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Abstract

An international initiative to increase the use of central clearing for OTC derivatives emerged as one of the reactions to the 2008 financial crisis. The move to central clearing is a fundamental change in the structure of the market. Central clearing will help control counterparty credit risk, but it also has potential implications for market liquidity. We analyze the relationship between liquidity and central clearing using information on credit default swap clearing at ICE Trust and ICE Clear Europe. We find that the central counterparty chooses the most liquid contracts for central clearing, consistent with liquidity characteristics being important in determining the safety and efficiency of clearing. We further find that the introduction of central clearing is associated with a slight increase in the liquidity of a contract. This is consistent with two countervailing effects. On one hand, central clearing will likely increase collateral requirements relative to the pre-reform bilaterally-cleared market, thereby increasing clearing costs and possibly reducing the liquidity of the market. On the other hand, improved management of counterparty credit risk, increased transparency and operational efficiencies at central counterparties could bring more competition into OTC derivative markets and serve to increase liquidity.

JEL classification: G30, G38
Bank classification: Financial markets

Résumé

Une initiative internationale visant à accroître le recours à la compensation centralisée des contrats de dérivés de gré à gré a été lancée en réponse à la crise financière de 2008. L'adoption de cette pratique constitue un changement fondamental de la structure du marché. La compensation centralisée aidera à limiter le risque de contrepartie, mais elle pourrait également se répercuter sur la liquidité du marché. Les auteurs analysent la relation entre liquidité et compensation centralisée à l'aide de données relatives à la compensation des swaps sur défaillance par ICE Trust et ICE Clear Europe. Ils constatent que la contrepartie centrale choisit d'effectuer la compensation des contrats les plus liquides, ce qui corrobore le rôle déterminant de cette caractéristique pour la sûreté et l'efficience de la compensation. Les auteurs notent aussi que la compensation s'accompagne d'une légère hausse de la liquidité des contrats. Ce résultat est compatible avec la présence de deux effets de sens opposé. D'un côté, la compensation centralisée pourrait accroître les exigences de garantie par rapport à celles en vigueur avant la réforme – lorsque les contrats étaient compensés bilatéralement –, d'où une augmentation des coûts de la compensation et une baisse possible de la liquidité. En revanche, la meilleure gestion du risque de contrepartie, le renforcement de la transparence et les gains d'efficience opérationnelle réalisés par les contreparties centrales pourraient stimuler la concurrence sur les marchés des dérivés de gré à gré et entraîner, de ce fait, une amélioration de la liquidité.

Classification JEL : G30, G38
Classification de la Banque : Marchés financiers

1. Introduction

What is the relationship between liquidity and central clearing? International reforms aimed at increasing the safety and the resilience of the global financial system require all standardized over-the-counter (OTC) derivatives transactions to be cleared through central counterparties (CCPs) by the end of 2012.[1] The principal objective of this change in market practice is to mitigate systemic risk by better controlling counterparty credit risk. But given that CCPs for OTC derivatives are a relatively new type of market infrastructure, little is known about how this important change in market structure will affect the liquidity of the newly cleared markets or how the liquidity of the existing markets will affect the success of the move to central clearing.

CCPs and their regulators will both have an ongoing role in determining which products should be centrally cleared.[2] Regulators agree that safe central clearing requires a liquid market (FSB, 2010), but there is little concrete analysis of factors that drive the relationship between central clearing and market liquidity. This information is critical for the implementation of OTC derivatives market reforms because it helps determine what products should be centrally cleared and what products should remain bilaterally cleared. Without an idea of what influences the level of liquidity necessary to clear a product, it is difficult to determine whether the appropriate amount of products are being centrally cleared. Given that CCPs will have to manage the risks associated with clearing OTC derivatives it is important that there be an ongoing role for the CCP and its regulator in determining which products are clearing eligible.

Central clearing may also have an impact on the liquidity of newly-cleared OTC markets. Yet it is not obvious, a priori, whether central clearing will support or impair market liquidity. Central clearing may negatively affect market liquidity because of increased costs—particularly in terms of collateral demands (Singh, 2010)—that may reduce incentives to trade cleared products. Central clearing may also reduce liquidity if some market participants are not able to obtain adequate access to CCPs (Fontaine, et al 2012). On the other hand, increased operational efficiencies at CCPs, combined with the CCPs' ability to mitigate counterparty risk and equalize

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[1] Group of 20, "Leaders' Statement: The Pittsburgh Summit," September 2009. http://www.g20.org/Documents/pittsburgh_summit_leaders_statement_250909.pdf

[2] For example, the CFTC and SEC cannot require a clearing agency to clear any category of swap or security-based swap that would "threaten the financial integrity of the clearing agency." (Dodd-Frank Wall Street Reform and Consumer Protection Act, 2010)

that risk across market participants may increase participation in centrally-cleared markets and thereby increase liquidity.

When deciding what products to clear, both CCPs and market regulators should consider the anticipated effect on liquidity. If market liquidity falls after the introduction of central clearing, this could put the CCP at risk because it may not have the appropriate level of market liquidity to safely and effectively manage the portfolio of a defaulting clearing member. As well, the effect of CCP clearing on liquidity is important because liquidity in the CDS market may have benefits in terms of prices and quantities in the underlying bond and loan markets.[3]

The contributions of this paper are threefold. First, we empirically identify the determinants of a CCP's decision to centrally clear OTC derivatives. ICE Clear Credit and ICE Clear Europe began clearing single name corporate credit default swap (CDS) contracts in 2009. To date they have selected a portion of this CDS market for central clearing. Using a Cox (1972) survival analysis, we find that these two CCPs selected contracts with larger net notional amounts outstanding that had lower risk, lower bid ask-spreads, and that were members of a CDS index. Overall, this conforms to the hypothesis that CCPs choose liquid contracts with more information production for central clearing.

Second, using an event study methodology, we empirically examine the change in liquidity surrounding the first date of central clearing. We examine four factors that can affect market liquidity as measured by the bid-ask spread (order processing costs, inventory holding costs, adverse selection costs, competition) and discuss how these factors will change with a move to central clearing. We cannot predict the effect of central clearing on bid-ask spreads because the resulting market changes may have countervailing impacts. We find evidence that central clearing is associated with a small decrease in bid-ask spreads, and a slight increase in the number of dealers providing pricing information on CDS contracts.

Third, the OTC derivative reforms are increasing the amount of data available to both regulators and to the public on OTC derivatives markets. This paper uses this newly available

[3] Ashcraft and Santos (2009) find that firms with liquid CDS contracts experience a reduction in their bank loan spreads after the onset of trading of their CDS contracts. In terms of quantities, Saretto and Tookes (2011) find weak evidence of a positive relation between the liquidity of a firm's CDS contracts and the firm's leverage ratios and debt maturities.

public information. Hence, we can learn some of the benefits of this information, as well as its limitations.

The rest of this paper is organized as follows. Section 2 presents the institutional background of the CDS market and central counterparties. In Section 3, we examine theoretical arguments regarding the relation between central clearing and liquidity. Section 4 describes our dataset while section 5 empirically investigates the relation between central clearing and liquidity. Section 6 concludes.

2. Institutional background

2.1 CDS market

CDS are bilateral contracts, negotiated in an over-the-counter market, for the purpose of managing credit risk. In exchange for a premium, the buyer of a CDS will receive compensation from the seller upon the occurrence of a credit event that affects the value of the contract's underlying reference obligation. The reference obligation is a debt security of a particular reference entity or name, typically either a corporation or a government. The CDS contract specifies the credit events that will trigger a default and require payment to the buyer of the CDS contract. These include failure to pay, bankruptcy and restructuring (IOSCO, 2012, page 13). A single name CDS typically provides protection on credit events of a corporate or sovereign entity, while index CDS provides protection against credit events in a portfolio of single name CDS contracts.[4]

Since its inception in the mid-1990s, the CDS market has experienced strong growth, particularly in the years preceding the financial crisis. Globally, the market grew from US$6.4 trillion in notional outstanding in 2004 to a peak of US$58 trillion in June 2007 (BIS data). This rapid growth can be linked in part to the advantages that CDS offer relative to corporate bonds in terms of creating a liquid market for trading credit products and a tool for market participants to manage their credit risk.[5]

[4] Refer to Markit (2012) for a description of the effect of credit events on the cash flows and composition of credit default swap indices.
[5] The rapid growth in the size of the CDS market can also be explained by the fact that CDS positions were often exited by setting up an offsetting position with another counterparty instead of cancelling the original trade, a practice attributed to the perception of small counterparty credit risks in the pre-crisis period (Vause, 2010; IOSCO, 2012).

In the period following the financial crisis, the size of the CDS market declined substantially. As of December 2011 the notional outstanding stood at US$28.6 trillion (See **Figure 1**). According to Vause (2010), the decline was linked in part to changes in operational practices designed to mitigate counterparty credit risk. He argues that most, if not all, of the decline in CDS volumes from 2007 to 2010 was due to trade compression and the move to central clearing, and that the volume of new trades continued to rise.[6]

The financial crisis highlighted a number of weaknesses in the infrastructure of the OTC credit default swaps market, notably a lack of transparency to both regulators and the public. As well, the collapse of both Lehman Brothers and Bear Stearns elevated concerns about interconnectedness and counterparty credit risk in the OTC derivatives market.[7] Amid concerns over Bear Stearns' potential failure, its counterparties attempted to mitigate their risk by novating trades for which Bear Stearns was a counterparty to other dealers. For a troubled dealer, these novation requests may result in a removal of the cash collateral, which could further undermine its cash position and propagate market gossip about the troubled dealer's weakness (Duffie, 2009).[8] The financial crisis thus provided the impetus to enhance the management of counterparty credit risk in OTC derivatives markets, and specifically the credit derivatives market.

2.2 Central clearing

Central clearing of OTC credit default swaps was introduced in 2009 in response to the demands of the regulatory community, specifically the supervisors of the largest global OTC derivatives dealers - the OTC Derivatives Supervisors' Group (ODSG) - and the Presidents' Working Group (PWG) of the U.S. Treasury.[9] The ODSG has been working with the global OTC derivatives industry since 2005, initially to reduce the large backlogs of unconfirmed CDS trades that had resulted from the rapid growth of the market. In a series of letters to the President

[6] In the process of trade compression, sufficiently standardized offsetting contracts are eliminated or replaced with a new contract for a smaller notional outstanding. Trioptima is one of the main providers of this service for credit derivatives. Trioptima tore up a record $30 trillion in CDS notional outstanding in 2008. See Vause (2010) and IOSCO (2012).
[7] CDS on subprime housing also played a prominent role in the downfall of AIG. CDS on subprime was estimated to account for $52 billion of the $173 billion the government extended for the bailout of AIG (Ng, 2009). These CDS contracts would not, however, be clearable at any current CCP due to their highly customized characteristics.
[8] Given a large influx of novation requests, some dealers began to refuse to accept these novations (Burrough, 2008).
[9] The ODSG is chaired by the Federal Reserve Bank of New York. See Chander and Costa (2010) for an in-depth discussion of the developments leading to the introduction of CDS clearing.

of the New York Federal Reserve, the largest global OTC derivatives dealers have made a number of commitments aimed at increasing the operational efficiency and resiliency of the CDS market. These included measures to increase contract standardization, electronic trade confirmations and straight through processing and to develop a trade repository that would improve market transparency.[10] However, regulatory efforts stopped short of requiring central clearing of CDS contracts until the events of the financial crisis, notably the failure of Bear Stearns in March 2008, revealed the risks to financial stability posed by weaknesses in market infrastructure. In a letter to the President of the New York Fed in July 2008, the largest global OTC derivatives dealers committed to developing central clearing for credit derivatives.[11] The PWG published its policy objectives related to central clearing of CDS in November 2008 (U.S. Department of the Treasury, 2008).

Intercontinental Exchange (ICE) provided the first central clearing service for OTC credit default swaps. ICE Clear Credit (formerly ICE Trust) began clearing standardized North American CDS indices (CDX) in March 2009 and ICE Clear Europe began clearing standardized European CDS indices (iTraxx) in July 2009. Clearing of single name CDS was introduced by both CCPs in December 2009. Several competing CCPs have introduced CDS clearing services (LCH.Clearnet SA, Eurex, and CME) but have not gained substantial market share. As shown in **Table 1**, ICE has emerged as the market leader in central clearing of Euro and U.S. dollar-denominated credit default swaps. Most of the cleared volume represents inter-dealer trades. Clearing of buy-side trades is limited to North American CDS indices, the volumes of which are still relatively small in comparison to clearing of inter-dealer trades. While there are fewer transactions in CDS indices relative to single-name CDS, the notional value traded in CDS indices is much larger than that of single-name CDS because transaction sizes for CDS indices tend to be much larger (Chen et al, 2011). As seen in Table 1, the same is true for the clearing of CDS.

[INSERT TABLE 1 HERE]

[10] In cooperation with regulators, DTCC established the first OTC derivatives trade repository, Warehouse Trust, which was supervised by the New York Federal Reserve and the New York State Banking Department. All CDS transactions were to be reported to the trade repository which would then provide reporting to regulators and to the public as appropriate.

[11] See http://www2.isda.org/G20objectives
http://data.newyorkfed.org/markets/otc_derivatives_supervisors_group.html

Regulatory efforts to encourage greater standardization of CDS contracts and increased trade process automation have helped to establish the conditions for credit default swaps to move to central clearing. A noteworthy development for standardization of single name CDS was the introduction, in early 2009, of the Big Bang protocol by the International Swaps and Derivatives Association (ISDA).[12] The Big Bang protocol introduced a number of global contract changes as well as changes to conventions observed in particular markets. The more important of these were the standardization of a small number of fixed coupon rates in North American CDS, which provided contract fungibility and enhanced liquidity; incorporation of the auction process into the standard CDS contract which supports a binding, standard cash settlement price upon the occurrence of a credit event; and the establishment of an event determination committee to provide a common and binding determination of whether a credit event has occurred (Markit, 2009; IOSCO, 2012).

Despite the efforts of industry and the regulatory community to increase contract and standardization and process automation—necessary prerequisites to central clearing—the share of the market that is currently centrally cleared is quite small. The Financial Stability Board (2012) estimates that 12 per cent of a total of $23.7 trillion in CDS notional outstanding was centrally cleared at the end of 2011.[13] Although single name CDS represent 60 per cent of notional outstanding, only 8 per cent was centrally cleared compared to 18 per cent of multi name CDS (i.e., CDS indices). Given that market participants have not yet been legally required to clear their trades it is difficult to determine the reason why the market share of cleared trades is small. However, one would expect the share to increase as jurisdictions begin to implement the G-20 commitments related to standardization and central clearing.

[12] Additional provisions that included convention changes to European CDS were implemented later in 2009. These are collectively referred to as the “small bang”. See Casey (2009a, 2009b).

[13] Using data obtained from DTCC’s Trade Information Warehouse (TIW) which includes the majority of trades captured in TIW, adjusted for double and triple counting.

3. Theory

3.1 Clearing criteria

An OTC derivatives CCP is, at its heart, a default management infrastructure; as the counterparty to every trade, the CCP must stand ready to assume the obligations entailed by the trades of a defaulting member. Products can be cleared only if the CCP is confident that it can handle a default quickly and efficiently, usually by finding a new counterparty to take on the obligations of the defaulter. The FSB (2010) outlines three factors that are important in determining whether a product can be safely cleared by a CCP.

The first factor is the degree of legal and operational standardization. Standardization facilitates trading and netting of products, thereby reducing risk and allowing a CCP to more easily transfer obligations of a defaulted member to a new counterparty. As discussed in Section 2, most CDS are highly standardized in terms of both legal and contractual terms as well as in operational processes and are therefore suitable for central clearing from a standardization point of view.

Second, market liquidity is important in determining whether a product is suitable for central clearing. In order for a CCP to manage the default of its clearing members, the CCP must be able to liquidate, hedge, or close out the defaulting positions. The degree of market liquidity will affect the CCP's ability to efficiently liquidate positions in the market. In terms of liquidity, most corporate, single-name CDS are thinly traded, with only a handful of corporate CDS trading more than ten times a day (Chen et al, 2011). Nonetheless, more than 200 CDS contracts are now centrally cleared on the ICE platforms. In Section 5, we examine in more detail the liquidity of cleared and non-cleared corporate single name CDS. Thus, we predict that CDS that are more liquid are more likely to be selected for central clearing.

Third, CCPs require accurate and up-to-date pricing information. Accurate pricing is needed so that a participant's positions can be accurately marked to market in order to calculate variation margin that is paid to cover current price movements. As well, participants must post initial margin to cover potential future losses: that is, the potential adverse price movements during the period of time between the member default and the closing-out of the defaulting member's positions, the hedging of these positions, or the transferring of these positions to another clearing member. A historical record of prices is necessary to accurately estimate these future movements. Hull (2010) suggests that OTC derivatives could be centrally cleared even without readily available market pricing since market participants could provide their pricing models to the CCP and the CCP could use these pricing models to set initial and variation margin requirements. Putting aside whether such derivatives would have adequate standardization or liquidity to facilitate their replacement in default, this clearing strategy is likely not feasible because market participants would have an incentive to submit models that underestimated the volatility of the product's pricing in order to minimize margin requirements.

CDS contracts are generally priced as a spread that represents the premium that a buyer of protection pays to the seller. Markit publishes daily end-of-day prices that are based on quotes submitted by dealers. All else equal, we would expect the accuracy of CDS prices to be related to the number of dealers providing quotes (referred to as "composite depth"). Therefore, if pricing is an important factor, we predict that CDS with more composite depth are more likely to be selected for central clearing.

A product's complexity and risk characteristics may also increase the risks and costs of clearing specific types of OTC derivatives (Pirrong, 2011). Risk management can be particularly challenging for CCPs clearing CDS relative to other types of derivatives because of *jump-to-default* risk: the value of a CDS contract may change very rapidly as the underlying security approaches default (Ivanov and Underwood, 2011). This increases the likelihood that a significant value change may occur between variation margin payments and makes it more difficult to determine the appropriate level of initial margin. Initial margin should depend on the contribution of the contract to the volatility of the participant's cleared portfolio and it is more challenging to determine how CDS and other OTC derivatives with *jump-to-default* risk contribute to initial margin requirements at the portfolio level (Hull, 2010). With these products, a CCP may therefore either risk being undercollateralized relative to the true risk of the position or risk collecting excess initial margin such that it is uneconomical for participants to centrally clear the contract (Pirrong, 2011). CCPs may have a preference for clearing contracts with a lower jump-to-default risk. While all CDS contracts contain a jump-to-default risk, those with a higher spread have a higher likelihood of experiencing discontinuous price movements. Hence, we expect that CCPs are less likely to clear contracts with higher spreads.

3.2 Effect of clearing on liquidity and pricing

3.2.1 Inventory holding costs

Dealers provide liquidity to the market by taking on temporary positions in their trades with clients. Their ability to do this depends on the cost of deviating from their desired portfolio. This is sometimes referred to as inventory holding costs (Demsetz, 1968). In OTC derivatives markets, dealers face counterparty credit risk in swap transactions and may need to post or collect collateral so that the counterparty risk in a transaction is managed from the perspective of both sides of the transactions. This additional collateral and counterparty risk exposure represents an inventory holding cost to the dealer. Central clearing will have an impact on both the amount of collateral in a transaction as well as the degree of counterparty risk exposure. Collateral could increase or decrease with the move to central clearing. This will depend on the margining policy of the CCP and the margining rules applying to non-cleared trades. It also depends on the netting efficiency of central clearing, which is a function of the number of CCPs a participant clears his trades through (Duffie and Zhu, 2011). If participants clear all their trades through a single CCP, then netting efficiency is increased and collateral would decrease with a move to central clearing. But netting efficiency decreases with an increase in the number of CCPs and clearing through multiple CCPs may increase collateral costs. Currently, there exist two central counterparties that account for most of the clearing in CDS, but other central counterparties exist that serve other asset classes so it is possible that a move to central clearing will increase collateral costs, and these increased collateral costs could be significant (Singh, 2010).[14, 15] While collateral costs may increase with a move to central clearing, counterparty risk will likely decrease. Overall, it is unclear which of these two effects will dominate.

3.2.2 Adverse selection costs

As in any trading relationship, dealers face an adverse selection problem in that a dealer may transact with an informed trader who has better information about a security's underlying value. An increase in the bid-ask spread compensates dealers for the risk of trading with an informed trader but also makes trading more costly for uninformed market participants (Copeland and

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[14] Market participants moving to central clearing may also lose some of the advantages of netting across products or asset classes since the netting sets available in CCPs tend to be limited.

[15] The International Monetary Fund (2010), for example, estimated that moving OTC derivatives to central clearing would require about $150 billion in additional collateral for initial margin and guarantee fund contributions.

Galai, 1983; Glosten and Milgrom, 1985; Easley and O'Hara, 1987). While central clearing in and of itself will not change the information possessed by different agents about the underlying security, it may reduce the information sensitivity of securities, which could reduce the adverse selection problem and lead to more trading. Carapella and Mills (2011) develop a model whereby securities become less information sensitive with a move to central clearing. This reduction is a result of two effects. The first is the mutualization of risk through a default fund, which increases payoffs to participants in states of the world where their counterparty is in default. The second effect is an increase in multilateral netting, which reduces the net exposure between counterparties and hence the value of acquiring information about a security. However, as discussed in Section 3.2.1, it is an open question whether central clearing will result in increased netting efficiency.

Participants also have different information sets with respect to counterparty credit risk. More specifically, participants are likely more informed about their own counterparty credit risk, and there is a counterparty risk externality in bilateral OTC derivatives transactions (Acharya and Bisin, 2010). The move to central clearing should reduce this counterparty risk externality, since participants are exposed to the credit risk of the central counterparty, rather than the risk of their OTC counterparty. This reduction in the counterparty risk externality could therefore contribute to a reduction of the adverse selection component of the bid-ask spread.

3.2.3 Competition

Central clearing will also have an impact on competition in the OTC derivatives market (Fontaine et al, 2012). There are barriers to entry in the bilateral market in that market making is limited to counterparties with high credit ratings. With the move to central clearing, transactions will be novated to the CCP; the credit quality of a counterparty will be less relevant, as long as the counterparty has efficient access to central clearing. But if access is severely restricted, fewer participants will be able to participate as market makers in OTC markets and competition will decrease, resulting in a reduction of liquidity (Slive et al, 2011). In contrast, the reduction and equalization of counterparty risk discussed above could open the market up to new participants, resulting in increased competition.

3.2.4 Order processing costs

Order processing costs, such as clearing fees, are a small component of the overall cost of an OTC derivatives transaction (Rowady, 2010). The move to central clearing will entail additional operating costs and clearing fees, but the bulk of these costs are likely to be fixed. The marginal cost of clearing an additional contract is likely to be small. In addition, more central clearing may also lead to an increase in process standardization, which could lead to a reduction in back office costs.

4. Data

Our methodology requires data on those contracts that have become centrally cleared, as well as data on contracts that have continued to clear bilaterally.

4.1 Universe of CDS contracts

We use Depositary Trust and Clearing Corporation's (DTCC's) Trade Information Warehouse to define the universe of OTC derivatives contracts used in this study. DTCC is a trade repository for credit derivatives and has been publishing data on the amounts outstanding for the Top 1000 contracts since October 2008. We chose this as our definition of the universe since the number of names in the list is several times larger than the number of names that have been centrally cleared, and all of the contracts that have been centrally cleared are in the Top 1000 list for DTCC. As well, contracts that are not in the Top 1000 have relatively little activity and therefore do not make an appropriate control group for our event study analysis of the effects of central clearing. DTCC covers a large portion of interdealer trades, but has much lower coverage of trades between non-dealers. Relative to CDS market size as measured by the Bank for International Settlements survey, DTCC covered 98% of the dealer market compared to 29% of the non-dealer market at the end of 2008 (European Central Bank, 2009). Since central clearing of CDS to this point has been concentrated on dealer activity and not on client activity, this lack of coverage of non-dealers should have little impact on our results.

We begin by collecting information on all contracts that appeared in the Top 1000 list at any point in time between October 2008 and August 2011. This original list consists of 1226 contracts, including both single-name sovereign and corporate CDS contracts. Our focus is on corporate CDS contracts since these are the type of contracts that have been centrally cleared to date. Although index CDS have been centrally cleared as well, the number of individual index CDS contracts is small, especially considering that new contracts that are introduced are typically just a new series of a similar contract. After eliminating sovereign CDS and contracts that are not denominated in US dollars (USD) or Euros from the list, we are left with 1027 single-name corporate CDS contracts.

DTCC provides information on the gross notional amount outstanding, net notional amount outstanding (both in USD), and number of contracts outstanding for each CDS contract in its list on a weekly basis. As well, beginning in the middle of 2010, DTCC publishes market risk transfer activity (dollar value traded and number of contracts traded). This activity captures transaction types that result in a change in the market risk position of market participants and is meant to exclude transactions that do not represent market activity such as moving bilaterally cleared trades to a CCP and portfolio compression.[16] We match the DTCC data by name to both Markit and Bloomberg. From Markit, we obtain daily closing prices (spreads) for each 5-year CDS contract, the implied average credit rating of the underlying entity, as well as information on the number of clean contributors to Markit's end of day pricing (composite depth). From Bloomberg, we collect daily data on CDS bid and ask spreads.

We select contracts that are in USD or Euros since these are the candidates for central clearing through ICE. As well, in Markit we focus on only those contracts with the standard restructuring clauses used in these respective regions (Markit, 2009). This includes the "No Restructuring" clause (XR) for U.S. dollar contracts and "Modified-Modified" restructuring clause (MM) for Euro contracts. Restructuring clauses define the characteristics of deliverable obligations (e.g., maturity of the deliverable obligations) for those CDS that have restructuring defined as a credit event. After this matching and screening process, our sample contains 674 single name corporate CDS contracts with information on CDS spreads, bid-ask spreads, amounts outstanding, and composite depth, consisting of 439 U.S. dollar contracts and 235 Euro contracts. To assess the validity of our matching, we compare the CDS spreads obtained from Markit to the bid-ask midpoint obtained from Bloomberg. In 95% of our matched pairs, the

[16] This covers new trades between two parties, a termination of an existing transaction, and the assignment of an existing transaction to a third party (DTCC, 2011a)

correlation between these two metrics is 0.99 or greater, indicating that we have most likely identified the proper match between Markit and Bloomberg.

4.2 Centrally cleared contracts

Both ICE Clear Europe and ICE Clear Credit provide a list of all cleared entities. There are 128 entities that are cleared through ICE Clear Europe, and 128 entities that are cleared through ICE Clear Credit. This list includes the name of the individual entities, as well as the date on which each entity was accepted for central clearing. As well, ICE provides data on trading volumes and open interest by entity for each entity after it has been accepted for central clearing. The contracts that are centrally cleared by ICE are matched to the universe of CDS contracts based on name (DTCC and ICE follow the same naming conventions). Based on this matching, there are 113 U.S. dollar contracts and 102 Euro contracts that have full data. Centrally cleared contracts in U.S. dollars represent just over 25% of the universe of contracts in U.S. dollars, whereas centrally cleared contracts in Euros represent more than 40% of the universe of contracts in Euros.

5. Results

5.1 Determinants of central clearing

In this section, we examine what characteristics CCPs use to select contracts for central clearing. Specifically, we examine liquidity and other characteristics of contracts that ICE Clear Europe and ICE Clear Credit use to choose CDS contracts for central clearing.

5.1.1 Summary statistics

We include in our analysis several variables that could impact a CCP's decision to centrally clear a contract. High yield CDS have a higher jump-to-default risk and a CCP (and its members) may be more reticent to expose itself to this risk. We include 5 year CDS spreads as a measure of this riskiness and expect firms with higher CDS spreads to be less likely to be selected for central clearing. The CDS spread measures the payments that protection buyers make to protection sellers—essentially the cost of buying CDS protection—and should not be confused with the bid-ask spread discussed below. 5 year CDS spreads are much lower for those contracts that are centrally cleared compared to those that are not (see **Figure 2**). Centrally cleared CDS spreads hover around 1% for much of the 2009-2011 sample period, whereas CDS spreads of those that are not centrally cleared are higher than 2% during all of the sample period. Over time, there does not appear to be a systematic difference between CDS that are accepted for central clearing earlier in the sample relative to those that are accepted for central clearing later in the sample period.

As measures of liquidity, we include both bid-ask spreads and composite depth. If liquidity is a factor in the decision to offer a contract for central clearing, then higher bid-ask spreads should be associated with a lower likelihood of becoming centrally cleared. This is indeed the case as average bid ask spreads for centrally cleared contracts are close to 5 bps throughout the sample period (see **Figure 3**). In comparison average bid-ask spreads for non-centrally cleared contracts range between 12 and 18 bps throughout the period. Composite depth, the number of dealers providing quotes, is a measure of liquidity but also is a measure of the precision of pricing information. That is, a CCP may not be comfortable centrally clearing a contract with only a small number of dealers as the source of pricing information.

We include two measures of size that may be related to information production on a given CDS contract and also may reflect central clearing demand from a CCP's membership. We use net notional amounts outstanding as one measure of size. From **Figure 4**, it is obvious that centrally cleared contracts are much larger than non-centrally cleared contracts. We also examine the ratio of gross notional amounts outstanding to net notional amounts outstanding. Since net notional amounts outstanding offset the value of CDS contracts bought and sold, the ratio of gross to net is a measure of the amount of trading activity relative to the net positions.

5.1.2 Survival analysis

In this subsection we test more formally the factors that affect the central clearing decision using a Cox (1972) proportional hazard model. Hazard models have been used previously in the finance literature to model bankruptcy and bond defaults (Shumway, 2001; Chava and Jarrow, 2004), the decision to cross-list (Pagano, Roell, and Zechner, 2002; Doidge et al., 2009) as well as the decision to cross-delist (Witmer, 2009). We are measuring survival as remaining bilaterally cleared so in the analysis a contract becomes a "failure" once it becomes centrally cleared. Once a contract becomes centrally cleared, it is removed from the analysis. Using the Cox proportional hazard model, we estimate the hazard rate of a contract becoming centrally cleared at time t, conditional on the contract being only bilaterally cleared beforehand.

The Cox model is fitted using maximum likelihood and determines the hazard rate, $\lambda(t|x)$,which takes the following functional form:

$$\lambda(t|x) = \lambda_0(t) \exp(\beta' x) \quad (1)$$

where x is a vector of contract-specific independent variables and β is a vector of the related coefficients. The model determines the proportional hazard rate, $\lambda(t|x)$, by multiplying the baseline hazard rate, $\lambda_0(t)$, by the relative hazard rate, $\exp(\beta' x)$. The model makes no assumptions about the baseline hazard rate, except that it is the same for all contracts. We measure all our variables at a weekly frequency in order to include data on notional amounts outstanding, which is measured at a weekly frequency. Our sample begins in November 2008 and ends in July 2011.

In the first model of **Table 2**, we estimate the Cox proportional hazard model for the entire sample of firms using 5 year CDS spreads, bid-ask spreads, net notional outstanding, gross to net ratio, composite depth and a CDS index dummy as independent variables. The index dummy equals 1 if the contract is a component of the Euro-denominated iTraxx index or the U.S. dollar-denominated CDX index. These indexes are made up of the most liquid CDS contracts and ICE Clear Credit and ICE Clear Europe focused on index components when selecting contracts for central clearing.[17] All of our independent variables have the appropriate sign and, with the exception of composite depth, all of their coefficients are statistically significant at the 1% threshold. Contracts with higher 5 year CDS spreads are less likely to be centrally cleared, as are contracts with higher bid-ask spreads. Larger contracts, as measured by net notional outstanding and gross-to-net ratio, are more likely to be selected for central clearing. As expected, index membership is also positively associated with being chosen for central clearing. We obtain similar results for the U.S. dollar subsample in model 2. In the Euro subsample in model 3, the coefficients on 5 year spreads and net notional outstanding are of the appropriate sign, but they are of a much smaller magnitude and are not statistically significant. Models 4 and 5 perform the Cox survival analysis on Pre-2011 and 2011 subsamples. In the pre-2011 subsample, the coefficient on 5 year CDS spreads is no longer statistically significant, whereas it is statistically significant in the 2011 subsample. In the 2011 subsample, however, the coefficients on the size measures are no longer statistically significant. This is consistent with

[17] Both the iTraxx and CDX index take into account the liquidity of the CDS contracts when determining inclusions and exclusions from its index. Liquidity is ranked according to trading volumes reported to the DTCC Trade Information Warehouse (Markit, 2012).

Figure 3 which shows that the size of contracts accepted for central clearing decreases over time and becomes more similar to the size of non-centrally cleared contracts towards the end of our sample period.

[INSERT TABLE 2 HERE]

In model 6, we examine whether our results are robust when examining only CDS contracts that are members of the iTraxx and CDX indexes. All of the CDS contracts selected for central clearing belong to one of these two indexes. In this model, all of the statistically significant coefficients remain so, with the exception of 5 year CDS spreads coefficient. It loses its statistical significance and this may be resulting from the fact that all of the CDS contracts that belong to these indexes are investment grade, so there is less variation in CDS spreads in this subsample.

5.2 Effect of central clearing on market liquidity

As discussed in section 3, central clearing could have a positive or a negative impact on market liquidity. In this section, we use an event study methodology to assess this impact by looking at various metrics of market liquidity before and after a contract is accepted for central clearing. These metrics include: notional dollar volume traded, number of contracts traded, bid-ask spreads, and composite depth of Markit quotes.

The event study methodology we employ has been used to examine the impact of listing on an option exchange (e.g., Mayhew and Mihov, 2004), the impact of crosslisting on a U.S. stock exchange (e.g., Baker, Nofsinger, and Weaver, 2002), as well as the effect of additions to and deletions from a stock index (e.g., Chen, Noronha, and Singal, 2004; Beneish and Whaley, 1996).

We begin by selecting an appropriate control group for our analysis. In section 5.1, we observe that contracts that are more liquid, and that have higher amounts outstanding, are those that are selected for central clearing. This could introduce a selection bias if the comparison group is systematically different than the control group. Panel A of Table 3 shows that there are substantial differences between contracts that are centrally cleared and those that are not. Non-centrally cleared contracts are much smaller in terms of notional amounts outstanding and have 5 year CDS spreads and bid-ask spreads that are more than three times greater than those of centrally cleared contracts. We employ the propensity score matching technique to attenuate this bias (Rosenbaum and Rubin, 1983; Heckman, Ichimura, and Todd, 1997). To implement this technique, we run logit regressions on an annual basis using the same independent variables as in the survival analysis in Section 5.1. In these regressions, the dependent variable is equal to 1 if the CDS contract is accepted for clearing in the following calendar year. The propensity score is the estimated likelihood of being accepted for central clearing from this logit regression. For each contract that is accepted for central clearing, we use "nearest neighbor" matching to select a matched control contract. That is, from the pool of contracts that were not selected for central clearing, we select a contract in the same currency that has the closest estimated likelihood to each contract that was accepted for centrally clearing.

Matching can either be performed with replacement or without replacement. When matching without replacement, each centrally cleared contract is matched to a unique contract in the control sample. The potential downside to this approach, however, is that a greater selection bias may remain in the control sample because there are not enough firms in the pool of non-centrally cleared contracts with propensity scores of similar magnitude to our treatment sample. Matching with replacement results in a control sample of firms that has less selection bias, but the downside is reduced precision given that a contract may appear multiple times in the control sample. While we match with replacement throughout our analysis, our results are comparable if matching without replacement. This matching results in a control sample that is similar to our treatment group in terms of observable characteristics such as size, bid-ask spreads, 5 year CDS spreads and composite depth (Table 3, Panel B).

[INSERT TABLE 3 HERE]

For each contract, we measure the average of each liquidity metric in the post-clearing period as well as in the pre-clearing period. The averages of the daily liquidity metrics (bid-ask spreads and composite depth) are measured in the fifty-day period on either side of the first date of central clearing, excluding five days preceding the event date and five days subsequent to the event date. We exclude the period directly surrounding event to avoid contaminating our results with volume or liquidity effects resulting from the transition to central clearing. Our volume metrics are not measured at a daily frequency. To use a relatively comparable period for the weekly measures of volume, we examine liquidity in the ten weeks prior to central clearing and in the ten weeks post central clearing, excluding one week before and after the first date of central clearing.

We calculate the ratio of post-clearing liquidity compared with pre-clearing liquidity for each contract and then calculate the average of this ratio across contracts in our treatment group and in our control groups. For example, for bid-ask spreads, we calculate:

$$Bid\ \ Ask\ \ Ratio_i = \frac{\sum_{t=5}^{50} Bid\ \ Ask_{it}}{\sum_{t=-50}^{-5} Bid\ \ Ask_{it}}$$

We then use both parametric and non-parametric tests to examine whether there is any change in liquidity when a contract gets accepted for central clearing. In our parametric tests, the variance is adjusted to take into consideration the fact that we are matching with replacement.[18]

5.2.1 Trading volumes

Table 4 displays the change in trading volume and number of contracts traded for the ten weeks on either side around the first clearing date. These trading volumes only cover market risk transfer transactions and specifically exclude transactions moving bilaterally cleared trades to CCPs, so would not be mechanically impacted by a move to central clearing. For our entire sample of treatment group contracts that become centrally cleared, the average post-pre ratio is 0.99, indicating that, on average, this measure of liquidity is about the same in the post-clearing period as it is in the pre-clearing period. This is very similar to both the market-wide impact around the first clearing date and the ratios for our propensity-matched control group (ratio = 1.08) and is not statistically different from our treatment group. Similar results are obtained with changes in the number of contracts traded around the first clearing date. There was no increase in the number of contracts traded in the post-clearing period; however, there was a larger increase in the number of contracts traded in our control sample firms. These results suggest that there was, if anything, a small decrease in market risk transfer volume associated with the move towards central clearing.

[INSERT TABLE 4 HERE]

[18] We use the method proposed by Abadie and Imbens (2006) and this adjustment results in standard errors that are slightly larger than the unadjusted standard errors.

5.2.2 Bid ask spreads

Bid-ask spreads in the 50 day post-clearing period are, on average, virtually identical to bid-ask spreads in the 50 day pre-clearing period for the full sample of contracts that became centrally cleared. In **Table 5**, the post-pre ratio for the full sample of centrally cleared contracts is equal to 1.01. While the overall market ratios are not statistically different from that of our treatment group, the ratio for the control group, on the other hand, is equal to 1.05 and is statistically different from the treatment group at the 5% threshold. From Table 3, the average bid ask spreads for contracts that became centrally cleared is 6.10 basis points in the pre-clearing period. Therefore, a 5% difference in bid-ask spreads is equivalent to about 0.30 bps. Across the various subsamples, the results are similar. While there exist larger differences for some subsamples (e.g., the 2011 subsample), the statistical significance of this effect is smaller due to a smaller sample size. The absence of a large change in bid-ask spreads could be due to a measurement issue. The bid-ask spreads used in our analysis are indicative – entities posting these spreads do not have an obligation to transact at these prices and usually negotiate prices and terms (including collateral required) depending on the specific counterparty with whom they are transacting. Therefore, the spreads they post may not be representative of the spreads they would offer for centrally cleared contracts. But, these spreads may be representative given that a large share of transactions in the post-clearing period are between major dealers and are centrally cleared.

[INSERT TABLE 5 HERE]

Different hypotheses predict that central clearing could have either a positive or negative impact on bid-ask spreads. Overall, we find evidence of a small reduction in bid-ask spreads around the introduction of a contract to central clearing for the group of contracts that are centrally cleared, relative to those that are not centrally cleared. This suggests that, of the competing effects, the reduction in counterparty credit risk slightly outweighs the effect of higher collateral costs on bid-ask spreads.

5.2.3 Composite depth

The composite depth of CDS prices (i.e., the number of distinct dealers providing quotes for each CDS contract) may be a measure of the availability of pricing information but also may be a measure of market liquidity. Qiu and Yu (2012) consider this measure to be an empirical proxy for market depth in the CDS market.[19] In section 3 we hypothesized that central clearing may increase competition in the CDS market by equalizing counterparty credit risk across more counterparties. This increased competition may show up as an increase in quoted depth. Overall, we find that there is a small increase in composite depth after a contract is introduced to central clearing (see **Table 6**). The average post-pre ratio for our full group of treatment firms is 1.02, whereas the average ratio for our control group is equal to 1.00. These latter ratios are statistically distinguishable from the ratio of our treatment group firm at the 5% level. This suggests a small 2% increase in the post-clearing period, which indicates that if the sample average of approximately 8 dealers were providing quotes in the pre-clearing period, 0.16 extra dealers would be providing quotes in the post-clearing period. There is a slightly large effect in some of the subsamples. In particular, the ratio equals 1.05 in the 2011 subsample, and is statistically different from the 1.01 ratio for our control group over the same period.

[INSERT TABLE 6 HERE]

6. Conclusion

In this paper we find that there is a liquidity difference between cleared and uncleared contracts. Much of this difference is due to the fact that CCPs select the most liquid derivatives for central clearing. Contracts with larger net notional amounts outstanding, smaller bid-ask spreads, and smaller CDS spreads, are more likely to be selected for central clearing. This supports the assertion that liquidity is an important determining factor for whether a CCP is willing to clear a contract. On the other hand, the number of dealers providing pricing information does not seem to determine whether a contract becomes centrally cleared. The availability of pricing information is considered a critical factor in the decision about whether to centrally clear a contract. Our results suggest that the available of pricing information has not been a constraining factor preventing more contracts from becoming centrally cleared. Rather, it is the liquidity of the contracts that differentiates cleared from uncleared contracts.

[19] Qiu and Yu (2012) find a positive cross-sectional relation between composite depth and the amount of information flow from the CDS market to the stock market. They interpret this finding to show that CDS liquidity is positively related to the level of informed trading in the CDS market. This is contrary to classical market microstructure models (e.g., Glosten and Milgrom, 1985), which predict a negative relation between liquidity and informed trading.

Central clearing has a minor, positive impact on the liquidity of CDS contracts. Relative to a control group of contracts matched by propensity scores, contracts that become centrally cleared experience a small drop in bid-ask spreads, and a small increase in the number of dealers providing pricing information. These results suggest that the reduction in counterparty credit risk associated with the move of CDS contracts to central clearing (more than) offsets the increase in collateral costs from such a move. Nonetheless, given concerns that central clearing would have a detrimental impact on market liquidity, these results are encouraging.

As well, the liquidity benefits for the contracts that CCPs have chosen to clear (i.e., the most liquid contracts) may not be representative of the liquidity benefits of contracts that have not been centrally cleared. Specifically, it is possible that the contracts that were chosen for central clearing may be less likely to extract a liquidity benefit from central clearing since they are already relatively liquid. Our results may also help to better understand the issues associated with the structure of central clearing. Specifically, there is a legitimate concern that mandating central clearing will reduce netting efficiency and increase collateral costs, especially as market participants divide their OTC derivatives portfolios across a larger number of CCPs (Duffie and Zhu, 2010). CCPs that concentrate on single products or asset classes, such as CDS contracts, will not be able to offer the cross-asset class netting and collateral efficiency that dealers receive in the bilateral market. Our paper shows that, despite the potential increase in collateral costs associated with a move of contracts to a single asset class (CDS) CCP, there is not a reduction in liquidity but in fact there may be a small increase in liquidity.

To date, there has only been a limited amount of central clearing performed by clients of the large dealers who are clearing members at the CCPs we examine. Hence, our results on liquidity may only apply to the interdealer market. Liquidity at the client level will depend on the structure and costs of accessing the CCP indirectly through the dealers (e.g., Slive, Wilkins, and Witmer, 2011). We leave an empirical examination of this issue to future work.

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Table 1
CDS clearing volumes on the Intercontinental Exchange CDS clearing platforms.

This table was extracted from the Intercontinental Exchange website on August 15, 2012 and the volumes in this table cover the period launch of the platform through August 10, 2012. CDS clearing began at ICE Clear Credit (formerly ICE Trust) in March 2009 and at ICE Clear Europe in July 2009. ICE Clear Credit also clears sovereign single name CDS. As of August10, 2012, four sovereign CDS single name instruments were cleared with $199 billion in gross notional cleared since the launch of sovereign CDS clearing on ICE Clear Credit.

	ICE Clear Credit		**ICE Clear Europe**	
	Index	**Corporate Single Names**	**Index**	**Corporate Single Names**
Instruments	45	132	40	121
Number of Trades Cleared	238,257	249,473	227,533	265,255
Gross Notional Cleared (billions)	$17,378	$1,636	€ 8,833	€ 1,401
Buy-side Notional Cleared (billions)	$40	n/a	n/a	n/a
Open Interest (billions)	$397	$379	€ 170	€ 386

Table 2
Cox analysis of the determinants of clearing eligibility.

This table presents the results of the Cox (1972) proportional hazard model. In the analysis a contract becomes a "failure" once it becomes centrally cleared. We estimate the likelihood of a contract becoming centrally cleared at time t, conditional on the firm being bilaterally cleared. Once a contract becomes centrally cleared, it is removed from the analysis. All the variables are measured at a weekly frequency, from December 2009 through July 2011. Gross notional amount outstanding is provided by DTCC and is the sum of CDS contracts sold for each reference entity. Net notional amount outstanding is the sum of net CDS protection sold by net sellers, and is calculated at the counterparty family level. (DTCC, 2011b). Gross CDS spread is obtained from Markit and is the CDS spread at the five year tenor and is measured in basis points. Composite depth represents the number of clean contributors to Markit's end of day pricing for the contract's CDS spread at the 5 year tenor. CDS bid and ask prices are from Bloomberg and the bid-ask spread is measured in basis points. Index member is a binary dummy variable that is equal to one if the contract belongs to the North American CDS index (CDX) or the European CDS index (iTraxx). Robust t-Statistics are presented in parentheses below regression coefficients and ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1) Full Sample	(2) U.S. dollars	(3) Euro	(4) Pre-2011	(5) 2011	(6) Index Members Only
CDS Spread	-47.428	-50.252	-6.364	8.478	-52.822	22.664
	(4.52)***	(4.04)***	(0.39)	(0.39)	(2.63)***	(1.19)
Bid Ask Spread	-0.094	-0.098	-0.217	-0.188	-0.090	-0.216
	(7.55)***	(6.30)***	(5.17)***	(4.42)***	(3.92)***	(5.71)***
Net Notional	0.635	0.952	0.180	0.749	0.119	0.591
	(4.57)***	(7.14)***	(0.83)	(4.55)***	(0.56)	(3.65)***
Gross to Net Ratio	0.120	0.099	0.116	0.134	0.049	0.116
	(8.72)***	(3.12)***	(6.36)***	(7.54)***	(1.56)	(7.06)***
Composite Depth	0.021	0.057	0.054	0.020	-0.051	0.007
	(0.69)	(1.11)	(1.43)	(0.63)	(0.60)	(0.24)
Index Member	3.890	5.320	3.011	5.530	3.506	
	(11.70)***	(6.74)***	(7.29)***	(5.30)***	(8.17)***	
Observations	37,166	25,285	11,881	26,354	10,812	5,921

Table 3
Summary Statistics broken down by cleared vs non-cleared stocks

This table reports the means of several key variables for the 214 CDS contracts in our sample that were eligible to be centrally cleared as well as for the other CDS contracts that are not eligible for central clearing. The means reported in this table for each variable are measured from 100 days before the first date of clearing eligibility to 5 days before the first date of clearing eligibility. For the control group in Panel A, these means are measured over the entire sample period. The control group in Panel B is assembled by matching each contract that became eligible for central clearing with a contract that is not centrally cleared, that has the closest propensity score. This matching is performed with replacement so contracts may appear more than once in the control group. Gross notional amount outstanding is provided by DTCC and is the sum of CDS contracts sold for each reference entity. Net notional amount outstanding is the sum of net CDS protection sold by net sellers, and is calculated at the counterparty family level. (DTCC, 2011b). CDS spread is obtained from Markit and is the CDS spread at the five year tenor and is measured in basis points. Composite depth represents the number of clean contributors to Markit's end of day pricing for the contract's CDS spread at the 5 year tenor. CDS bid and ask prices are from Bloomberg and the bid-ask spread is measured in basis points. We report the mean difference between the trading attribute of the non-clearing eligible group and the clearing eligible group, the standard error of the mean difference estimate, and the p-value from a t-test of the null hypothesis that the difference between the two groups is statistically indistinguishable from zero. Standard errors in Panel B are adjusted to account for the matching with replacement as described by Abadie and Imbens (2006).

	Treatment Group (Clearing Eligible)	**Control Group (Not Clearing Eligible)**	**Difference**	**Std. error**	**p-value**
Panel A: Control group consisting of all non-cleared contracts					
CDS Spread	86.33	284.89	-198.56	25.93	0.000
Composite Depth	7.86	7.53	0.33	0.18	0.063
Bid Ask Spread	6.10	19.81	-13.71	1.50	0.000
Gross Notional	23.64	22.72	0.92	0.06	0.000
Net Notional	21.08	20.31	0.77	0.05	0.000
Contracts	18.32	19.68	-1.36	2.41	0.572
Panel B: Control group based on propensity score matching technique (with replacement)					
CDS Spread	86.33	82.75	3.59	4.54	0.430
Composite Depth	7.86	7.76	0.11	0.11	0.306
Bid Ask Spread	6.10	6.11	-0.01	0.20	0.943
Gross Notional	23.64	23.58	0.07	0.03	0.024
Net Notional	21.08	21.11	-0.03	0.04	0.405
Contracts	18.43	20.79	-2.35	2.57	0.363

Table 4
Trading volumes around first clearing date.

This table examines trading volumes around the first clearing date for our treatment group (clearing eligible) and matched control group stocks. The variable examined in this table is the ratio of the average volume for each firm during days 5 through 50 after CDS clearing became eligible to the average volume for each contract during days -50 through -5 before CDS clearing became eligible:

$$Volume\ Ratio_i = \frac{\sum_{t=5}^{50} Volume_{it}}{\sum_{t=-50}^{-5} Volume_{it}}$$

In Panel A, this ratio is averaged across all stocks in our treatment group and compared to the average for the matched control group as well as to the average ratio for the market as a whole (measured as the total volume reported by DTCC). Panel B performs a non-parametric comparison using a Wilcoxon matched pairs sign rank test. The numbers in Panel B represent the proportion of clearing eligible firms that have a higher volume ratio than their control group counterparts. Standard errors in Panel A are adjusted to account for the matching with replacement as described by Abadie and Imbens (2006). Robust t-Statistics are presented in parentheses below regression coefficients and ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Comparison of Means

	Treatment Group (Clearing Eligible)	**Control Group (Not Clearing Eligible)**	**Market**
Gross Volumes (U.S. Dollars)	0.99	1.08	0.98
		(0.38)	(0.86)
Contracts traded	1.03	1.18	1.00
		(0.07)*	(0.78)

Panel B: Non-parametric Comparison

	% Treatment > Control	**% Treatment > Market**
Gross Volumes (U.S. Dollars)	0.41	0.45
	(0.39)	(0.51)
Contracts traded	0.30	0.39
	(0.01)***	(0.53)

Table 5
Bid ask spreads around first clearing date.

This table examines bid ask spreads around the first clearing date for our treatment group (clearing eligible) and matched control group stocks. The variable examined in this table is the ratio of the average bid ask spread for each firm during days 5 through 50 after CDS clearing became eligible to the average bid ask spread for each contract during days -50 through -5 before CDS clearing became eligible:

$$Bid\ Ask\ Ratio_i = \frac{\sum_{t=5}^{50} Bid\ Ask_{it}}{\sum_{t=-50}^{-5} Bid\ Ask_{it}}$$

In Panel A, this ratio is averaged across all stocks in our treatment group and compared to the average for the matched control group as well as to the average ratio for the market as a whole (measured as the average bid ask spread across all sample stocks). Panel B performs a non-parametric comparison using a Wilcoxon matched pairs sign rank test. The numbers in Panel B represent the proportion of clearing eligible firms that have a higher bid ask ratio than their control group counterparts. CDS bid and ask prices are from Bloomberg and the bid-ask spread is measured in basis points. Standard errors in Panel A are adjusted to account for the matching with replacement as described by Abadie and Imbens (2006). Robust t-Statistics are presented in parentheses below regression coefficients and ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Comparison of Means			
	Treatment Group (Clearing Eligible)	**Control Group (Not Clearing Eligible)**	**Market**
Full Sample	1.01	1.05	1.01
		(0.02)**	(0.87)
USD Sample	0.99	1.03	1.01
		(.09)*	(0.21)
EUR Sample	1.03	1.07	1.02
		(0.12)	(0.30)
Pre-2011 Sample	1.03	1.06	1.02
		(0.10)*	(0.61)
2011 Sample	0.93	1.01	0.97
		(0.10)*	(0.24)

Panel B: Non-parametric Comparison		
	% Treatment > Control	**% Treatment > Market**
Full Sample	0.44	0.53
	(0.02)	(0.93)
USD Sample	0.45	0.50
	(0.09)	(0.30)
EUR Sample	0.43	0.56
	(0.10)	(0.36)
Pre-2011 Sample	0.47	0.57
	(0.14)	(0.48)
2011 Sample	0.33	0.36
	(0.03)	(0.17)

Table 6

Composite depth around first clearing date.

This table examines composite depth around the first clearing date for our treatment group (clearing eligible) and matched control group stocks. The variable examined in this table is the ratio of the average composite for each firm during days 5 through 50 after CDS clearing became eligible to the average composite depth for each contract during days -50 through -5 before CDS clearing became eligible:

$$Depth\ Ratio_i = \frac{\sum_{t=5}^{50} Composite\ Depth_{it}}{\sum_{t=-50}^{-5} Composite\ Depth_{it}}$$

In Panel A, this ratio is averaged across all stocks in our treatment group and compared to the average for the matched control group as well as to the average ratio for the market as a whole (measured as the average bid ask spread across all sample stocks). Panel B performs a non-parametric comparison using a Wilcoxon matched pairs sign rank test. The numbers in Panel B represent the proportion of clearing eligible firms that have a higher depth ratio than their control group counterparts. Composite depth represents the number of clean contributors to Markit's end of day pricing for the contract's CDS spread at the 5 year tenor and is measured in basis points. Standard errors in Panel A are adjusted to account for the matching with replacement as described by Abadie and Imbens (2006). Robust t-Statistics are presented in parentheses below regression coefficients and ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Comparison of Means

	Treatment Group (Clearing Eligible)	**Control Group (Not Clearing Eligible)**	**Market**
Full Sample	1.02	1.00	1.01
		(0.03)**	(0.007)***
USD Sample	1.00	0.98	0.98
		(0.06)*	(0.02)**
EUR Sample	1.04	1.03	1.03
		(0.26)	(0.18)
Pre-2011 Sample	1.01	1.00	1.00
		(0.24)	(0.01)***
2011 Sample	1.05	1.01	1.03
		(0.03)**	(0.30)

Panel B: Non-parametric Comparison

	% Treatment > Control	**% Treatment > Market**
Full Sample	0.53	0.52
	(0.07)*	(0.03)**
USD Sample	0.55	0.53
	(0.11)	(0.04)**
EUR Sample	0.52	0.49
	(0.39)	(0.39)
Pre-2011 Sample	0.50	0.53
	(0.37)	(0.02)**
2011 Sample	0.64	0.45
	(0.05)**	(0.71)

Figure 1. CDS notional amounts outstanding.

This figure displays the year-end CDS notional amounts outstanding, as reported by the Bank for International Settlements (BIS).

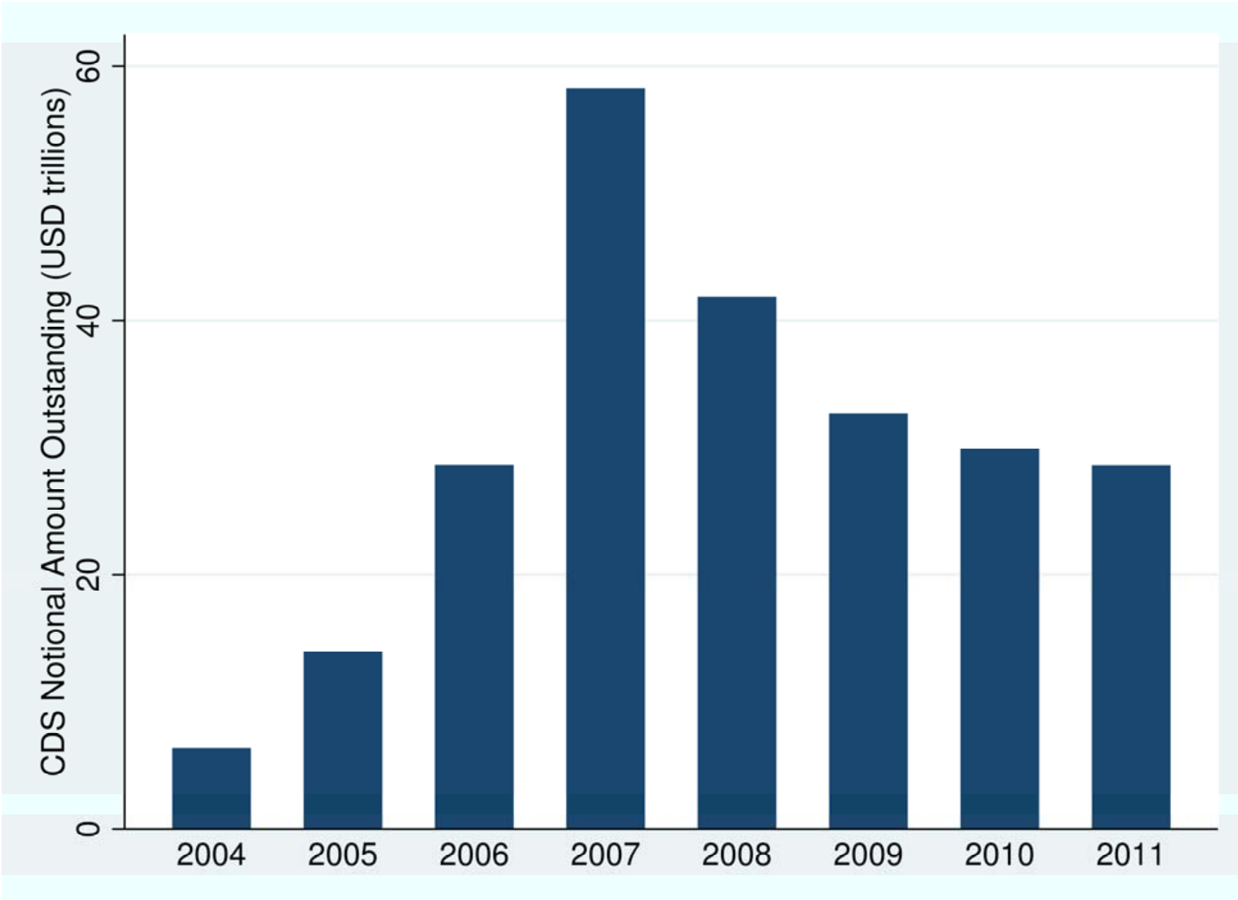

Figure 2. Central clearing and five year CDS spreads.

This figure displays 5 year CDS spreads for three groups of contracts. The first group of contracts include those contracts that have been accepted for central clearing. This group is represented by the dots in the figure and the value is the average CDS spread for the group of contracts that are accepted for central clearing on that date. The second group of contracts include those contracts that have been previously accepted for central clearing (up until the point in time on the graph) and the solid line in the figure displays the average CDS spread for this group. The third group includes those contracts that had not yet been accepted for central clearing at that point in time and the average 5-year CDS spread of this group is illustrated by the dashed line. The 5 year CDS spreads are obtained from Markit and are measured in percentage points.

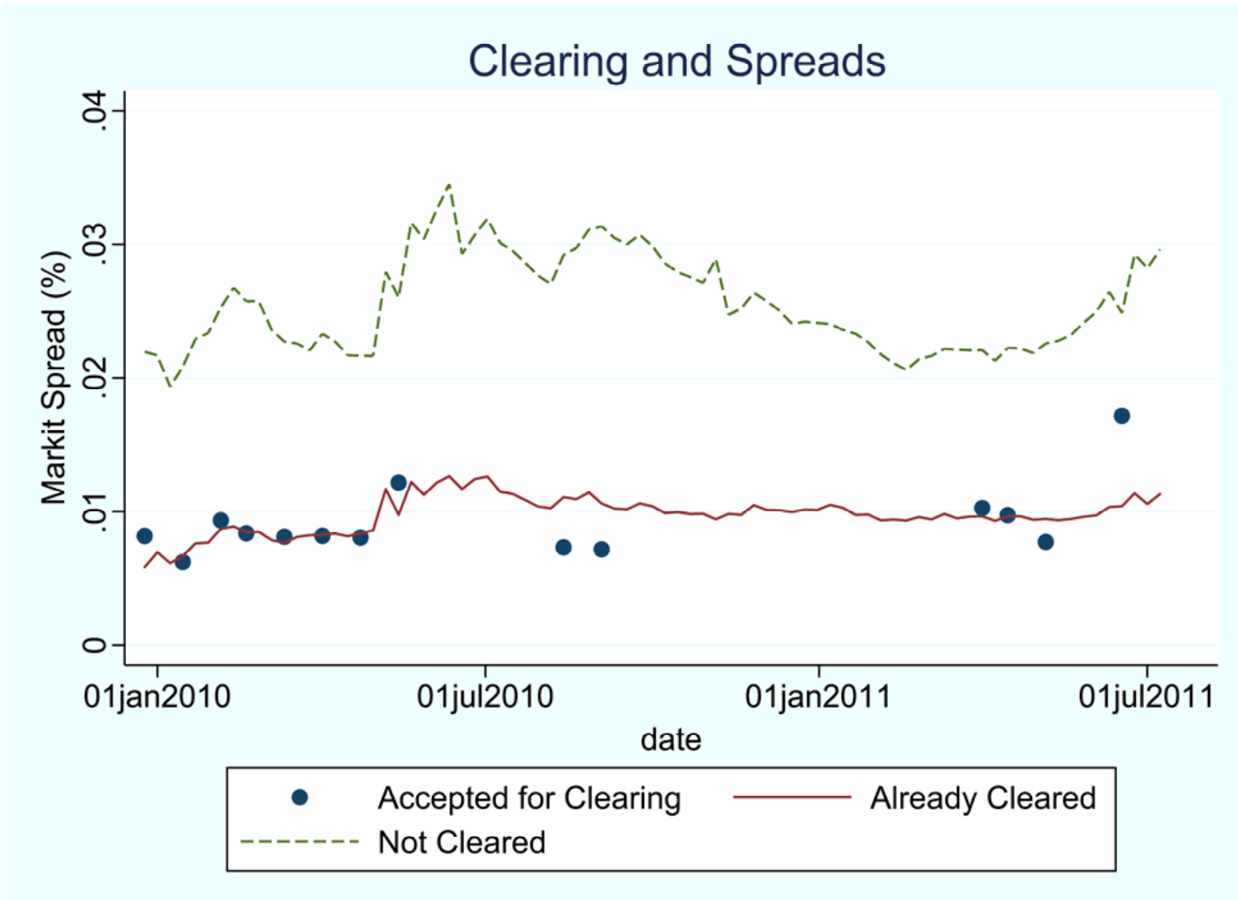

Figure 3. Central clearing and bid-ask spreads.

This figure displays bid-ask spreads for three groups of contracts. The first group of contracts include those contracts that have been accepted for central clearing. This group is represented by the dots in the figure and the value is the average bid-ask spread for the group of contracts that are accepted for central clearing on that date. The second group of contracts include those contracts that have been previously accepted for central clearing (up until the point in time on the graph) and the solid line in the figure displays the average bid-ask spread for this group. The third group includes those contracts that had not yet been accepted for central clearing at that point in time and the average bid-ask spread of this group is illustrated by the dashed line. CDS bid and ask prices are from Bloomberg and the bid-ask spread is measured in basis points.

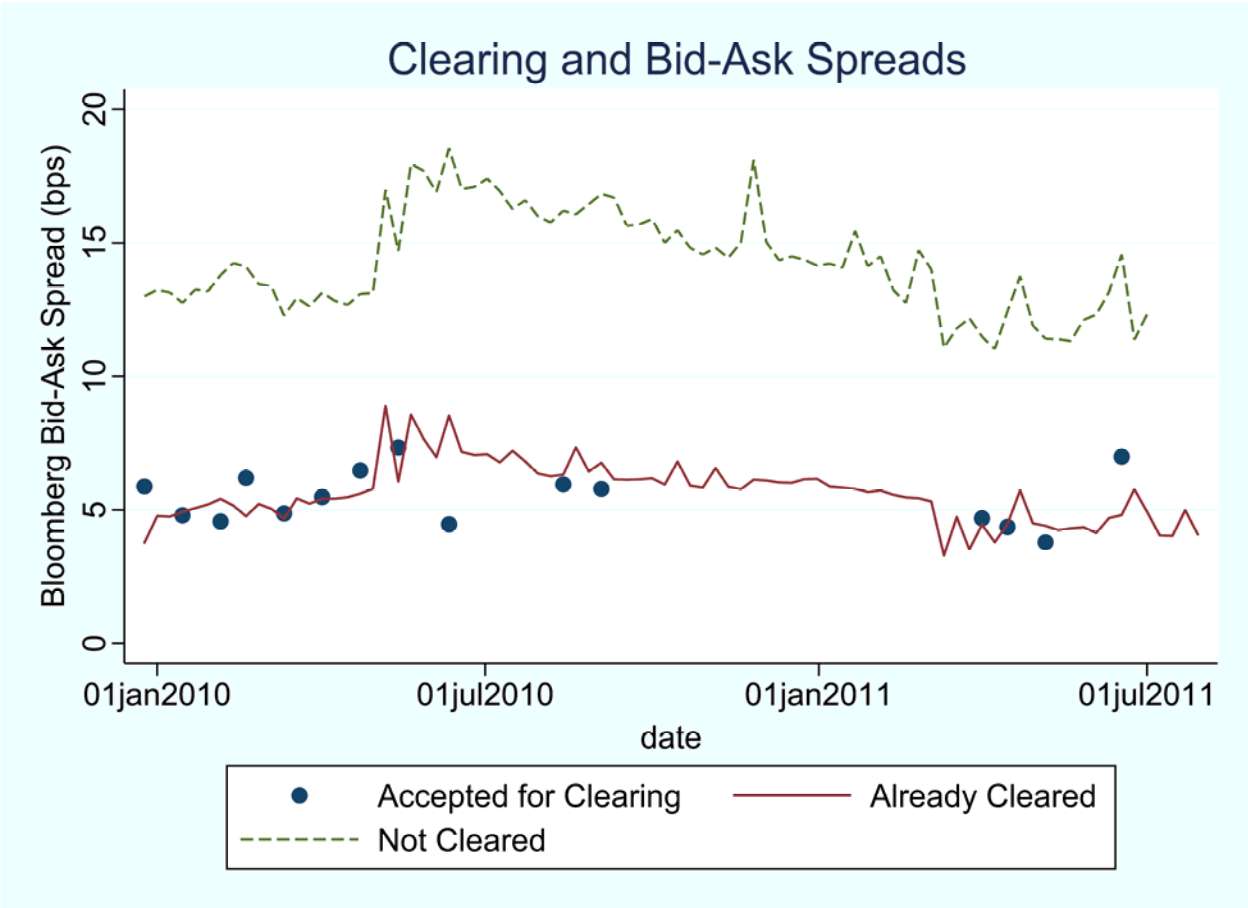

Figure 4. Central clearing and net notional outstanding.

This figure displays the logarithm of the net notional outstanding for three groups of contracts. The first group of contracts include those contracts that have been accepted for central clearing. This group is represented by the dots in the figure and the value is the average logarithm of the net notional outstanding for the group of contracts that are accepted for central clearing on that date. The second group of contracts include those contracts that have been previously accepted for central clearing (up until the point in time on the graph) and the solid line in the figure displays the average logarithm of the net notional outstanding for this group. The third group includes those contracts that had not yet been accepted for central clearing at that point in time and the average logarithm of the net notional outstanding of this group is illustrated by the dashed line. Net notional amount outstanding is the sum of net CDS protection sold by net sellers, and is calculated at the counterparty family level. (DTCC, 2011b).