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Strategic conduct in credit derivative markets ☆

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ABSTRACT

This paper reviews recent research at the intersection of industrial organization and corporate finance on credit default swap (CDS) markets. These markets have been at the center of the financial crisis of 2007–09 and many aspects of their operation are not well understood. The paper covers topics such as counterparty risk in CDS markets, the "empty creditor problem," "naked" CDS positions, super-senior status of credit (and other) derivatives in Chapter 11 bankruptcy, and strategic behavior in CDS settlement auctions.

1. Introduction

One of the most significant changes in financial markets during the decade preceding the crisis of 2007–09 was the creation and subsequent exponential growth of the market for credit insurance, particularly credit default swaps. From relatively small beginnings of around $180 billion in 1997,[1] the CDS market has grown, according to BIS statistics, to over $32 trillion in notional amount in mid-2011. At its peak in 2007 the CDS market exceeded $58 trillion in notional amounts and has since shrunk in size partly due to the impact of the financial crisis and partly due to new netting rules.[2]

A *credit default swap* (CDS) is essentially an insurance contract against losses incurred by creditors in the event that a debtor defaults on its debt obligations. The contract is between a "protection buyer" and a "protection seller." As part of the contract, the protection buyer pays a premium (the CDS premium) to the protection seller, in exchange for a payment from the protection seller to the protection buyer if a "credit event" occurs on a reference credit instrument within a predetermined time period. Common credit events are bankruptcy, failure to pay, and, in some CDS contracts, debt restructuring or a credit-rating downgrade. However, while a CDS is similar to an insurance contract, a fundamental difference between a CDS and a traditional insurance contract is that a CDS offers a payment from the protection seller to the protection buyer even when the buyer is not a holder of debt referenced in the CDS contract. In contrast, a traditional insurance contract typically offers coverage only for damages incurred (the insuree must have "insurable interest"). In other words, in contrast to traditional insurance, a CDS contract can be "naked" (i.e., it provides payment in case of a credit event even without any underlying credit exposure on behalf of the insuree).

Credit default swaps were at the heart of the financial crisis of 2007–09, and they have continued to be a major focus of attention in the aftermath of the crisis, in particular in the context of the European banking and sovereign debt crises. One major issue is the fact that credit default swaps are typically traded in opaque over-the-counter markets and the financial crisis has revealed the hazards involved in the buildup of systemically important risks in a few undercapitalized institutions under the radar screen of regulators charged with maintaining financial stability.

Prior to the recent financial crisis, the finance literature on CDS markets mostly focused on the pricing of CDS contracts. Typically, in these pricing models CDS markets are (essentially) frictionless and competitive. The general view of this literature is that CDS are a valuable financial innovation, because they provide new or cheaper forms of value-enhancing risk-sharing opportunities (see Jarrow, 2011). However, given that CDS pricing models, like most other derivative pricing models, value the CDS via a replicating portfolio comprising a long position in the underlying bond and a short position in a Treasury bond (with similar coupons, maturity, and notional value), it is

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[1] See Acharya et al. (2009).

[2] The BIS survey data is available from 2004 at http://www.bis.org/statistics/derstats.htm. For an analysis of the determinants of net CDS positions at the reference entity based on recently available CDS position data, see Oehmke and Zawadowski (2012).

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not clear that the CDS offers risk-sharing opportunities that were not available before. In fact, in the frictionless pricing model, the CDS is a redundant security. Once trading frictions are introduced, as with other financial derivatives, the main added value of the CDS is to lower transaction costs in building a hedged position. However, beyond the potential reduction in transaction costs, CDS contracts usually do not affect economic outcomes in these pricing models.

Indeed, one of the main benefits of CDS is that they make it easy and rather safe to short a risky debt instrument. Unlike a short position in a stock, which subjects the holder of the position to potentially large losses should the underlying stock price move up rather than down, a CDS contract limits the exposure of the protection buyer to the payment of the running premium. The worst outcome for a CDS protection buyer is that there is no default on the underlying debt instrument. In that case he would have paid for protection, which in the end was not needed. In contrast, a short seller of stocks risks losing the difference between the price at which he must purchase the stock (to be able to deliver it) and the price at which he sold the stock. This price difference can be huge in the event of a *short squeeze* (a recent example is the Volkswagen–Porsche short squeeze of 2008, in which short sellers incurred substantial losses).[3] This limited downside risk for CDS protection buyers is particularly attractive when the buyer purchases protection over long maturities.

The crisis of 2007–09, however, has shown that CDS markets are far from frictionless and that considerable strategic conduct has been present in these markets. A growing recent literature on CDS markets thus attempts to explore the economics of CDS markets using models with frictions, in which the CDS is not redundant and in which there may be significant scope for strategic behavior. Rather than frictionless and competitive, this literature thus examines frictions in CDS markets and allows for strategic conduct (or misconduct).

The most egregious misconduct arguably took place at the AIG Financial Products (AIGFP) unit in London, which sold default protection on a massive scale to the point of building a net exposure of $411 billion in CDS on super-senior tranches of securitized loans and mortgages, all rated AAA by June 30, 2008 (see Stulz, 2010). AIGFP was able to take on such an exposure without posting a commensurate amount of collateral (to reduce counterparty risk for the protection buyers) due to the fact that AIG had an AAA rating. Although AIGFP could avoid posting collateral by relying on the AIG AAA rating, it were still exposed to the risk of collateral calls in the event that AIG were to lose its AAA rating. However, while the pricing model used by AIGFP for its CDS positions "harnessed mounds of historical data to focus on the likelihood of default…as AIG was aware, [the] models didn't attempt to measure the risk of future collateral calls or write-downs, which have devastated AIG's finances."[4]

In light of the AIG debacle, it is not entirely surprising that the post-crisis literature on credit derivatives has focused attention on the moral hazard problems involved in writing credit default insurance. We thus begin with a discussion of this issue in Section 2. We then turn to another form of moral hazard created by CDS insurance – the "empty creditor problem" – in Section 3. In Section 4, we address potential strategic concerns arising from the fact that the buyer of CDS protection may have a "naked" position in the CDS. In Section 5, we discuss the highly concentrated, oligopolistic nature of over-the-counter CDS markets and the considerable market power that the handful of investment banks dealing in this market seems to wield. In Section 6, we point to the special treatment for CDS and other derivative contracts in bankruptcy and discuss the implications of this special status for financial stability. In Section 7, we discuss how CDS contracts are settled in the event of a credit event, with a focus on the complex strategic bidding considerations that arise in CDS settlement auctions, which have become the standard settlement procedure for CDS contracts. Finally, Section 8 offers some concluding comments on the regulation of CDS markets and points to some current policy questions that warrant further research.

2. Dealing with counterparty risk

While there is an extensive principal-agent literature that analyzes the trade-off between risk sharing and incentives on the part of the agent, the moral hazard problem on the side of the principal insuring the agent has not been considered until recently, presumably because insurers were thought to be sufficiently capitalized to be able to meet any promised payments, such that counterparty risk is zero.[5] Two recent papers have taken up the problem of counterparty moral hazard.

Thompson (2010) considers the moral hazard problem of a protection seller dealing with a privately informed buyer. The seller can hold more or less liquid capital. The more he holds in liquid capital the lower the counterparty risk he imposes on the buyer. But more liquid capital also generates lower returns. There is a moral hazard problem for the seller to the extent that insurance premia do not vary with the underlying risk of the seller's portfolio. If a seller imposing higher counterparty risk on a buyer gets the same premium payments as a seller imposing lower counterparty risk, then sellers will have an incentive to be undercapitalized. Thompson, however, argues that there is a mitigating effect when the protection buyer has private information about the risk exposure he seeks to insure. The buyer trades off lower-cost insurance against higher counterparty risk. The buyer understands that if he purchases cheap insurance from a poorly capitalized seller he takes on high counterparty risk, especially if he knows that the bond he is seeking to insure has a high probability of default. Accordingly, Thompson shows that a unique separating equilibrium may be obtained in which protection buyers with high risk exposure purchase expensive insurance from well-capitalized sellers with low counterparty risk and buyers with low risk exposure choose to purchase cheap insurance from sellers with higher counterparty risk. Thus, the very presence of a moral hazard problem for the protection seller helps mitigate a lemons problem on the side of protection buyers.

Biais et al. (2012b) characterize the optimal insurance contract between a risk-averse protection buyer and a risk-neutral protection seller with limited liability. As in Thompson (2010), the seller can hold more or less risky assets to back his obligations toward the buyer. The key trade-off they consider is a form of risk-return trade-off: The insurance contract could be secured with a lot of safe collateral earning a low return, but then the insurance premium would have to be higher to compensate the seller for the opportunity cost of investing in low-return assets.

Their model has three dates, with the buyer and seller agreeing to an insurance contract at the initial date. The contract specifies an insurance premium, damage payments, and also margin (or collateral) requirements for the seller. The buyer holds a risky asset (say, a risky bond) and seeks to hedge some of the risk of the asset (say, in the form of a CDS). The seller also has risky asset holdings $A > 0$ generating an expected unit return of $\overline{R}$ at the final date. At an interim date, the seller can rebalance his portfolio of assets so as to increase or decrease the overall riskiness of his portfolio. He can do so after observing a (public) signal on the likely required payment on the insurance contract. When this signal indicates that the insurance contract is under water, the insurance seller may choose to increase the riskiness of his portfolio in order to gamble for resurrection. This generates endogenous counterparty risk, since now the insurer's assets

[3] See Floyd Norris, "Porsche reinvents the short squeeze," *New York Times*, October 30, 2008.

[4] *Wall Street Journal*, October 31, 2008: "Behind AIG's Fall, Risk Models Failed to Pass Real-World Test."

[5] *Counterparty risk* is the risk that an undercapitalized protection seller may be unable to make all contractual payments on a derivative or other financial contract.

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may not be sufficient to honor payments on the insurance contract. To avoid this outcome, it must be the case that the seller of insurance has sufficient "skin in the game."

This constraint imposes both limits on how much risk the seller can take on and explicit contractual constraints on the (cash) collateral he must post in a margin account. A central result of Biais et al. (2012b) is that, under an optimal insurance contract, hedging payments are in general contingent on the realized signal observed at the interim date. This implies that the protection buyer in general faces the trade-off between reducing counterparty risk or interim "signal risk." The buyer cannot reduce both at the same time. Reducing signal risk amounts to making the hedging payment less sensitive to the realization of the interim signal. But this inevitably means that the buyer accepts to take on more counterparty risk in the event of a bad signal realization. When the protection seller has little capital his moral hazard risk is higher, and maintaining the seller's incentives after a bad signal realization then requires a considerable reduction in insurance. The model of Biais et al. (2012b) provides an elegant and simple workhorse model to analyze counterparty risk in insurance contracts and has already served as a building block for some of the other contributions discussed below.

3. The empty creditor problem

Another form of strategic behavior in the context of CDS contracts emerges as a result of the transfer of default risk away from creditors to the protection sellers. This results in the so-called empty creditor problem. As Hu and Black (2008) have argued:

> "Even a creditor with zero, rather than negative, economic ownership may want to push a company into bankruptcy, because the bankruptcy filing will trigger a contractual payoff on its credit default swap position."

Creditors with CDS protection not only have lower incentives to monitor the debtor, but also have a lower interest (as the quote from Hu and Black emphasizes) in sustaining the debtor and helping him avoid default by rolling over debt, granting new financing, or agreeing to voluntary debt restructuring.

Concerns about a possible empty creditor problem emerged, for example, at the onset of the financial crisis of 2007–09, when, in response to the massive buildup of CDS positions by AIG, Goldman Sachs chose to protect itself by purchasing insurance against the possible default of AIG, rather than to monitor AIG more closely and alert other market participants to the potential risk emanating from the buildup of CDS positions at AIG. Because of this hedge, Goldman Sachs was arguably an empty creditor of AIG and was therefore less concerned about the possibility of an AIG default.[6]

Discussions about a potential empty creditor situation also arose in the Greek sovereign debt crisis. However, the role of CDS on Greek debt was probably misunderstood by most commentators and policy makers. The presence of CDS held by Greece's creditors created an opening rather than an obstacle to Greek debt restructuring: Insured holders of Greek debt, who stood to obtain a payment on their CDS positions in the event of restructuring (a credit event under the CDS contract),[7] were more (not less) willing to accept a "haircut" on their debt. However, instead of recognizing this opportunity, policy makers were (probably overly) concerned that, in the event that the Greek CDS triggered, required payments on those CDS might lead to systemic risk (in essence, a repeat of an AIG type meltdown). Worse still, to avoid this outcome policy makers attempted to defuse the CDS on Greek debt by arguing that the restructuring should not be considered a credit event, thereby introducing unnecessary uncertainty on the enforcement of CDS contracts and delay in the debt restructuring negotiations. As it turns out, the contagion fear proved to be unfounded and, following the restructuring, CDS on Greek debt were settled in an orderly fashion.

Bolton and Oehmke (2011) provide a formal analysis of the empty creditor problem in a model with three dates, where a firm raises funds by issuing debt at the initial date to invest in a two-period investment project generating stochastic cash flows at the interim and final dates. The firm may default on its debt obligations at the interim date if the project does not generate sufficient cash flow. A key assumption of the model is that the firm faces a limited commitment problem (as in Bolton and Scharfstein, 1990) when raising debt financing for the project, such that renegotiation of the firm's debt obligations at the interim date plays a central role. In particular, if the firm's date 1 cash flow is insufficient to meet the promised payment on the debt contract, renegotiation of the debt contract is ex-post efficient. The main insight in Bolton and Oehmke (2011) is that this debt renegotiation game is modified as a result of the presence of CDS protection for the lenders. Specifically, a lender that holds CDS protection has a better outside option in renegotiation, since the CDS pays out when renegotiation fails and the firm goes into default. This outside option allows the lender to extract more in renegotiation with the firm. However, if the lender's CDS protection exceeds the resources available for renegotiation, then renegotiation becomes impossible and the lender (now an empty creditor) forces the firm into default to collect the CDS payment, even though renegotiation would be preferable.

The central result of the analysis in Bolton and Oehmke (2011) is that while CDS protection can give rise to an ex-post empty creditor problem akin to that described by Hu and Black (2008), the strengthening of the creditors' bargaining position through CDS protections in ex-post debt renegotiations also helps relax the firm's ex-ante financial constraints. Overall, we show that some CDS protection for creditors can be desirable, but left to their own devices, because creditors do not internalize the loss in surplus that arises from failed renegotiation, they tend to purchase too much protection relative to the social optimum.

The main predictions of this analysis seem to be borne out in the data. For example, consistent with the empty creditor hypothesis, Subrahmanyam et al. (2012) find that the probability of a credit downgrade or bankruptcy increases after creditors purchase CDS protection. They show that this effect is due to both lenders' greater reluctance to restructure the debts of distressed firms and their greater willingness to lend to riskier borrowers. In a similar vein, Peristiani and Savino (2011) find that firms during 2004-08 with traded CDS exhibit higher expected default frequency than comparable firms without traded CDS. Danis (2012) documents that firms with traded CDS find it harder to reduce their debt through out-of-court restructurings, although Bedendo et al. (2011) do not find a significant effect of CDS on restructuring outcomes.[8] Finally, consistent with the relaxation of ex-ante financial constraints, Saretto and Tookes (forthcoming) document that borrowers with traded CDS take on more leverage than borrowers without CDS.

4. Naked credit default swaps

We have pointed out above that the CDS makes it easy and rather safe to short a risky debt instrument. The increasing role of CDS contracts in debt markets has led some commentators to voice concerns that CDS could help speculators destabilize (or possibly manipulate)

[6] See the opinion piece by Henry Hu in the *Wall Street Journal*, April 10, 2009: "Empty Creditors and the Crisis: How Goldman's $7 bn Was Not Material."

[7] Initially, there was uncertainty regarding whether a voluntary restructuring of Greek debt would be considered a credit event. In the end, because Greece made use of so-called *collective action clauses*, the restructuring was involuntary for some creditors and thus triggered the CDS.

[8] Danis (2012) argues that this non-significance may be a result of a small-sample problem.

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debt markets. These concerns became particularly strident during the Eurozone sovereign debt crisis that followed the crisis of 2007–09, so much so that the European Union has now acted on these concerns and introduced a ban on naked CDS for European sovereign debt effective from November 1, 2012. Henceforth an investor will not be allowed to purchase CDS protection on sovereign debt issued by a European Union member state, unless that investor also holds the underlying debt instrument (or one that is highly correlated with this instrument). This effectively bans naked positions in CDS on European Union debt.

The concerns about naked CDS positions are often confused with those related to naked short selling of stocks. However, these are two very different issues. A major problem with naked shorting of stocks is that the seller may not be able to deliver the stock in a short squeeze, which can result in major market disruptions, as recently witnessed in the Volkswagen–Porsche short squeeze of 2008.[9] However, there is no such concern with naked CDS. If there is a worry with naked CDS, it has to do with market manipulation. Some leading financial executives (e.g., John Mack, then the CEO of Morgan Stanley) have claimed that speculators were seeking to bring down their firm in a complex trade combining positions in both CDS on the firm's debt and short positions in the firm's stock.[10] By purchasing more CDS protection these speculators would drive up the CDS spread on the firm's debt, which in turn would result in a negative stock price reaction, allowing the speculators to make at least a quick profit on their short positions on the firm's stock, even if they would not necessarily succeed in driving the firm into default.

This particular form of manipulation involving a combination of CDS trades and short selling of stocks is not available for naked CDS trading on sovereign debt.[11] So, then, what was the concern with naked CDS positions on Greek debt? The allegation was that a group of hedge funds attempted to produce a self-fulfilling debt rollover crisis by driving up the CDS spread on Greek debt and thereby forcing Greece to roll over its debt at unsustainably high interest rates, thereby precipitating a Greek default.

Even if such allegations have a ring of truth to them, they are inherently difficult to substantiate without more rigorous analysis on the economics of naked CDS positions. One recent attempt in this direction is Che and Sethi (2012). They consider a model where (risk-neutral) investors with limited wealth have differences of opinion (i.e., they agree to disagree) about the default risk on a given corporate debt instrument. In the absence of a CDS market, the equilibrium in the corporate debt market is such that the more *optimistic* investors end up holding the debt and setting the cost of borrowing for the firm. The *pessimists* simply stay out of the market and don't invest at all.[12] In the presence of a CDS market, but absent the ability to take naked positions in the CDS, optimists both hold the underlying debt and sell CDS protection to pessimists, who are then willing to invest in the debt thanks to the default protection they have obtained. When naked CDS trading is permitted, pessimists may purchase CDS protection even when they do not hold the underlying debt. Optimists then put up more of their wealth as collateral for the CDS protection they sell to pessimists and thus have fewer resources left to purchase the firm's debt. As Che and Sethi (2012) show, the overall effect of the naked CDS bets may then be to drive up the cost of borrowing for firms, as more and more optimists reduce their positions in the corporate debt market to speculate in the CDS market. To the extent that betting in the CDS market does not generate social value (i.e., it is zero sum), the introduction of naked CDS may then result in a socially inefficient outcome with too little borrowing by corporations.

In an extension of their model Che and Sethi (2012) also show that self-fulfilling "bear raids"can arise with naked CDS. They consider the situation of a firm that borrows funds using short maturity debt. By borrowing short term, the firm exposes itself to debt rollover risk. Che and Sethi (2012) show that in the same manner in which naked CDS can drive up the cost of borrowing for the firm, they can also increase the firm's rollover risk: The likelihood that the firm is solvent is lower when the firm must roll over its debt at higher interest rates at the interim rollover date. This greater likelihood of insolvency at the interim date in turn invites more bets against the firm through naked CDS, thus giving rise to a self-fulfilling debt crisis.

5. Imperfect competition and the concentration of risk

Credit default swaps are traded in highly concentrated over-the-counter (OTC) markets. As Atkeson et al. (2012) observe, only a small number of financial institutions (essentially six: HSBC, Bank of America, Citigroup, Morgan Stanley, Goldman Sachs, and JPMorgan Chase) act as market makers for CDS contracts. Given that a large fraction of CDS contracts are highly standardized and given that potentially hundreds of financial institutions are able to enter this market, it is striking that this market is so concentrated. This is the central question addressed in Atkeson et al. (2012). A related question (which they do not take on) is whether there are potential concerns with collusion among the six large market makers, given the high concentration of the market and its opacity. Indeed, anecdotal evidence suggests that trading in CDS markets appears to be highly lucrative.

A transaction in OTC markets is typically a bilateral trade; it occurs after a buyer and seller meet and agree to bilaterally negotiated contractual terms. There is no (or very little) transparency in these markets, and neither bid and ask offers nor transaction terms are publicly disclosed. Accordingly, Atkeson et al. (2012) model the CDS market as a matching market with free entry of buyers and sellers. Atkeson et al. (2012) explain the high concentration in this market based on a combination of factors. First, new entrants to this market face fixed entry costs. Therefore, only banks that are large enough and/or have large underlying risk exposures that they seek to hedge with CDS will enter. Depending on their balance sheets, some of these banks will want to hedge their exposures by selling CDS protection and others by buying CDS protection. To the extent that there are both buyers and sellers of the same CDS contract, Atkeson et al. (2012) show that there is room for dealers to enter and act as intermediaries. The very largest banks are naturally placed to act as market makers, as they are best able to generate enough fee income from trading CDS to cover the fixed cost of entry. Moreover, these banks can make efficient use of their balance sheets to support large notional CDS exposures by "netting" long and short positions, holding collateral only in proportion to their net exposures.

Atkeson et al. (2012) show that the combination of fixed entry costs, trading frictions, and benefits of netting results in an equilibrium outcome in the OTC market that is characterized by too much concentration. This is not entirely surprising, given the presence of increasing returns to scale for dealers. Atkeson et al. (2012) establish that the equilibrium under free entry is socially inefficient by comparing it to the (more efficient) allocation that would obtain if one of the large dealer banks were to be replaced with a smaller customer bank in the equilibrium allocation.

An interesting alternative thought experiment would be to ask how the equilibrium changes if trade were to take place on a central clearing platform (CCP) with full price disclosure (prices at which trades would take place would be observable as on a regular stock market). In fact, in response to the large concentration of (net) CDS

[9] The disruptions in the Volkswagen–Porsche short squeeze were minor relative to other episodes at the beginning of the 20th century, such as the short squeeze of Northern Pacific stock in 1901.

[10] *Wall Street Journal*, November 24, 2008: "Anatomy of the Morgan Stanley Panic."

[11] The closest analogy of such a manipulation would be to short the country's currency while at the same time driving up the CDS spread by purchasing a lot of CDS protection. In the case of Greece, this may be less relevant as speculators would have had to profit from shorting the Euro.

[12] The analysis assumes that short selling of the debt instrument is not possible, reflecting the difficulty of short selling loans or bonds in practice.

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exposures at AIG, which proved to be a major source of systemic risk, the new financial regulations introduced under the Dodd–Frank Act of 2010 mandate the migration of trading of more standardized swaps and derivatives onto a CCP. The main objective of these regulations is to be better able to monitor the buildup of risks and the concentration of exposures, so as to preempt the emergence of another too-big-to-fail case à la AIG. Another potential benefit of the migration of CDS trading onto an organized and regulated exchange could be the increase in competition and a reduction in oligopoly rents that could result from the increase in price transparency in CDS trading. Unfortunately, however, it is far from clear how much transparency will be available in the new CCP. Note also that the CCP may result in more efficient, multilateral netting of CDS contracts, although, as Duffie and Zhu (2011) point out, the benefits from netting CDS contracts on a central clearing platform have to be weighed against the reduction in bilateral cross-product netting (that is, netting CDS against positions in currency or interest rate derivatives, for example).

6. The super-senior status of swaps and derivatives

The advent and spectacular growth of derivative markets in the three decades prior to the financial crisis of 2007–09 have generally been seen as a positive development for the economy and, in particular, for the ability to share and spread risk efficiently through financial markets. In fact, the Greenspan-era consensus was that derivative markets provided such clear and unmitigated risk-sharing benefits that there was no need to regulate them (or that only very light regulatory oversight was required). As a result, derivative markets have indeed faced only few regulatory hurdles during their explosive growth over the last decades.

What is more surprising is that derivative markets have not only been lightly regulated, but also that they directly benefited from the introduction of special rules governing the treatment of swaps and derivatives in bankruptcy. Specifically, this special treatment gives swaps and derivatives privileged bankruptcy status relative to other credit instruments.

The main bankruptcy provision favoring swaps and derivatives under U.S. bankruptcy law (as well as in a number of other jurisdictions) is that derivative counterparties have the right to collect payment by seizing and selling collateral when a firm files for bankruptcy. In contrast, creditors (even secured) are subject to the *automatic stay* and cannot collect payments or collateral when the firm places itself under bankruptcy protection. As a result of these privileges, derivative counterparties of Lehman Brothers were able to seize large amounts of collateral after Lehman had filed for bankruptcy, causing "a massive destruction of value" by transferring resources out of the Lehman's bankruptcy estate and thus reducing its going concern value, as Harvey Miller, the main bankruptcy lawyer for Lehman, pointed out in his congressional testimony (Miller, 2009).

What are the costs and benefits of this super-senior status for derivatives and swaps? This is the question addressed in Bolton and Oehmke (2012). An obvious ex-post cost of this special treatment of derivatives and swaps is that, because of the withdrawal of resources through collateral calls before bankruptcy, the going concern value of the firm is impaired after filing for Chapter 11 protection. Another obvious ex-ante cost is that, as a result of this special treatment of swaps and derivatives, firms have an incentive to rely on funding sources that benefit from this special treatment and are thus relatively cheap. Classic examples of these funding sources are short-term *repos* (essentially, these are short-term collateralized loans that are exempted from the automatic stay because they are treated like swaps rather than debt) and *total return swaps* (another form of debt financing masquerading as a swap).

Bolton and Oehmke (2012) provide a formal analysis of the costs and benefits of the super-seniority of derivatives in a model with three dates, where a firm raises funds by issuing debt at the initial date and can subsequently purchase a derivative to hedge against a negative cash flow shock at the interim date. If the firm does not default on its debt at the interim date, then it obtains a further continuation value at the final date. The key question considered is whether it is preferable to make the derivative contract *junior* or *senior* to the firm's debt.

If firms can commit to their hedging policy, then the main effect of the super-senior treatment of derivatives is to transfer default risk away from the provider of the derivative (the derivative counterparty) to the firm's creditors. As a result the firm must promise higher debt payments to compensate lenders for the added default risk that results from making the derivative senior to debt. Higher promised debt repayments in turn increase the cash shortfall the firm faces in low cash flow states, which in turn increases the amount of the derivative the firm needs to purchase in order to hedge. Overall, the super-senior treatment of derivatives results in higher net costs of funds for firms (and lower surplus), unless the reduction of counterparty risk in the derivative market that results from the privileged bankruptcy status of derivatives brings about a sufficient reduction in (deadweight) collateral costs for derivative counterparties.

If firms cannot commit to their hedging policies and only decide on the derivative positions once debt is in place, then the super-senior treatment of derivatives is likely to induce firms to do too much hedging. The reason is that some of the costs of hedging are imposed on (junior) creditors, who are partially diluted by the firm's hedging positions. Firms may even choose to use the derivative as a tool for speculation (rather than hedging), thereby diluting debtholders even more. Both of these effects are undesirable consequences of the current privileged treatment of derivatives in bankruptcy. However, Bolton and Oehmke (2012) also show that, for some parameter constellations, the subsidy to hedging provided by dilution of junior debtholders may mitigate the firm's incentive to hedge too little (which can arise as a result of the typical asset substitution problem that can arise in the presence of risky debt). Specifically, equityholders may choose to limit costly hedging if benefits mainly go to the firm's creditors. In such a situation, allowing for dilution of debt by the derivative counterparties can improve efficiency.

The potential destruction of value in Chapter 11 bankruptcy that may result from the collateral calls by derivative counterparties is an important reason why the preferred resolution institution for banks and systemically important financial institutions (SIFI) is *FDIC receivership*. Under receivership, derivatives and swaps are de facto fully guaranteed by the FDIC, thus removing the risk of a run on the firm's working capital. However, a major concern with this solution is that this constitutes, in effect, a form of institutionalized bailout of all the so-called *qualified financial contracts* (that is, all swaps and derivatives) the firm has issued. Should banks and SIFI decide to entirely substitute their term-debt financing with repos and swaps, then all their liabilities would be guaranteed in the event of default. To avoid such an outcome, new regulations will likely have to be introduced, requiring banks and SIFI to issue a certain fraction of unsecured debt that can be wiped out in the event of default.

7. Credit default swap auctions

In the early years of CDS markets, settlement in the event of default of the insured debt instrument involved the protection seller paying the buyer the face value of the debt and, in return, the buyer would deliver the defaulted debt claim to the protection seller. Thus, the seller would effectively pay the difference between the face value and the recovery value of the defaulted bond.

With the growth in naked CDS, however, this settlement procedure was no longer feasible. In particular, the requirement to deliver the bond resulted in large buying pressure on the defaulted bond around the settlement date, as holders of CDS scrambled to buy the underlying bond for delivery in CDS settlement. Instead, a CDS is

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now settled in the form of a cash payment by the protection seller to the protection buyer that is equal to the difference between the face value of the debt and its (estimated) recovery value. The main difficulty with this settlement procedure is that it is not obvious how one determines the recovery value of the debt. To do this, CDS contracts are now settled via a complex two-stage CDS settlement auction procedure. This procedure involves complex strategic interactions between the bidders in the auction, who can be protection sellers, protection buyers, or dealers.

The mechanism of the CDS settlement auction is roughly as follows. In the first stage of the auction, buyers and sellers of bonds submit bid and ask offers for the defaulted bond. These bids and offers are then aggregated into a *net open interest*. At the same time, dealers submit bid and ask prices (with a requirement to be willing to transact a certain amount at those prices), which are used to compute the *initial market midpoint*. In the second stage, a uniform price, divisible-good auction is run, in which the net open interest is cleared. The price at which the net open interest clears is then taken as the reference price (recovery value of the bond) to settle CDS contracts in cash.

This auction procedure has recently been analyzed both theoretically and empirically by Chernov et al. (2013), Gupta and Sundaram (2012), and Du and Zhu (2012). A common theme among these papers is that the complicated auction procedure may lead to a misvaluation of the underlying reference bond. This misvaluation occurs because the auction procedure is prone to manipulation, with protection buyers trying to drive down the price so as to receive a larger settlement payment and vice versa for protection sellers. Hence, in a somewhat ad hoc attempt to limit manipulation, the rules of the auction require that the final auction price may not differ by more than a predetermined amount from the *initial market midpoint* determined from the dealers' bid–ask quotes in the first stage of the auction.

Chernov et al. (2013) show theoretically that the equilibrium of this auction procedure tends to result in mispricing of the defaulted bond. In their empirical analysis, they find that the net open interest in the first stage of the CDS auctions tends to be on the sell side and that second stage market-clearing prices undervalue the bonds on average by about 6% (relative to an average of bond prices in a window around the settlement date). This suggests that bond prices used to settle CDS are lower than the actual recovery value of the bond, resulting in protection payments that are higher than the true cost of default.

8. Conclusion

This short review of recent research on strategic conduct in CDS markets highlights that, while CDS markets have grown to play a major role in the economy, and while some important issues relating to strategic conduct in this market have been identified, the economics of CDS markets are still imperfectly understood and many open questions remain for future research. The burgeoning literature reviewed here has only scratched the surface and each of the topics discussed above still requires deeper analyses.

Going forward, there are three major policy initiatives that are likely to affect CDS markets substantially. The first is the implementation of the transition of standardized CDS away from OTC markets to central clearing platforms. Biais et al. (2012a) build on their earlier model of optimal insurance contracting in the presence of counterparty risk to analyze the costs and benefits of OTC markets versus trading on a CCP. They show that when the CCP is optimally designed, the CCP dominates OTC markets. The reason is that in general a CCP can make more efficient use of the mutualization of counterparty risks. Unfortunately, it is far from clear that current CCP proposals are designed optimally (i.e., maximize the benefits of mutualization). One specific concern, for example, is that the CCP itself may become a source of systemic risk, should rules on margin requirements be poorly designed. This is why the Dodd–Frank Act of 2010 includes provisions that require the Financial Stability Oversight Council (FSOC) to monitor CCPs and allows the FSOC to put any CCP that is a threat to financial stability under the supervision of the Federal Reserve Board. Another potential design flaw of existing CCPs is that they are far from transparent and thus may continue to protect the oligopoly rents of the large dealers (see Bolton et al., 2012).

The second major initiative is the implementation of restrictions on proprietary trading by banks via the so-called Volcker Rule.[13] To the extent that trading in CDS is not a hedging but a speculative activity, dealer banks may face restrictions in their CDS trading. This issue rose to prominence in the spring of 2012 with the disclosure of massive losses from CDS positions incurred by JPMorgan Chase (through the so-called London Whale).[14]

The third major policy question for the coming years concerns the special status of derivatives and swaps in bankruptcy or bank receivership. As pointed out above, current regulations give banks inefficient incentives to rely on funding through swaps and repos for their financing as opposed to more stable funding sources such as long-term unsecured bond financing. This is a major loophole in existing financial regulations, which seek to eliminate *moral hazard in lending* to banks. Left unchanged, this loophole could make short-term wholesale funding through repos even more the preferred source of cheap funding for banks in the next lending boom.

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[13] The Volcker Rule, part of the Dodd–Frank Act of 2010, aims to restrict speculative trading by U.S. banks. It was originally proposed by former Federal Reserve Chairman Paul Volcker.

[14] Because of the size of his trades, the trader behind JPMorgan Chase's positions in CDS became known as the London Whale (a "whale" in poker jargon is a bad player with a fat wallet).

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