Does a Central Clearing Counterparty Reduce Counterparty Risk?

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Abstract

We show whether central clearing of a particular class of derivatives lowers counterparty risk. For plausible cases, adding a central clearing counterparty (CCP) for a class of derivatives such as credit default swaps reduces netting efficiency, leading to an increase in average exposure to counterparty default. Clearing two or more different classes of derivatives in separate CCPs always increases counterparty exposures relative to clearing the combined set of derivatives in a single CCP.

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A central clearing counterparty (CCP) stands between over-the-counter (OTC) derivatives counterparties, insulating them from each other's default. Effective clearing mitigates systemic risk by lowering the risk that defaults propagate from counteparty to counterparty. Clearing also reduces the degree to which the solvency problems of a market participant are suddenly compounded by a flight of its OTC derivative counterparties, as occurred when Bear Stearns' solvency was threatened.

We show whether central clearing for a particular class of derivatives reduces counterparty exposures and collateral demands. For plausible cases, adding a new CCP dedicated to only one class of derivatives, such as credit default swaps (CDS), reduces netting efficiency, thereby increasing average exposure to counterparty default, or increasing collateral demand, or both.

We show that it is always more efficient to have a single CCP that jointly clears various classes of derivative than to have separate CCPs that clear the respective classes. For example, regarding the debate over whether dealers should have separate CCPs for their U.S. and European credit default swaps,[1] we show that it is more efficient to clear U.S. and European credit derivatives contracts on a single CCP. Of the current proposed and approved CDS central clearing counterparties, two are based in the United States, while four are based in Europe.[2]

Our results are based on a simple model, but clarify an important trade-off between two types of netting opportunities: bilateral netting between pairs of counterparties across different underlying assets, versus multilateral netting

[1]See, for example, European Central Bank (2009).

[2]U.S.-approved CCPs for CDS are those of the ICE Trust and the CME Group. The Europe-based CCPs (and proposals) include those of NYSE-LIFFE/BClear and LCH.Clearnet, Eurex, ICE Trust Europe (an arm of ICE dedicated to Europe-based CDS clearing), and LCH.Clearnet SA (a French subsidiary of LCH.Clearnet, dedicated to Eurozone CDS clearing). See European Central Bank (2009) p. 77 for more details.

among many clearing participants across a single class of underlying assets, such as credit default swaps. The introduction of a CCP for a particular class such as credit derivatives is only effective if the opportunity for multilateral netting in that class dominates the resulting loss in bilateral netting opportunities across uncleared derivatives from other asset classes, including uncleared OTC deriatives for equities, interest rates, commodities, and foreign exchange.

For instance, suppose that Dealer A is exposed to Dealer B by \$100 million on CDS, while at the same time Dealer B is exposed to Dealer A by \$150 million on interest rate swaps. The bilateral exposure is the net, \$50 million. The introduction of central clearing dedicated to CDS eliminates the bilateral netting benefits and increases the exposure between these two dealers, before collateral, from \$50 million to \$150 million. In addition to any collateral posted by Dealer A to the CCP for CDS, Dealer A would need to post a significant amount of additional collateral to Dealer B. Collateral is a scarce resource, especially in a credit crisis. The introduction of a CCP for CDS can nevertheless be effective when there are extensive opportunities for multilateral netting. For example, if Dealer A is exposed by \$100 million to Dealer B through a CDS, while Dealer B is exposed to Dealer C for \$100 million on the same CDS, and Dealer C is simultaneously exposed to Dealer A for the same amount on the same CDS, then a CCP eliminates this unnecessary circle of exposures. The introduction of a CCP therefore involves an important tradeoff between bilateral netting without the CCP and multilateral netting through the CCP.

Naturally, our results show that introducing a CCP for a particular set of derivatives reduces average counterparty exposures if and only if the number of clearing participants is sufficiently large relative to the exposure on derivatives that continue to be bilaterally netted. For plausible parameters, we show that it is far from obvious that this condition is met for the separate clearing of credit default swaps.

The benefits of a central clearing counterparty dedicated to credit derivatives has been significantly reduced through the aggressive use of compression trades, which has lowered exposures in the CDS market to about half of their mid-2008 levels. Proposals by European regulators to have one or more CCPs dedicated to clearing European credit default swaps could further reduce the netting opportunities of a CCP, relative to combining the clearing of CDS in a single CCP. We provide numerical examples of the impact of this proposal on expected counterparty exposures.

Working with twelve prominent CDS dealers, ICE Trust (U.S.) has cleared \$3.5 trillion notional of index-based CDS contracts in the United States, as of January 2010.[3] According to DTCC data, the total notional amount of standard index-based and single-name CDS that reference corporations and sovereigns is currently about \$25 trillion. Our results suggest that clearing CDS through a dedicated central clearing counterparty improves netting efficiency for twelve similarly sized dealers if and only if the fraction of a typical dealer's total expected exposure attributable to cleared CDS is at least 66% of the total expected exposure of remaining bilaterally netted classes of derivatives.

Our results show that a single central clearing counterparty that clears both credit derivatives and interest rate swaps is likely to offer significant reductions in expected counterparty exposures, even for a relatively small number of clearing participants. For example, in a simple illustrative calculation based on data provided by U.S. banks, we show that once 75% of interest rate swaps are cleared, the incremental reduction in before-collateral average expected counterparty ex-

[3]See http://ir.theice.com/releasedetail.cfm?ReleaseID=439697.

posures obtained by clearing 75% of credit derivatives in a separate CCP is negligible, because of the loss of bilateral netting opportunities. In the same setting, however, clearing these credit derivatives in the same CCP used for interest rate swaps reduces average expected exposures by about 7%, despite the loss of bilateral netting opportunities. Relative to the case of fully bilateral netting (no clearing), substantial benefits can be obtained by the joint clearing of the four major classes of derivatives monitored by the Office of the Comptroller of the Currency. Our rough estimates suggest that the joint clearing of 75% of interest rates swaps and credit derivatives, along with 40% of other derivatives classes, results in a 37% reduction in pre-collateral expected counterparty exposures, relative to a market without CCPs. Because we lack direct data on bilateral counterparty relationships, these estimates are rough approximations.

As we will explain, some important aspects of systemic risk are not captured by our model. We do not consider the extent to which CCPs mitigate the likelihood and severity of knock-on defaults that propagate from the failure of a large counterparty. An analysis of knock-on defaults would depend in part on the collateral and guarantees that clearing participants provide to a CCP, as well as the liquidity resources of all market participants. Modeling the dynamics of knock-on effects is well beyond the reach of currently available methods. Nevertheless, our results make it clear that regulators and clearing participants should carefully consider the tradeoffs involved in carving off a particular class of derivatives for separate clearing. This makes sense, from the viewpoint of counterparty exposures and collateral demands, only if the class of derivatives to be separately cleared is big enough and if the subset of clearing participants clearing through the same central clearing counterparty is large enough. So far, proposals for separate CDS clearing have not made this case effectively. Proposals for a number of distinct new CCPs dedicated to credit default swaps raise a particular concern.

The interoperability of CCPs, by which at least some of the benefits of joint clearing can be obtained through agreements among CCPs and their participants, can in principle achieve significant reductions in counterparty risk, although obtaining effective interoperability agreements currently presents a number of legal and financial engineering challenges, in addition to business-incentive hurdles. For related discussions of interoperability, see EuroCCP (2010) and Kalogeropoulos, Russo, and Schönenberger (2007).

I. Netting Efficiency in an OTC Market

We consider N market participants, whom we shall call "entities," whose over-the-counter derivative exposures to each other are of concern. These N entities may also have exposures to other entities.

We consider the opportunity for the N entities to novate some OTC derivative positions to a central clearing counterparty. For example, if entities i and j have a CDS position by which i buys protection from j, then both i and j can novate to a CCP, who is then the seller of protection to i and the buyer of protection from j. Novation to a CCP is sometimes called "clearing," although the term "clearing" is often used in other contexts.[4]

We allow for K classes of derivatives. These classes could be defined by the underlying asset classes, such as credit, interest rates, foreign exchange, commodities, and equities. One can also construct derivatives classes by grouping more than one underlying asset type.

[4]See Bliss and Steigerwald (2006), Pirrong (2009), and Stulz (2009) for discussions of CCPs in the context of over-the-counter derivatives market.

For entities i and j, let X_{ij}^k be the net exposure (when positive) of i to j of all positions in some derivatives class k, before considering collateral. By definition,

$$X_{ij}^k = -X_{ji}^k. \tag{1}$$

Before setting up a CCP, this exposure X_{ij}^k is uncertain because the level of exposure that will exist on a typical future day is yet to be determined. The uncertainty in X_{ij}^k also includes the risk associated with marks to market that will occur before additional collateral can be requested and received. If entity j defaults and $X_{ij}^k > 0$, then entity i loses X_{ij}^k on positions in asset class k, before considering the benefits of netting across asset classes, collateral, and default recovery.[5]

For now, we suppose that all exposures (X_{ij}^k) are of the same variance and are independent across asset classes and pairs of entities, excluding the obvious case represented by (1). We later relax all of these assumptions. For simplicity, we assume symmetry in the distributions of exposures across all pairs of entities. This implies in particular that $E(X_{ij}^k) = 0$. We will also relax the symmetry assumption. With N entities and K asset classes, there are $K \times N \times (N-1)/2$ exposure distributions to be specified. Symmetry allows a dramatic reduction in the dimension of the problem.

A reasonable measure of the netting efficiency offered by a market structure is the average, across entities, of total expected counterparty exposures, after netting, but before collateral. The lower is this average, the more efficient is the netting arrangement. Before considering the introduction of a CCP, the netting

[5]Bliss and Kaufman (2006) provide an analysis of the legal implications of settlement of OTC exposures at default.

efficiency is

$$\phi_{N,K} = (N-1)E\left[\max\left(\sum_{k=1}^{K} X_{ij}^{k}, 0\right)\right], \tag{2}$$

where we have used symmetry by fixing attention on a particular entity i. Assuming normality, we have

$$\phi_{N,K} = (N-1)\sigma\sqrt{\frac{K}{2\pi}}, \tag{3}$$

where σ is the standard deviation of X_{ij}^{k}.

For given collateralization standards, the risk of loss caused by a counterparty default is typically increasing in average expected exposure. (Under normality and symmetry, essentially any reasonable risk measure is increasing in expected exposure.) Risk of loss from counterparty default is a first-order consideration for systemic risk analysis.

Going beyond counterparty default risk, as expected exposures go up, the expected amount of collateral that must be supplied goes up. Collateral use is expensive. In an OTC market without a CCP, whatever collateral is supplied by one counterparty is received by another, so the net use of collateral is always zero. The need to supply collateral is nevertheless onerous, for several reasons. First, some individual counterparties on a given day will supply more collateral to others than others supplied to them. The net drain on the assets that could be supplied as collateral is costly, because of the lost opportunity to use that collateral for secured borrowing, as a cash management buffer, or for securities lending as a rent-earning business. Second, there is a question of the timing of collateral settlement. One must often supply collateral to a particular counterparty on a given day before collateral is received from another counterparty. If this were not the case, for instance, there would be no specials in treasury repo markets. This sort of frictional demand for collateral, analogous to the demand for money that arises from a limited velocity of circulation of money, is considered by Duffie, Gârleanu, and Pedersen (2002). So long as the average cost of supplying collateral to others is larger, on average, than the average benefit of receiving collateral from others, a market with poorer netting efficiency is also a market with higher net cost of collateral use. For a simple illustration, if the amount of collateral to be supplied is on average some multiple U of exposure, and if the average benefit b per unit of collateral value received is less than the average cost c per unit of collateral value supplied, then the average net expected cost to an entity of collateral usage arising from counterparty exposure is $(c-b)U\phi_{N,K}$, where $\phi_{N,K}$ is the average total expected exposure measure defined above. Under market stress, collateral demand from derivative counterparties may exacerbate the liquidity problem of an already-weakened dealer bank, as explained by Duffie (2010).

Although average expected exposure, after netting and before collateral, is a reasonable measure of a market's netting efficiency and is closely related to systemic risk, this measure misses some important aspects of systemic risk. Most importantly, this measure does not consider the joint determination of defaults across entities. In particular, as opposed to the joint solvency analysis of Eisenberg and Noe (2001), our netting efficiency measure does not consider the implications of jointly determined defaults in a network of entities. For example, the likelihood that entity i cannot cover its payments to j plays a causal role in determining the likelihood that entity j cannot cover its payments to entity m, and so on. Adding a CCP could in principle increase or decrease the potential for jointly determined defaults, depending on the capitalization of the CCP and of the clearing entities, and on the collateralization standards of bilateral netting and central clearing. In addition to the capital that it holds, a CCP is typically backed by member guarantees. (See the appendix of Duffie, Li, and Lubke (2010).) A full analysis of the implications of a CCP for the joint solvency of its members is beyond the scope of our research.

In addition to the benefits of a CCP from the viewpoint of netting and of insulating counterparties from default by each other, a well run central clearing counterparty can also offer improved and more harmonized trade and collateral settlement procedures than those that may apply to uncleared derivatives, as suggested by BIS (2007). The International Organization of Securities Commissions (IOSCO) has provided a set of standards for the operational risk and capitalization of CCPs.

The assumption of normality clearly does not apply well to the exposures of many individual derivatives positions, such as individual CDS contracts, which have heavily skewed and fat-tailed market values due to jump-to-default risk. Aggregating within the class of all CDS, however, may result in a net exposure of one entity to another that is substantially less skewed and less fat-tailed, given the diversification across underlying names and the effect of aggregating across long and short positions. For example, two dealers running large active matched-book CDS intermediation businesses may have almost no skew in the distributions of their exposures to each other.

II. Netting Efficiency with a CCP

We consider the implications of a CCP for one class of derivatives, say Class K. Taking the previously described setting, suppose that all positions in Class K are novated to the same CCP. The expected exposure of entity i to this CCP is then

$$\gamma_N = E\left[\max\left(\sum_{j\neq i} X_{ij}^K, 0\right)\right] = \sqrt{\frac{N-1}{2\pi}}\sigma. \tag{4}$$

In practice, the exposure of a clearing participant to a CCP has two components. The first part is the direct exposure to the failure of the CCP, as to any other counterparty. We have explicitly modeled this source of exposure. The second part of the exposure to the CCP is indirect, in the form of new contributions by the entity to the CCP guarantee fund that are payable in the event that one or more other members of the CCP fail. The latter exposure depends in part on the CCP rules for collateral, guarantee funds, and default management.[6] We have not modeled these indirect exposures. Our measure of netting efficiency is thus likely to be somewhat biased in favor of clearing.

The expected exposure of entity i to the other $N-1$ entities for the remaining $K-1$ classes of derivatives is $\phi_{N,K-1}$. Thus, with a CCP for one class of derivatives, the average entity expected exposure is

$$\phi_{N,K-1} + \gamma_N. \tag{5}$$

Introducing a CCP for this single class of derivatives therefore improves netting efficiency if any only if $\gamma_N + \phi_{N,K-1} < \phi_{N,K}$, which applies if and only if

$$K < \frac{N^2}{4(N-1)}. \tag{6}$$

Normally, a CCP does not post as much collateral to its counterparties as it receives from them. Thus, the comparison (4) overstates the benefits of a CCP from the viewpoint of collateral efficiency.

[6]See Appendices A and B of Duffie, Li, and Lubke (2010).

Based on (4), if there are $K = 2$ symmetric classes of uncleared derivatives, then central clearing of one of the classes improves netting efficiency if and only if there are at least 7 entities clearing. If there are 4 symmetric classes of derivatives, then central clearing of one of the classes improves efficiency if and only if there are at least 15 entities clearing. A CCP is always preferred, in terms of netting efficiency, if it handles all classes of derivatives (which is, in effect, the case of $K = 1$).

In Appendix A, we allow for correlations across derivatives classes, and show that the benefit of introducing central clearing increases with cross-class exposure correlation. We also point out that counterparties have an incentive to create exposures with each other that are negatively correlated across asset classes, in order to hedge their counterparty risks.

It could be argued that the exposure of an entity to a CCP is likely to be of less concern than its exposure to another entity, because a CCP is likely to be well regulated, bearing in mind the systemic risk posed by the potential failure of a CCP. We do not model this "benefit" of a CCP; our average expected exposure measure weights all counterparty exposures equally. Arguing the other way, the centrality of a CCP implies that its failure risk could be more toxic than that of other market participants.[7] Likewise, we do not consider this effect. For a more comprehensive review of policy issues regarding OTC derivatives market infrastructure, see Duffie, Li, and Lubke (2010) and European Central Bank (2009).

Our measure of netting efficiency is based on the total of the expected exposures of an entity to its counterparties. This measure does not consider concentra-

[7]Examples of clearing-house failures include those of Caisse de Liquidation, Paris, (1974), the Kuala Lumpur Commodity Clearing House (1983), and the Hong Kong Futures Guarantee Corporation (1987). See Hills, Rule, Parkinson, and Young (1999).

tion risk. Even putting aside the systemic risk of a CCP caused by its centrality, a CCP tends to represent a concentration of exposure to its counterparties. In our simple setting, this is true whenever the number of entities clearing one of the classes of derivatives is greater than the number of derivatives classes, that is $N > K$. Specifically, the expected exposure of an entity to its CCP, as a multiple of that entity's expected exposure to each of its other counterparties, is $\sqrt{(N-1)/(K-1)}$. For instance, if there are $N = 10$ entities and $K = 5$ classes of equally risky derivatives, then after novation of positions in one class to a CCP, the expected exposure of an entity to the CCP is 50% more than its exposure to any other counterparty.[8]

A. Derivatives Classes with Different Degrees of Risk

We now generalize by considering the netting efficiency allowed by the central clearing of a class of derivatives that may have particularly large exposures, relative to other classes of derivatives. That is, we now allow the expected exposure $E[\max(X_{ij}^k, 0)]$ of class k to be different than that of another class. Our other assumptions are maintained. A class could include derivatives with more than one underlying asset type. For example, we could group together all CDS and all interest rate swaps into a single class for clearing purposes.

Suppose that derivatives in Class K are under consideration for clearing. The ratio of an entity's expected exposure with a given counterparty in this asset class to the total expected exposure with the same counterparty in all other classes

[8]When comparing instead to the expected exposure to a counterparty that existed *before* novation to a CCP, this concentration ratio is $\sqrt{(N-1)/K}$, which is 1.34 in our example. This represents a 34% increase in concentration due to "clearing," under our simple assumptions. For $N = 20$ entities and $K = 5$ classes of derivatives, the corresponding increase in concentration is 94%.

combined is

$$R = \frac{E\left[\max\left(X_{ij}^K, 0\right)\right]}{E\left[\max\left(\sum_{k<K} X_{ij}^k, 0\right)\right]}. \tag{7}$$

For example, if all classes have equal expected exposures, then $R = 1/\sqrt{K-1}$, using the fact that expected exposures are proportional to standard deviations. If Class-K exposures are twice as big (in terms of expected exposure) as each of the other $K-1$ classes, then $R = 2\sqrt{1/(K-1)}$. A calculation analogous to that shown previously for the symmetric case leads to the following result.

PROPOSITION 1 *The introduction of a CCP for a particular class of derivatives leads to a reduction in average expected counterparty exposures if and only if*

$$R > \frac{2\sqrt{N-1}}{N-2}, \tag{8}$$

where R is the ratio of the pre-CCP expected entity-to-entity exposures of the class in question to the expected entity-to-entity exposure of all other classes combined.

For example, we can take the case of $N = 12$ entities, the number of entities that partnered with ICE Trust to create a CCP for clearing credit default swaps.[9] Under our assumptions, with $N = 12$, clearing the derivatives in a particular class through a CCP improves netting efficiency if and only if the fraction R of an entity's expected exposure attributable to this class is at least $R = 66\%$ of the total expected exposure of all remaining bilaterally netted classes derivatives. With $N = 26$, the cutoff level drops to $R = 41.7\%$. Although the CDS market poses a large amount of exposure risk, with a total notional market size of roughly

[9]The participants of the ICE Trust are Bank of America, Barclays, BNP Paribas, Citibank, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, JPMorgan Chase, Merrill Lynch, Morgan Stanley, Royal Bank of Scotland, and UBS. See https://www.theice.com/publicdocs/ice_trust/ICE_Trust_Participant_List.pdf. Presumably the acquisition of Merrill Lynch by Bank of America now implies the effect of only $N = 12$.

$25 trillion, it would be difficult to make the case that it represents as much as 41.7% of dealer expected exposures in all other "uncleared" derivatives classes combined.

The Bank for International Settlements provides data on OTC derivatives exposures of dealers in several major asset classes. The latest available data, for June 2009, are shown in Table I. Although these data merely show gross current credit exposures, and therefore do not incorporate the add-on exposure implications of risky marks to market, they do give a rough indication of the relative amount of exposure in each of the major underlying asset classes, before netting and collateral. The effect of bilateral netting reduced the total gross exposures shown in Table I from $25.4 trillion to $3.7 trillion, but because of the manner in which these data are collected, the net exposures do not include the effects of credit default swaps held by non-U.S. dealers.

In light of Proposition 1, it would be hard to base a case for the netting benefits of a central clearing counterparty dedicated to credit default swaps on the magnitudes of OTC derivatives credit exposures shown in Table I. Credit derivatives account for only about 12% of the total gross exposures. If one assumes that total counterparty expected exposures of a given dealer are proportional, class by class, to the gross credit exposures shown in Table I, and that X_{ij}^k are independent across k, the implied ratio R of expected exposures on credit derivatives to expected exposures on the total of other classes would be about[10] 19%. This

[10] To calculate the implied ratio R, denote by Z_k the total gross exposure on derivative of class k, for $k = 1, 2, \ldots, K$. Assume that the total expected counterparty exposure on class k is a fixed fraction α of Z_k, and that these expected counterparty exposures are independent across k. Without loss of generality, let class K be centrally cleared while all remaining classes are bilaterally netted. Then the implied ratio of total expected counterparty exposure on class K to that on classes 1 to $K-1$ combined is

$$R = \frac{\alpha Z_K}{\sqrt{\sum_{k=1}^{K-1} (\alpha Z_k)^2}} = \frac{Z_K}{\sqrt{\sum_{k=1}^{K-1} Z_k^2}}.$$

Table I: Gross credit exposures in OTC derivative markets.

This table shows gross credit exposures of dealers in OTC derivatives markets by asset class, counterparty type, and single versus multi-name CDS, as of June 2009. Source: BIS.

Asset class	Exposure ($ billions)
CDS	2,987
Commodity	689
Equity Linked	879
Interest Rate	15,478
Foreign Exchange	2,470
Unallocated	2,868
Total	25,372
Total after netting	3,744
CDS by Counterparty	
Dealer to dealer	1,476
Dealer to other financial institution	1,332
Dealer to non-financial customers	179
Total	2,987
CDS by type	
Single name	1,953
Multi-name	1,034
Total	2,987

would in turn imply, from Proposition 1, that a central clearing counterparty dedicated to CDS reduces average expected counterparty exposures if there are more than about 120 entities clearing together. After adding to gross exposures the add-on effect of highly volatile CDS marks to market (relative to other asset classes), the threshold number of entities necessary to justify a central clearing counterparty dedicated to CDS is likely to be lower.

Exposures on credit derivatives among dealers have been reduced significantly since June 2008 due to CDS compression trades.[11] According to DTCC DerivServ data, dealer CDS positions continued to shrink throughout 2008 and 2009. The total size of the CDS market in terms of notional positions in January 2010 is about half of mid-2008 levels.[12]

The data in Table I suggest that there would be a much stronger case for the joint clearing of CDS and interest rate swaps, which together accounted for about 73% of the total gross exposures. Indeed, interest rate swaps on their own represent large enough exposures to justify a dedicated central clearing counterparty, and a significant fraction of interest rate swaps are already cleared through CCPs.[13]

Ironically, our model suggests that it is easier to justify the netting benefits of a central clearing counterparty dedicated to a particular class of derivatives after a different CCP has already been set up for a different class of derivatives. In this sense, "one mistake justifies another." For example, the threshold size of the CDS market that justifies the netting benefits of a CDS-dedicated CCP is lowered once a significant fraction of interest rate swaps are cleared.

One could argue that CDS exposure is rather special, because of jump-to-default risk and because default risk tends to be correlated with systemic risk. Given the typical practice of daily re-collateralization, the revaluation of CDS

[11] According to a press release by Markit of July 2, 2008, a compression trade "involves terminating existing trades and replacing them with a far fewer number of new 'replacement trades' which have the same risk profile and cash flows as the initial portfolio, but with less capital exposure. The initiative, available to both the U.S. and European CDS markets, will be managed jointly by Creditex and Markit and has the support of 13 major CDS market participants." See "Markit and Creditex Announce Launch of Innovative Trade Compression Platform to Reduce Operational Risk in CDS Market," July 2, 2008, at www.markit.com.

[12] See http://www.dtcc.com/products/derivserv/data/index.php.

[13] According to a February 3, 2009 press release on its web site, LCH.Clearnet stated that it clears about 50 percent of the OTC global interest rate swap market in a CCP for interest rate swaps. However, Duffie, Li, and Lubke (2010) provides a lower estimate of 35% for dealer-to-dealer clearing based on a survey of dealers by the Federal Reserve Bank of New York. U.S.-based CCPs for interest rate swaps include CME Cleared Swaps and IDGC. Ledrut and Upper (2007) provide details on the central clearing of interest rate swaps.

positions caused by any defaults on a given day would need to be extremely large in order to build a strong case for separate CDS clearing on the implications of jump-to-default risk. Our results show that jump-to-default risk is better reduced through bilateral netting or joint clearing with interest rate swaps, unless the jump-to-default risk is large relative to that of all other OTC derivatives exposures. Of the total of $2,987 billion in gross credit exposures shown in Table I for credit derivatives, $1,034 billion are on multi-name CDS products, mainly in the form of index contracts such as CDX and iTraxx, which represent equal-weighted CDS positions in over 100 corporate borrowers. These products have relatively small jump-to-default risk, in comparison with single-name CDS.

Initially, at least, CCPs dedicated to CDS clearing have restricted attention to a subset of actively traded CDS. For example, ICE Trust been clearing index CDS contracts. Some single-name CDS contracts are expected to be cleared in 2010. The smaller the subset of CDS that is cleared, the lower is the netting efficiency offered by central clearing relative to bilateral netting.

The benefit of multilateral netting among a large set of entities is reduced by a concentration of exposures among a small subset of the entities. For example, among U.S. banks, data available through the Office of the Comptroller of the Currency show that, as of the third quarter of 2009, the five largest derivative dealers – JPMorgan Chase, Bank of America, Goldman Sachs, Morgan Stanley, and Citigroup – account for 95% of total notional credit derivatives positions held by all U.S. banks. The effective number of U.S. CDS market participants for purposes of our analysis may not be much more than 5. The proposal for derivatives clearing becomes relatively more attractive if a single CCP handles clearing for all standard CDS positions of large global dealers, including those in Europe and the U.S, and much more attractive if credit derivatives are cleared together with interest rate swaps in the same central clearing counterparty.

B. An Example of Exposure Reduction

We now provide a simple illustrative example of exposure reduction under various clearing scenarios for the six largest U.S. derivative dealers. The notional amounts of OTC derivatives contracts reported to the Office of the Comptroller of the Currency[14] are shown in Table II. Because we do not have similar data on non-U.S. banks, we assume there are six other derivative dealers with the same total notional amounts of derivatives by class, giving a total of $N = 12$ major dealers globally.

Let S_i^k be the aggregate (notional) size of the positions of dealer i in derivatives class k. We suppose that the standard deviation of exposures due to class-k derivatives is a scaling m_k of the associated notional position S_i^k. Here, m_k incorporates both the effect of market value on a typical future date (which is uncertain from the current perspective), as well as the effect of volatility of changes in market value between that day and the time by which additional collateral could partially be collected before the counterparty fails. We also assume that the exposure of dealer i to dealer j on class k is proportional to S_j^k. Thus the standard deviation of the pre-collateral pre-clearing exposure of dealer i to dealer j on derivatives class k is

$$m_k S_i^k \frac{S_j^k}{\sum_{h \neq i} S_h^k}. \tag{9}$$

[14]The Office of the Comptroller of the Currency does not provide notional amounts by the underlying asset classes, such as interest rate, credit, equity, and so on. However, we note that almost all swap contracts are interest rate swaps, and that almost all credit derivatives are credit default swaps. For that reason we use the notional amounts of swaps contracts as proxies for those of interest rate swaps, and the notional amounts of credit derivatives as proxies for those of CDS.

Table II: Notional sizes of six largest U.S. derivative dealers.

This table shows the notional sizes of six largest U.S. derivative dealer banks, published by the Office of the Comptroller of the Currency, as of 2009 Q3. The identities of the banks are omitted.

	Forwards	Swaps	Options	Credit	Total
Bank 1	8177	51203	10059	6376	75815
Bank 2	8984	49478	5918	5590	69970
Bank 3	1651	31521	6980	5762	45914
Bank 4	5718	24367	4064	5482	39631
Bank 5	5536	16375	6384	2764	31059
Bank 6	1198	2192	477	268	4135
Total	31264	175136	33882	26242	266524

We let α^k be the fraction of notional positions in derivatives of class k that are centrally cleared. Keeping our normality and independence assumptions, we have

$$X_{ij}^k \sim N\left(0, \left(m_k S_i^k \frac{S_j^k}{\sum_{h\neq i} S_h^k}\right)^2\right). \tag{10}$$

The expected exposure of Dealer i to a CCP dedicated to class-k derivatives is thus

$$E\left[\max\left(\sum_{j\neq i} \alpha^k X_{ij}^k, 0\right)\right] = \frac{1}{\sqrt{2\pi}} \alpha^k m_k S_i^k \left[\frac{\sum_{j\neq i}(S_j^k)^2}{\left(\sum_{j\neq i} S_j^k\right)^2}\right]^{\frac{1}{2}}. \tag{11}$$

The expected exposure of Dealer i to Dealer j on all uncleared positions is

$$E\left[\max\left(\sum_{k=1}^K (1-\alpha^k) X_{ij}^k, 0\right)\right] = \frac{1}{\sqrt{2\pi}} \left[\sum_{k=1}^K \left((1-\alpha^k) m_k S_i^k \frac{S_j^k}{\sum_{j\neq i} S_j^k}\right)^2\right]^{\frac{1}{2}}. \tag{12}$$

Table III shows the dealers' pre-collateral expected exposures under various clearing approaches. These exposures are shown as multiples of total exposures

Table III: Expected counterparty exposures under various clearing approaches.

This table shows the expected counterparty derivatives exposures of dealers under various clearing approaches, as multiples of total exposures when all classes are bilaterally netted. "Mult." refers to the case of multiple CCPs, each clearing one class of derivatives. "Same" refers to the case of a single CCP clearing all derivative classes considered. The estimates are based on $N = 12$ dealers, the six dealers of Table II and six others with the same exposures class-by-class. The standard deviation scaling m_k for non-interest-rate-swap derivatives is assumed to be three times that for interest rate derivatives.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Fractions cleared on CCP(s)								
Forwards	0	0	0	0	0	0	0	0.4	0.4
Swaps	0	0	0	0	0.75	0.75	0.75	0.75	0.75
Options	0	0	0	0	0	0	0	0.4	0.4
Credit	0	1	1	0.75	0	0.75	0.75	0.75	0.75
Number of CCP	-	Same	Mult.	Same	Same	Mult.	Same	Mult.	Same
	Total exposures as fractions of exposures without CCPs								
Bank 1	1	1.05	1.09	1.03	0.88	0.89	0.83	0.79	0.63
Bank 2	1	1.05	1.09	1.03	0.84	0.85	0.79	0.76	0.62
Bank 3	1	1.05	1.10	1.02	0.88	0.85	0.78	0.76	0.61
Bank 4	1	1.04	1.10	1.01	0.94	0.91	0.83	0.80	0.63
Bank 5	1	1.05	1.09	1.03	1.00	1.02	0.97	0.86	0.69
Bank 6	1	1.04	1.06	1.03	1.00	1.02	0.99	0.83	0.70
Total (ratio)	1	1.05	1.09	1.03	0.90	0.90	0.83	0.79	0.63

for the case in which all derivatives are bilaterally netted. For this example, we use a standard-deviation scaling m_k for non-interest-rate-swap derivatives that is three times that for interest rate derivatives.[15]

Relative to the no-clearing base case, the introduction of a CCP that clears 100% of credit derivatives actually increases market-wide expected exposures by

[15]From BIS data as of June 2009, the market value of interest rate swaps is roughly 3.5% of the notional amounts. The market value of all the other derivatives classes combined is about 5.9% of the notional amounts. These numbers suggest a ratio of roughly 1.67 to 1 for the current valuations of non-interest-rate-swaps to interest rate swaps, per unit notional. We scale up from 1.67 to 3 in order to allow for the volatility of changes in market value between the time of valuation and the time by which additional collateral could be received before a potential default.

about 5% in this setting (Column 2), as suggested by our theory. If a CDS-dedicated CCP clears 75% of CDS, then expected exposures are about 3% higher than for the case of fully bilateral netting (Column 4).

If we divide CDS positions into two classes, say "European" and "U.S.," of equal total notional sizes, then clearing the U.S. and European CDS separately increases expected exposures by 9%, relative to bilateral netting (Column 3).

Estimated expected exposures are reduced by about 10%, relative to bilateral netting, if 75% of interest rate swaps are centrally cleared (Column 5). Morgan Stanley (2009) forecasts the clearing of about 75% of dealer-to-dealer interest rate swaps and CDS in the next 2-3 years. With this 75% level of interest-rate-swap clearing, adding a CDS-only CCP has a negligible effect on expected exposures (Column 6). If, however, 75% of CDS and interest rate swaps are cleared by the same CCP, then expected exposures are reduced by 17%, compared to bilateral netting (Column 7).

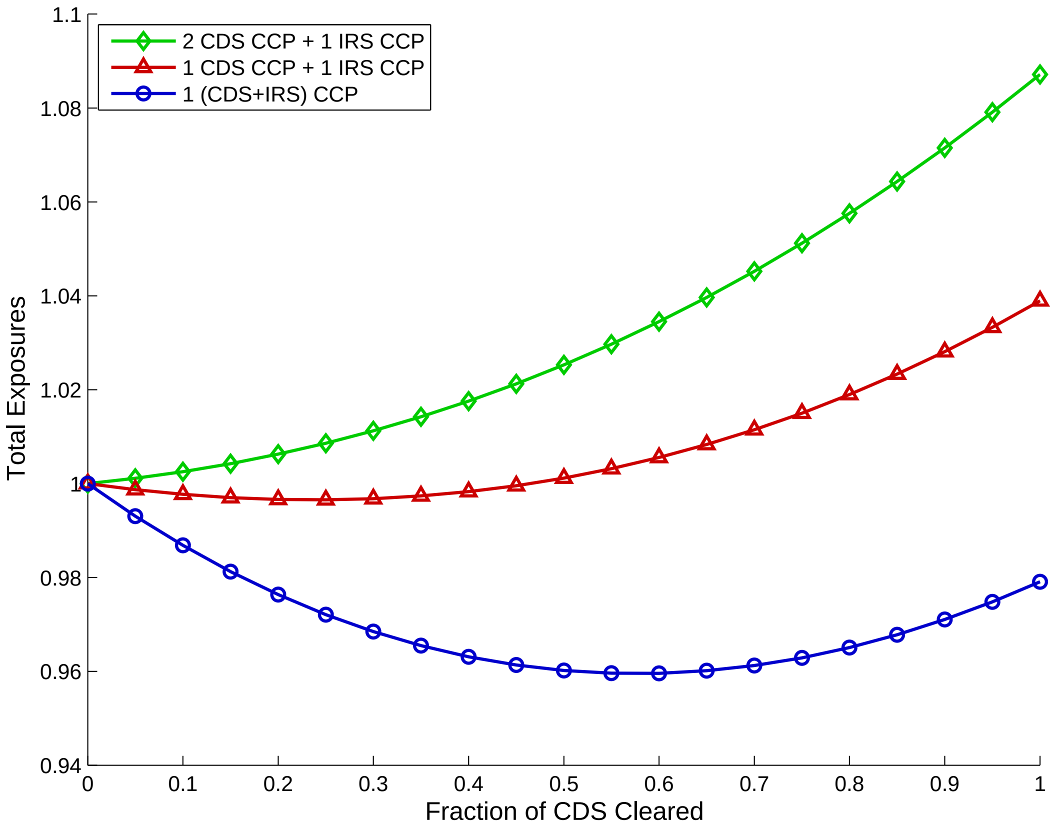
Clearing a moderately large fraction of all classes of derivatives in the same CCP reduces average estimated exposures by 37% (Column 9). This high degree of netting efficiency is not achieved if the same amounts are cleared centrally but separately (Column 8).

Figure 1 illustrates total expected exposures under various clearing approaches. We fix the fraction of interest rate swaps that are centrally cleared to be 35%, the estimate of clearing obtained in a dealer survey conducted by the Federal Reserve Bank of New York.[16] When CDS and interest rate swaps are cleared together in the same CCP, the reduction in exposure is positive and convex in the cleared fraction of CDS. Total expected exposures are strictly higher if CDS are cleared separately from interest rate swaps.

[16] See Duffie, Li, and Lubke (2010).

Figure 1: Total expected exposures under various clearing approaches.

This figure shows the total expected exposures under various clearing approaches, as a function of the cleared fraction of CDS. In all cases, we assume that 35% of interest rate swaps (IRS) are cleared. In the case of two CDS-dedicated CCPs, we assume that the total notional sizes of CDS cleared on the two CDS CCPs are equal.



Our numerical results highlight the trade-off between bilateral and multilateral netting. Our results indicate that counterparty exposures can be reduced significantly if the same CCP jointly clears multiple classes of derivatives. Joint clearing also reduces margin requirements. Singh (2009) estimates that if two thirds of all OTC derivatives are cleared through CCPs using current CCP approaches, then roughly $400 billion in additional clearing margin and guarantee funds will be needed.

III. Netting Efficiency with Multiple CCPs

In this section, going beyond the illustrative estimates of Section 3.3, we prove a general result on the loss of netting efficiency caused by dedicating different CCPs to each of several classes of derivatives, as opposed to the joint clearing of various classes of derivatives in a single CCP.

We drop our normality and symmetry assumptions, and allow for an arbitrary joint distribution of X_{ij}^k. We suppose that C of the K classes of derivatives are centrally cleared, while the remaining $K - C$ classes are bilaterally netted. Without loss of generality, classes $1, 2, \ldots, C$ are cleared through CCPs. The expected exposure of Entity i on uncleared derivatives is

$$\phi_{i,N,K-C} = E\left[\max\left(\sum_{k=C+1}^{K} \sum_{j \neq i} X_{ij}^k, 0\right)\right]. \tag{13}$$

With a single CCP that clears all of the first C classes, the total expected exposure of Entity i is

$$U_i = E\left[\max\left(\sum_{k=1}^{C} \sum_{j \neq i} X_{ij}^k, 0\right)\right] + \phi_{i,N,K-C}. \tag{14}$$

With the separate clearing of the first C classes of derivatives, the expected exposure of Entity i to the C different CCPs is instead

$$\begin{aligned} \hat{U}_i &= E\left[\sum_{k=1}^{C} \max\left(\sum_{j \neq i} X_{ij}^k, 0\right)\right] + \phi_{i,N,K-C} \\ &\geq E\left[\max\left(\sum_{k=1}^{C} \sum_{j \neq i} X_{ij}^k, 0\right)\right] + \phi_{i,N,K-C} \\ &= U_i, \end{aligned} \tag{15}$$

using the convexity of $\max(\,\cdot\,)$ and Jensen's inequality. That is, each entity has higher expected counterparty exposure with multiple CCPs than with a single CCP. This result formalizes the intuition of the example given in Section 3.3.

Proposition 2 *For an arbitrary joint distribution of bilateral exposures* (X_{ij}^k), *each entity's total expected counterparty exposure with* $C > 1$ *CCPs clearing derivative classes separately is greater than or equal to its total expected exposures with a single CCP clearing all* C *classes jointly.*

Similarly, any increase in joint clearing – that is, any reduction in the number C of CCPs obtained by combining different classes of derivatives clearing into the same CCP – reduces expected exposures. These comparisons are strict under non-degeneracy assumptions on the joint distribution of $\left(X_{ij}^k\right)$.

In Appendix B, we examine the case of separate CCPs for two groups of market participants. We show that whenever introducing a unique CCP for all market participants strictly reduces counterparty exposures, it is always more efficient to have one CCP than separate CCPs for each group of market participants.

IV. Conclusion

We show that the central clearing of one class of derivatives such as credit default swaps may reduce netting efficiency, leading to higher expected counterparty exposures and collateral demands. When multiple derivatives classes are cleared, it is always more efficient to clear them on the same CCP rather than on different CCPs. An obvious policy recommendation is a move toward the joint clearing of standard interest rate swaps and credit default swaps in the same clearing house.

Appendices

A Cross-Class Exposure Correlation

We now allow for the possibility that derivatives exposures are correlated across asset classes. For simplicity, we suppose that the correlation ρ between X_{ij}^k and X_{ij}^m does not depend on i, j, or the particular pair (k, m) of asset classes. (We continue to assume joint normality, symmetry, and equal variances.)

For entity-to-entity exposures, it would be reasonable to assume that ρ is small in magnitude, bearing in mind that this correlation depends in part on whether the exposure between i and j in one particular derivative contract is likely to be of the same sign as that of its exposure in another. For pairs of dealers with large matched-book operations, one might anticipate that ρ is close to zero.

The average total expected exposure without a CCP is

$$\phi_{N,K} = \frac{1}{\sqrt{2\pi}}\sigma(N-1)\sqrt{K(1+(K-1)\rho)}. \tag{16}$$

With a CCP for Class-K positions only, the average total expected exposure is

$$\gamma_N + \phi_{N,K-1} = \frac{1}{\sqrt{2\pi}}\sigma\left(\sqrt{N-1} + (N-1)\sqrt{(K-1)(1+(K-2)\rho)}\right). \tag{17}$$

The reduction in average expected exposure due to the introduction of a CCP for one class of derivatives is therefore

$$\theta(N, K) = \phi_{N,K} - (\gamma_N + \phi_{N,K-1}). \tag{18}$$

Proposition 3 *The introduction of a CCP for one class of derivatives reduces the average total expected exposure of an entity if and only of*

$$\theta(N,K) > 0 \Leftrightarrow \beta_K > \frac{1}{\sqrt{N-1}}, \tag{19}$$

where

$$\beta_K = \frac{1 + 2\rho(K-1)}{\sqrt{K(1+(K-1)\rho)} + \sqrt{(K-1)(1+(K-2)\rho)}}. \tag{20}$$

This result follows from the fact that

$$\theta(N,K) = \frac{1}{\sqrt{2\pi}}\sigma(N-1)\left(\sqrt{K(1+(K-1)\rho)} - \sqrt{(K-1)(1+(K-2)\rho)} - \frac{1}{\sqrt{N-1}}\right). \tag{21}$$

Rearranging terms, we have the result.

Figure 2 shows the mean reduction in average total expected exposure for various combinations of N, K, and ρ. (The reduction is scaled to the case of $\sigma = 1$.) Increasing the correlation between positions increases the relative netting benefits of a CCP, because between-entity netting is not as beneficial if cross-class exposures are positively correlated.[17] Indeed, one can show that

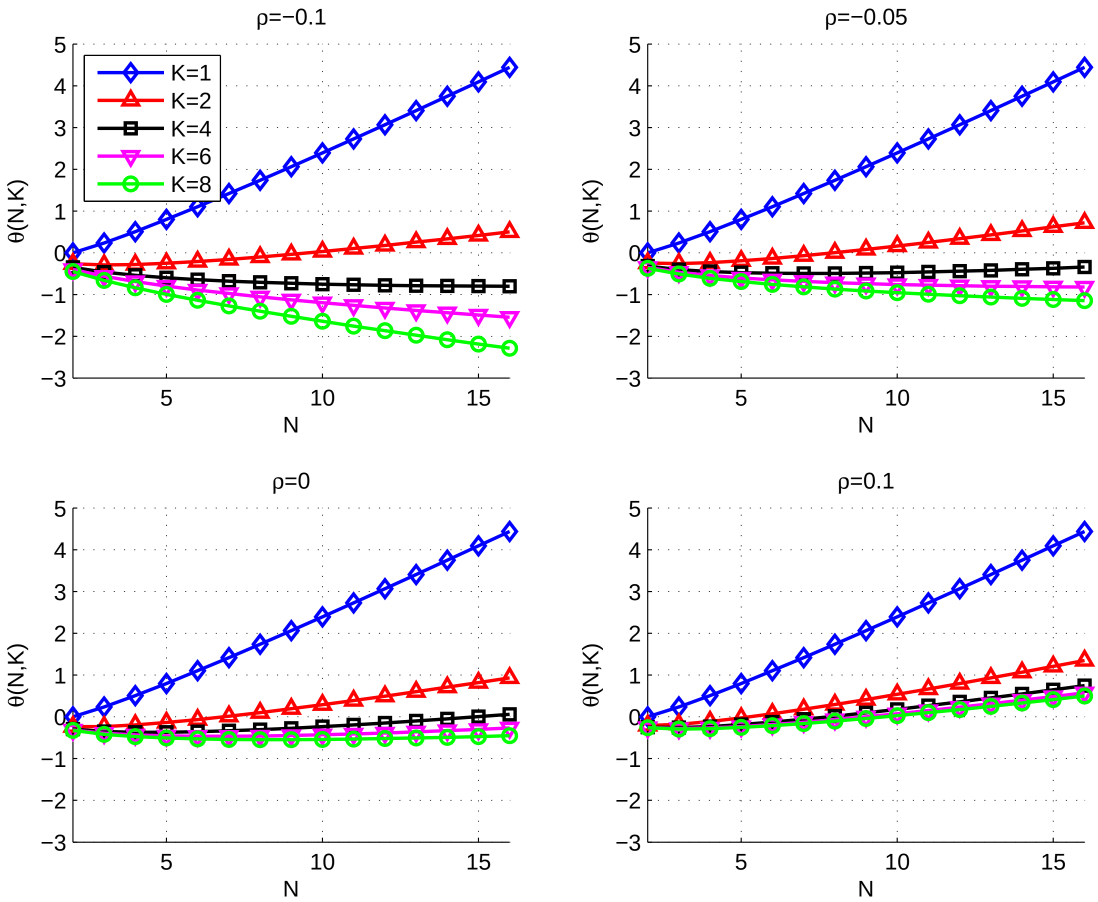
$$\frac{\partial\theta}{\partial\rho} = \frac{1}{\sqrt{2\pi}}\sigma(N-1)\frac{1}{2}\left[\frac{\sqrt{K}(K-1)}{\sqrt{1+(K-1)\rho}} - \frac{\sqrt{K-1}(K-2)}{\sqrt{1+(K-2)\rho}}\right] > 0. \tag{22}$$

Because dealers may have a tendency, especially when their counterparties are distressed, of entering derivatives trades that offset exposures arising in other classes of derivatives, we believe that extra emphasis should be placed on the case of negative ρ.

[17] For a fixed number N of entities, as the number K of derivatives classes gets large, β_K converges to $\sqrt{\rho}$, for $\rho > 0$. Thus, in this sense of increasingly many classes of derivatives, or more generally as the expected exposure in the class to be centrally cleared becomes small relative to that in other classes of derivatives, a CCP is asymptotically efficient if and only if $\rho > 1/(N-1)$.

Figure 2: Reductions in average expected exposures with a single CCP.

This figure shows the reductions (θ) in average expected exposures associated with clearing one class of derivatives with a single central clearing counterparty, based on N entities, K classes of derivatives, and a cross-class exposure correlation of ρ. The reductions are scaled for the case of $\sigma = 1$.



We calculate, treating N as though a real number, that

$$\frac{\partial \theta(N,K)}{\partial N} = \frac{1}{\sqrt{2\pi}}\sigma\left(\beta_K - \frac{1}{2\sqrt{N-1}}\right) \tag{23}$$

$$\frac{\partial^2 \theta(N,K)}{\partial N^2} = \frac{\sigma}{\sqrt{2\pi}}\,\frac{1}{4(N-1)^{3/2}} > 0. \tag{24}$$

The convexity of $\theta(N, K)$ with respect to N is evident from Figure 2.

B Separate CCPs by Entity Groups

In this appendix we consider the cost of having two CCPs, each dedicated to a particular group of entities, for the same class of derivatives. This separation of CCPs is different from that in Section III.. We return to our original assumption of independence of exposures across classes of exposures. We assume that the entities are partitioned into two groups for separate clearing, Group A with M entities and Group B with $N - M$ entities. We allow for the possibility that entities within a group have higher exposures with each other than they do with entities in the other group. Specifically, if entities i and j are in different groups, while i and n are in the same group, we let

$$q = \frac{E[\max(X_{ij}^k, 0)]}{E[\max(X_{in}^k, 0)]} \tag{25}$$

be the ratio of cross-group expected exposures to within-group expected exposures. We will always assume, naturally, that $q \leq 1$. Our assumptions are otherwise as before.

With the introduction of CCPs for Class-K derivatives, one for each group, we suppose that all entities continue to bilaterally net exposures on the remaining $K - 1$ classes, that they clear Class-K derivatives within their own group, and that they continue to bilterally net exposures on Class-K derivatives with those counterparties that are not in their own group. The total expected exposure of an entity in Group A, for instance, is therefore

$$\phi_{M,K-1}+q\phi_{N-M+1,K}+\gamma_M = \frac{1}{\sqrt{2\pi}}\sigma\left((M-1)\sqrt{K-1}+q(N-M)\sqrt{K}+\sqrt{M-1}\right). \tag{26}$$

For $M = N/2$, with N even, the average total expected entity exposure (in both groups) is

$$\begin{aligned}
& \frac{1}{2}\left(\phi_{M,K-1}+q\phi_{N-M+1,K}+\gamma_M+\phi_{N-M,K-1}+q\phi_{M+1,K}+\gamma_{N-M}\right) \\
= & \frac{1}{\sqrt{2\pi}}\sigma\left[\left(\frac{N}{2}-1\right)\sqrt{K-1}+\frac{qN}{2}\sqrt{K}+\sqrt{\frac{N}{2}-1}\right].
\end{aligned}$$

Similarly, with only one CCP, the average total expected entity exposure is

$$\frac{1}{\sqrt{2\pi}}\sigma\left[\left(\frac{N(1+q)}{2}-1\right)\sqrt{K-1}+\sqrt{\frac{N(1+q^2)}{2}-1}\right]. \tag{27}$$

We let $\Theta(N,K,M)$ be the reduction in expected exposures associated with two CCPs, over using one CCP for the same class of derivatives for all entities. For the case of $M = N/2$, we calculate that

$$\Theta(N,K,N/2) = \frac{1}{\sqrt{2\pi}}\sigma\left[-\frac{qN}{2(\sqrt{K}+\sqrt{K-1})}-\sqrt{\frac{N}{2}-1}+\sqrt{\frac{N(1+q^2)}{2}-1}\right]. \tag{28}$$

For $M = N/2$, having two CCPs is more efficient than having one CCP if and only if

$$\Theta(N,K,N/2) > 0 \Leftrightarrow \sqrt{K}+\sqrt{K-1} > \frac{1}{q}\left(\sqrt{\frac{N}{2}-1}+\sqrt{\frac{N(1+q^2)}{2}-1}\right). \tag{29}$$

Without any CCP, the expected exposure is

$$\frac{1}{\sqrt{2\pi}}\sigma\left(\frac{N(1+q)}{2}-1\right)\sqrt{K}. \tag{30}$$

Provided $M = N/2$, a unique CCP for all Class-K derivatives reduces average expected exposure, relative to no CCP, by

$$\delta(N,K,q) = \frac{1}{\sqrt{2\pi}}\sigma\left[\left(\frac{N(1+q)}{2}-1\right)(\sqrt{K}-\sqrt{K-1})-\sqrt{\frac{N(1+q^2)}{2}-1}\right]. \tag{31}$$

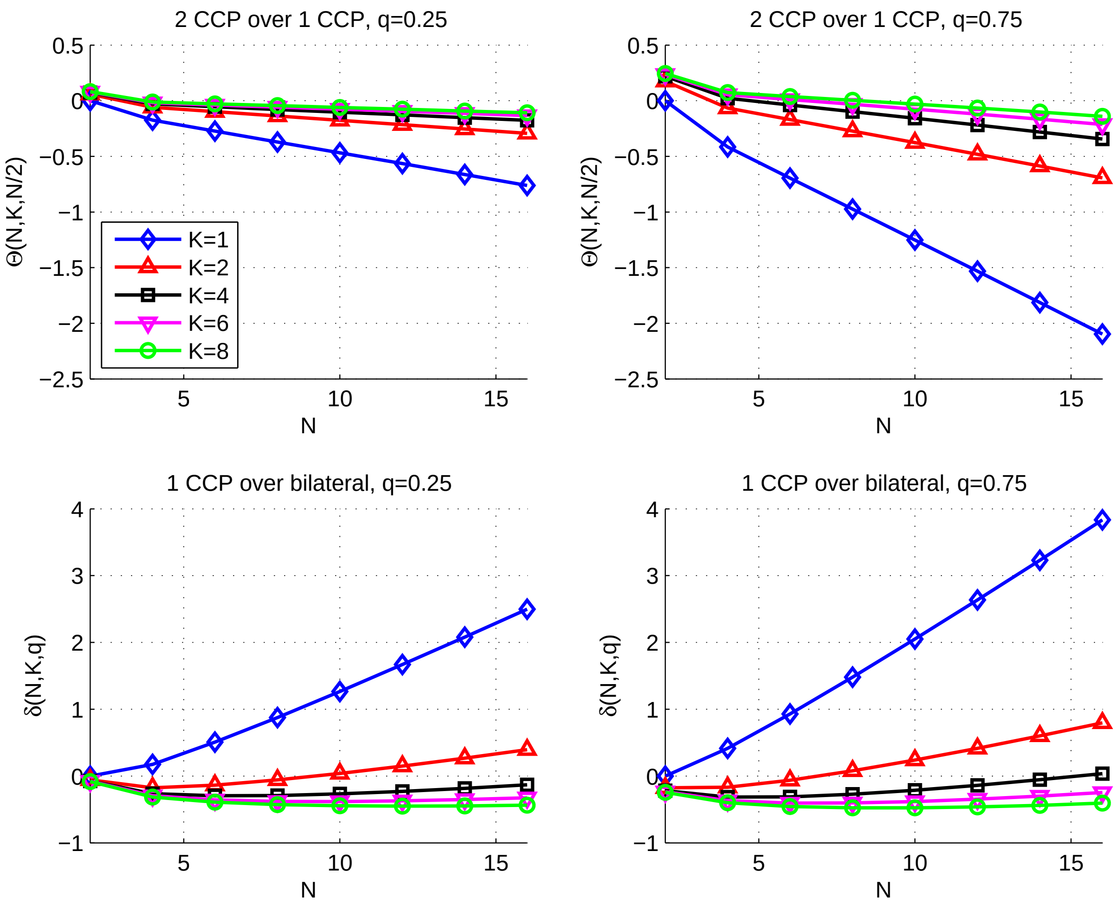
Having a single CCP for all entities improves efficiency, relative to having none, if and only if

$$\delta(N,K,q) > 0 \Leftrightarrow \sqrt{K}+\sqrt{K-1} < \frac{\frac{N(1+q)}{2}-1}{\sqrt{\frac{N(1+q^2)}{2}-1}}. \tag{32}$$

Comparing (10) and (11), for equally sized groups of entities, one can show that whenever introducing a unique CCP for all entities strictly improves efficiency, it is always more efficient to have one CPP than to have separate CCPs for each group of entities. This implication can also be observed in Figure 3.

Figure 3: Reductions in average total expected exposure allowed by having two CCPs.

The top panel shows the reductions (Θ) in average total expected exposures allowed by having two CCPs, one for each group of entities, relative to having one CCP for all entities. The bottom panel shows the reductions (δ) in average total expected exposures allowed by having one CCP relative to none (fully bilateral netting of exposures). The reductions are normalized by taking $\sigma = 1$.



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