. OIV is at-the-money option-implied volatility. Jump is the difference implied volatility between at the money option and in-the-money option. NQT is number of quotes and trades within the month for the reference issue. Stock illiquidity is the daily average of square root absolute return to volume ratio. Issuer-clustering is adjusted to obtain robust t-values.

	Coef.	t-stat
Constant	458.18	6.69
OIV	484.46	14.31
Jump	356.80	1.81
Credit Rating	-21.50	-10.99
Leverage	78.22	5.01
B/M	0.00	-12.70
Market Cap	38.43	5.23
NQT	0.12	3.55
Stock Illiquidity	1189.18	4.39
N	8652	
Cluster	495	
Adj-R^2	0.608	
F	30.15	

Table VI
Illiquidity Spillover from Stock Option Market to CDS Market

This table shows the effects of illiquidity spillover from stock option market to CDS market on CDS spreads. Shown in the table are panel regression results. The dependent variable is monthly average CDS spreads. Monthly dummies (not shown) are also included in the regressions. OIV is at-the-money option-implied volatility. Jump is the difference implied volatility between at the money option and in-the-money option. NQT is number of quotes and trades within the month for the reference issue. Option B/A is option bid-ask spread. Option O/I is the open interest (in log). Issuer-clustering is adjusted to obtain robust t-values.

	(1)		(2)		(3)		(4)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	533.17	7.85	515.25	7.20	541.30	8.10	439.85	6.20
OIV	517.82	15.18	498.36	14.87	500.91	14.97	513.77	15.22
Jump	639.46	3.39	710.40	3.96	707.09	3.90	556.02	2.90
Credit Rating	-22.73	-11.17	-23.44	-11.91	-23.33	-11.54	-22.67	-11.48
Leverage	84.58	5.18	82.73	4.95	83.63	4.98	81.30	5.04
B/M	0.00	-12.49	0.00	-11.78	0.00	-11.94	0.00	-10.72
Market Cap	39.32	5.14	33.49	4.99	34.45	4.78	35.75	5.04
NQT	0.11	3.36	0.10	2.85	0.10	2.87	0.10	3.04
Option Volume	-4.33	-2.33					-17.35	-5.66
Option B/A			51.36	1.54			45.10	1.37
Option O/I					-1.50	-0.74	16.13	4.65
N	8652		8652		8652		8652	
Cluster	495		495		495		495	
Adj-R^2	0.599		0.597		0.597		0.603	
F	28.55		30.52		28.35		31.63	

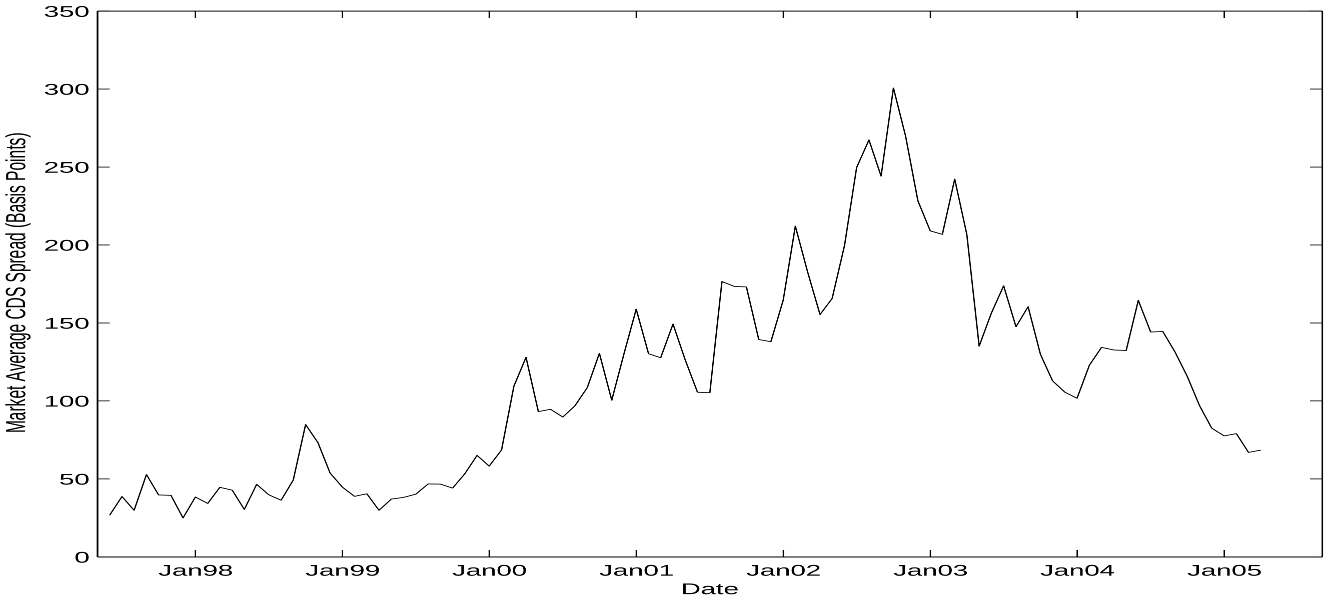

Figure 1. Market average CDS spreads.
The sample includes only U.S. dollar denominated contracts for U.S. corporations with reference issues being senior unsecured bonds and maturity around 5 years, from one CDS broker.

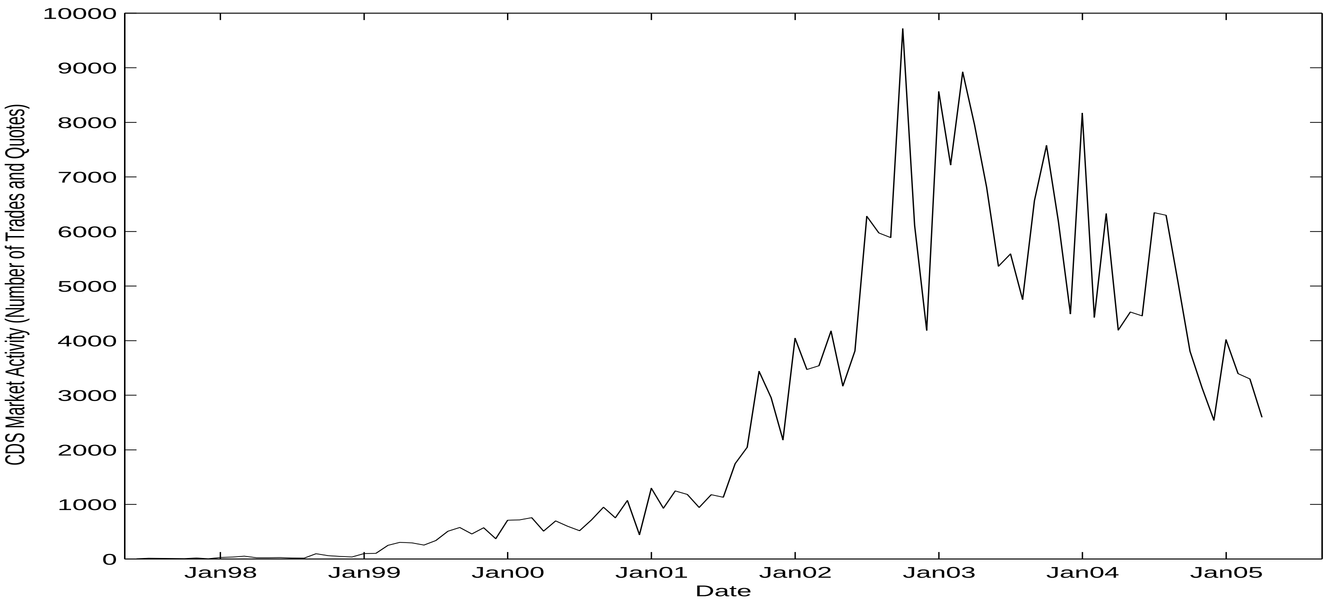

Figure 2. Total number of quotes and trades in the sample.
The sample includes only U.S. dollar denominated contracts for U.S. corporations with reference issues being senior unsecured bonds and maturity around 5 years, from one CDS broker.

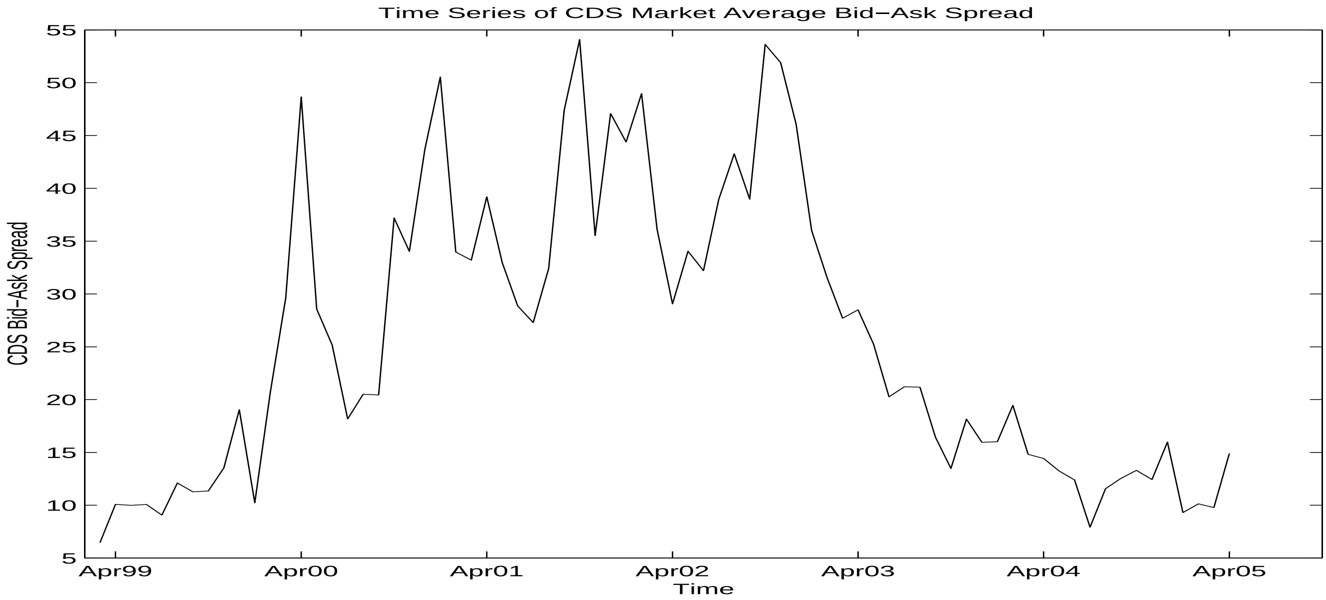

Figure 3. Time-series plot of CDS market average bid-ask spread.

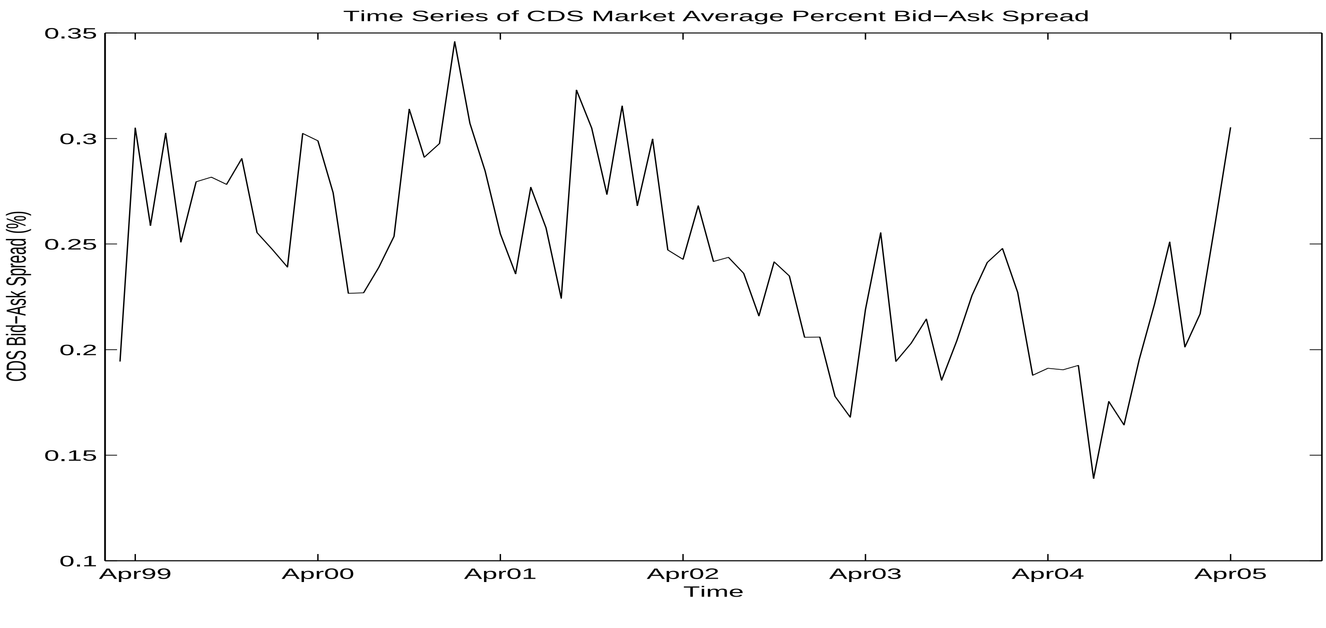

Figure 4. Time-series plot CDS market average percentage bid-ask spread.

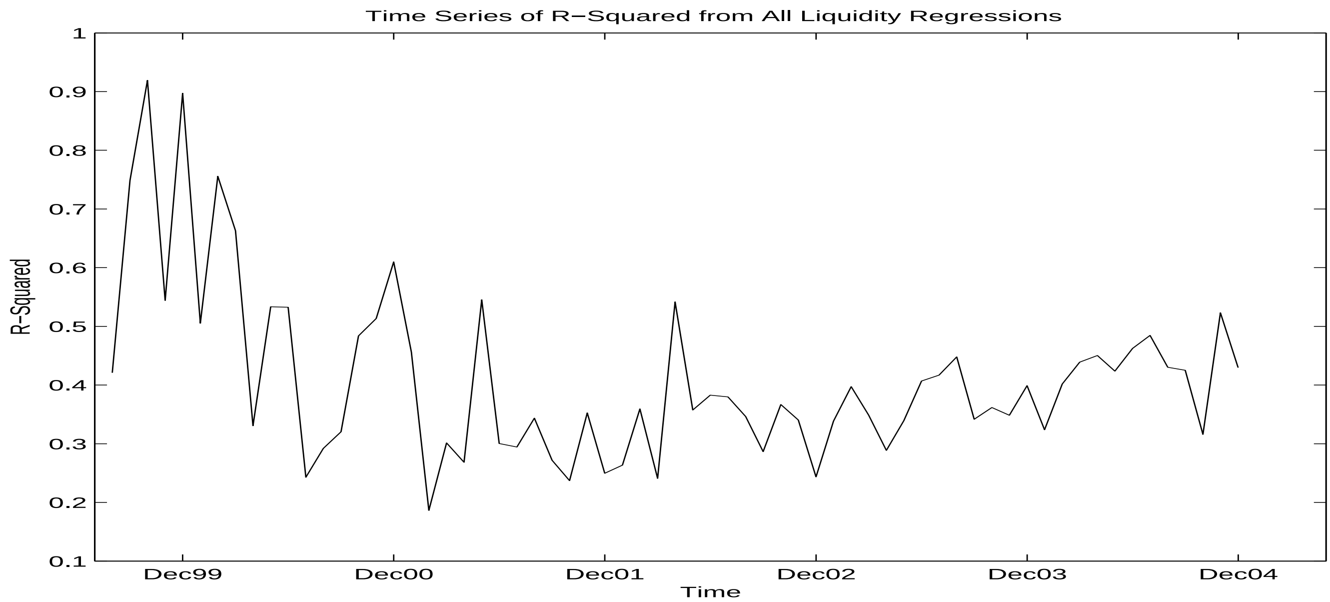

Figure 5. Time-series plot of R^2 from regressing CDS spreads on all liquidity proxies.