WHY PROTECT FINANCIAL MARKETS?

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Abstract

The purpose of this paper is to estimate the benefits from adopting close-out netting to decrease the exposure to counterparty risk across the world markets and to establish the additional benefits from central counterparties towards decreasing counterparty risk. The novelty of the approach is to estimate a figure for counterparty credit risk (CCR) grouping together most of the financial transactions that generate counterparty risk and to analyze the benefit of netting possibilities in reducing the overall risk exposure, using three different scenarios. In the first scenario, counterparty credit risk is calculated assuming that no close-out netting is possible across different contracts. The second scenario assumes bilateral negotiations and netting across contracts. The third scenario contemplates the existence of a central counterparty as the center of transactions. Benefits from netting and central counterparty are assessed by comparing the risk exposure in each scenario.

Results from the model show that netting provides a decrease in world counterparty risk of over $17 trillion. Netting is thus a powerful tool available in the world markets to manage counterparty risk while decreasing systemic risk, and as such policies to facilitate and standardize netting procedures across different jurisdictions should be encouraged. Moreover, results show that the use of central counterparties for settling the outstanding contracts would additionally decrease CCR by over $2 trillion***.

Keywords: Counterparty Credit Risk, Central Counterparty, Close-Out Netting, Systemic Risk

JEL classification: G18, G28

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1 Introduction

The 2007 credit crunch and the subsequent crisis emphasized previously unnoticed facts about financial markets. One of them was the astonishing size of financial institutions when compared to national economies. On the other hand, the tacit insurance provided by governments to financial participants perceived as too big to fail. Society became worried. Suddenly an unwanted guest, recession, came into the scene. Public opinion and leading economists pointed their fingers at the financial industry as the origin of this chaos. Nowadays many topics related to financial markets are being examined, seeking to abolish the practices that may exacerbate risk again. This methodical revision has also included the legal framework that supports financial markets around the world.

Historically, financial markets (and therefore financial market participants) have been provided with a legal framework that is meant to foster a friendly environment and protect financial transactions in case of distress situations. When looking at the interlocking risks associated with financial markets, counterparty credit risk (CCR), i.e., situations where there is the risk that participants in a contract may not fulfill their obligations, is a main source of risk propagation, as it can build into systemic risk when a financial institution fails (i.e., risk that default will propagate to other counterparties). This paper analyses policies that impact on the exposure to counterparty risk and that have been under fire by new pressure groups.

The legal framework protects participants in financial transactions from CCR arising as a result of one or several participants becoming insolvent. Specifically, financial contracts have super senior priority over other creditors in an insolvency situation, with close-out netting (netting the difference of obligations derived from outstanding contracts when an institution fails) facilitating the immediate termination and settlement of outstanding derivative contracts. These protective mechanisms thus aim to reduce risk exposure and the consequent financial distress of market participants. For example, Mengle (2010) estimates that the loss of netting in derivatives markets would increase exposure by $22 trillion.

In the aftermath of the credit crisis in 2008-2009, the legal protection of participants in financial transactions has been criticized for a couple of reasons. Firstly, the legal protection did not prevent the contagion of risk as intended as it actually reduces incentives for adequate monitoring of counterparty risk by market players. In this case, derivatives and complex financial instruments, until that time supposed to help hedging risk, were accused of causing the cataclysm. Secondly, the super senior priority of financial transactions diminishes other creditors' recoveries when an institution becomes insolvent. In that vein, some scholars point out that policies established to protect financial markets can be fundamentally unfair with society as a whole (Roe, 2010). They argue that they provide a 'financial haven' where special rules apply that prioritize financial market participants at the expense of other stakeholders (e.g., lenders) when an institution turns insolvent. As a result, policies and practices that seem to favor financial markets are now seen with suspect and distrust. However, abolishing the protection of financial transactions would impact a market (both OTC and exchange market) worth more than $700 trillion. It would be anticipated that many insolvency clauses of derivative contracts would not be enforceable, with CCR dramatically increasing. Overall, negotiations would carry more risk and the ease of performing a transaction would decrease, therefore general liquidity would also decrease. The first research question is thus how would CCR exposure be affected by removing legal protection (close-out netting) from participants of all financial transactions?

Awareness of CCR has increased both for companies and policy makers since the credit crisis. Public policy and opinion have turned to the use of central counterparties, i.e., institutions that stand between the transactions of any two participants, as a mechanism to protect financial markets from systemic risk. As such, this paper investigates the impact of further encouraging the use of institutions such as clearing houses and developing models to increase the netting alternatives across different transactions and assets.The second research question is thus how would CCR exposure be affected by introducing settlements through central counterparties for all transactions?

The model used in this paper is built on Duffie and Zhu (2010) and JP Morgan (1997). Instead of a conceptual approach, the aim is to bring in some quantitative values to the discussion by providing estimates for the exposure to counterparty risk, as well as the potential risk reductions derived from the benefits of netting and central counterparties. The results suggest that netting reduces CCR by over $17 trillion. Moreover, the use of central counterparties for settling the outstanding contracts would additionally decrease CCR by over $2 trillion, or an additional benefit of 9% when compared to the current situation,
The results raise the question of whether the overall amount of new risks that would be democratized into the society by eliminating these procedures might be higher than the benefits of democracy per se. Therefore, the special legislation for dealing with financial markets may need to be protected. This legislation mitigates risk exposure in financial markets and increases wealth for society, thus avoiding the spread of unnecessary risks across all market participants.

The paper is organized as follows: Section 2 presents a review of the literature. Section 3 describes the mathematical framework used for running the simulation of credit exposure benefits from netting and using central counterparties. Section 4 discusses the results and the implications derived from them. Section 5 concludes.

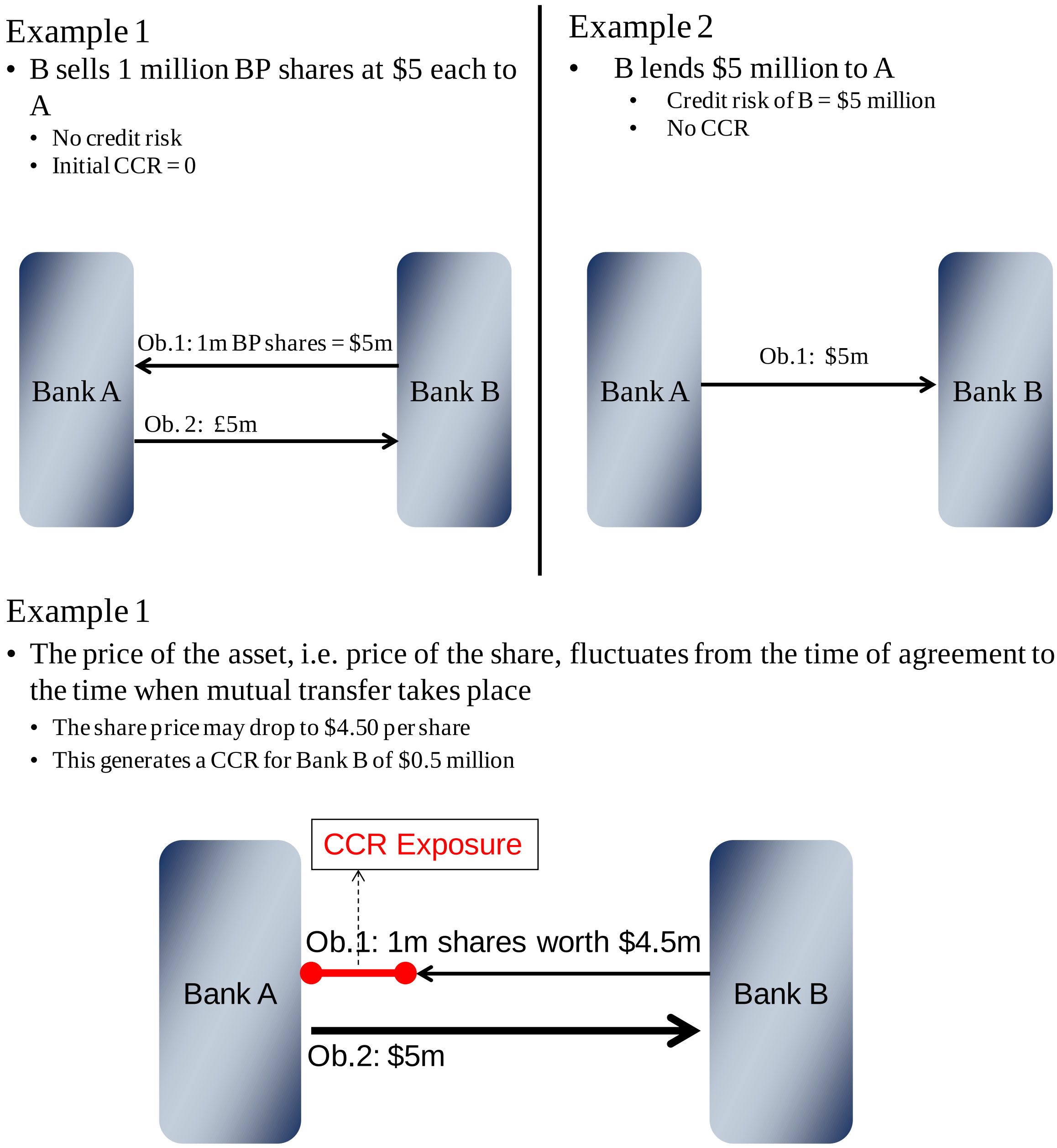
2 Literature Review

2.1 Operating Concepts

2.1.1 Counterparty Credit Risk

Counterparty risk in its broad sense results from any contract where two or more participants oblige to each other. The risk that any of the participants (counterparty) does not fulfill its obligations is called counterparty risk. For the specific case of financial markets the concept focuses on CCR. CCR is naturally present whenever two parties engage on a financial transaction. CCR risk is thus risk which arises as a result of a financial transaction between two parties of mutual obligations before settlement, where the economic value of the transaction fluctuates (e.g., when the price of the underlying asset fluctuates). For example, suppose Bank A buys 1 million BP shares at $5 each from Bank B. This transaction generates two mutual obligations for each of the participants of the deal.At the time when a financial transaction is agreed, the mutual obligations usually have the same economic value, in which case the initial CCR is nil. It should be noted that CCR is not the same as credit risk. Credit risk arises in transactions which include one unilateral obligation from one counterparty towards another. As soon as the transaction commences, the obliged counterparty generates credit risk towards the other party, e.g., when a bank lends money the borrower has the unilateral obligation to pay it back. As such, the credit risk exposure is equivalent to the value of the loan. The top part of Figure 1 shows these two situations, depicted as Examples 1 and 2, respectively.

Figure 1. Counterparty credit risk versus credit risk



After both parties comply with their obligations, i.e., Bank A has transferred the money to Bank B and Bank B has transferred the shares to Bank A, the transaction finishes and CCR disappears. However, before both parties fulfill their obligations, there is a possibility that one of them does not meet the obligation. To simplify, suppose that a special mechanism is set to guarantee that both transfers occur simultaneously, in such a way that there is no possibility of one counterparty owing the other at any time during the settlement of the transaction (a standard practice of delivery versus payment is an approximation to this situation). Now, suppose Bank A does not meet the obligation to deliver the cash. In this case, what happens is that Bank B will then also refrain from delivering the shares to Bank A and the transaction is never completed. Since neither side gave anything away it seems there was no loss and therefore that CCR risk had no financial effect on the counterparties. However, the reality of financial markets is that most of the times one of the participants makes a loss when the transaction is not completed. In theory, the loss is equivalent to the gain the other counterparty makes when the deal is broken (Hull, 1997).

The reason for this situation is the time gap between the moment when the deal is closed and the moment when it is settled. Since in financial markets stock prices change minute by minute, the buyer of the shares (Bank A) would have made a profit/loss proportional to any price movement during the settlement period. Therefore, Bank A could be the contractual owner of an asset with less value than what it was paying for. Correspondingly, Bank B would have the obligation to deliver an asset with less value than the money it would receive in exchange. If the transaction fails to settle, Bank B will realize a loss proportional to this price difference. Figure 1 depicts the situation of a 50-cent drop in price, which generates a CCR exposure of $0.5 million for Bank B.

The first lesson from this example is that the risk exposure is proportional to the variation of price from the moment the deal is closed. In case the prices did not change, no risk would arise. The second lesson is that the exposure to CCR does not imply a loss equivalent to the overall amount of the transaction. The loss is related to the fluctuation on the value of the contract.

Two concepts often used when referring to CCR will be introduced. The notional value refers to the total amount of the transaction generating the exposure. The exposure value is what the counterparty that has a positive value contract would lose if the transaction failed to settle. As the example shows, the exposure value is much less than the notional value. The exposure value is closely related to the price fluctuation of the underlying asset of the transaction. The same principles are fundamentally true for most financial transactions. A formal definition of CCR can be found from the Basel Committee on Banking Supervision (2006):

'The counterparty credit risk is defined as the risk that the counterparty to a transaction could default before the final settlement of the transaction's cash flows. An economic loss would occur if the transactions or portfolio of transactions with the counterparty has a positive economic value at the time of default. Unlike a firm's exposure to credit risk through a loan, where the exposure to credit risk is unilateral and only the lending bank faces the risk of loss, the counterparty credit risk creates a bilateral risk of loss: the market value of the transaction can be positive or negative to either counterparty to the transaction. The market value is uncertain and can vary over time with the movement of underlying market factors.' (Basel Committee on Banking Supervision, 2006, p. 19)

Within this context, default means that the counterparty does not live up to meet its contractual commitments. Most spot transactions as the one previously described carry relatively small CCR exposure. Therefore, when compared with other credit commitments, for example the credit risk linked to inter-bank deposits, CCR exposure is much smaller, which means that in these situations counterparty risk is normally ignored.When the time gap between the closing of the deal and the final settlement of the transaction increases the CCR can also increase. In transactions with a greater time gap CCR exposure may build up, as the time to settlement goes by. In these cases the potential risk when the transaction starts is higher. Derivatives are transactions that are normally settled in the future, and the final settlement date in some cases can even extend several years into the future. For this reason, they are considered the biggest source of counterparty risk exposure.

Nevertheless, no matter how big the exposure is, CCR risk only turns into a loss when the counterparty really defaults to meet its obligations settling a transaction. Until recent years, the possibility of default by counterparties with the highest credit scores was perceived to be almost zero. Therefore, in practice many market participants perceived no risk when dealing with these counterparties. However, after the credit crunch and the failure of Lehman Brothers, perception has somewhat changed. Nowadays not even AAA graded national governments are seen as completely safe (Kaso, 2010).

2.2 Settlement Netting

In a practical sense, set-off is the settlement of reciprocal obligations between two counterparties by transferring the net difference. From a legal point of view, each debtor uses its claims to settle its debt instead of using cash. In other words, '...he uses the claim owed to him to pay the claim he owes' (Wood, 2007, p. 4).

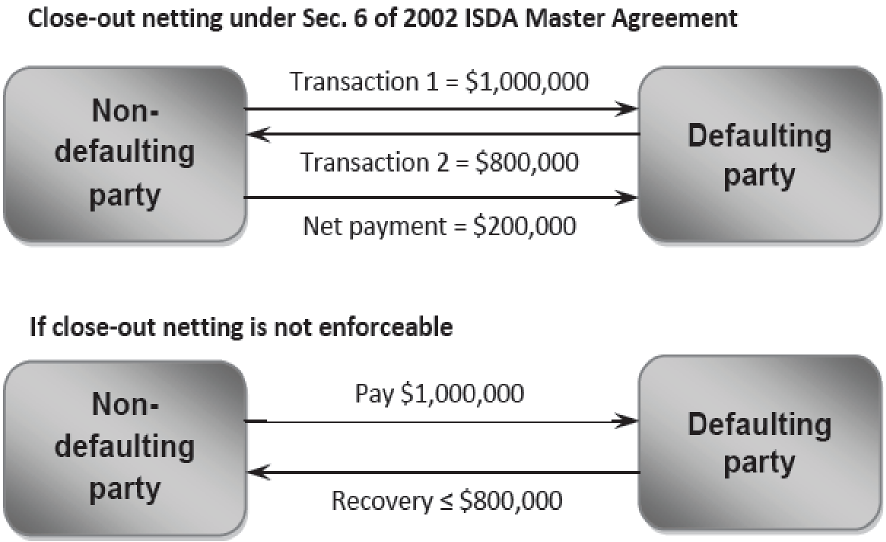
Suppose Bank B has two non-delivery forward contracts with Bank A expiring on the same day. For the first contract, A has the obligation to pay £100,000 to Bank B. For the second contract, Bank B is obliged to pay £100,000 to Bank A. For settlement purposes, no counterparty transfers money and the obligations offset each other. Notice that the possibility of set-off is crucial for the CCP efficiency.

The implication of no set-off is that the exposure to the counterparty is always equivalent to the total gross amount of obligations that the counterparty has towards the participant. Any offsetting obligation towards the counterparty will not diminish the amount.

2.3 Close-Out Netting

The objective of close-out netting is to reduce the exposure of open contracts still to be performed by both counterparties if one of them becomes insolvent before the maturity date (Wood, 2007). In this type of netting, when a counterparty becomes insolvent outstanding contracts are cancelled at their current market price (negative exposure offsets positive exposure) and the resulting net liability ends up being the final exposure, following Sec. 6 of the 2002 International Swaps and Derivatives Association Inc (ISDA) Master Agreement. Figure 2 depicts an example of close-out netting. Because of the need to cancel the contracts at market prices, the term replacement netting is also used. Regulation about insolvency, a very crucial instance of CCR, is full of specific details and variations across different regulatory jurisdictions.

Figure 2. Close-Out Netting



Source: ISDA Research Notes 2010

2.4 Central Counterparties

Shifting transactions across markets to central counterparty (CCP) clearing houses is one of the regulatory trends that have evolved during the past few years (Glass, 2009). Central counterparties are seen as a key element to decrease CCR risk as central counterparty's activities can enable them to avoid duplicate off-setting transactions. They are neutral to market risk because of their matched positions and spread the default risk from one counterparty to all members. During the settlement of transactions the clearing house is a mechanism to avoid direct credit risk.

When the CCP stands in the middle of the settlement between two counterparties, for example a deal to buy securities, it receives the cash from Bank A and it receives the securities from Bank B. When both counterparties have fulfilled their obligation, so the clearing-house has both the cash and the securities, it closes the deal and transfers the corresponding part to each counterparty. Suppose the trading day starts and Bank B buys 1 million shares issued by company X from Bank A at $3.40, which is actively selling shares. Later in the day, the price rises and Bank B decides to profit from the situation by selling the X shares to Bank C at a price of $3.50. Later on a trader at Bank A notices he was so active selling shares that he actually is 1,000,000 short of X shares to deliver. Bank A calls Bank C to ask if they have any shares. Since Bank C has just bought 1 million of them, they decide to sell them to Bank A at $3.60. The last trade is not profitable for Bank A but it now has enough shares to settle the deal with Bank B. CCP clearing is effective at reducing the spread of risk. Without a CCP, Bank A would inevitably default its $3,400,000 transaction with Bank B. Consequently, unless Bank B had some additional shares, it might also end up defaulting on its transaction with Bank C. With a CCP, all banks would send their trading orders to the CCP which could then cross-reference all transactions. Bank A bought 1 million shares at $3.60 from Bank C and sold 1 million shares at $3.40 to bank B. Bank B bought 1 million shares at $3.40 from Bank A and sold 1 million shares at $3.50 to bank C. Bank C bought 1 million shares at $3.50 from Bank B and sold 1 million shares at $3.60 to Bank A. To settle the transactions the CCP would transfer $100,000 from Bank A's account to Bank C's account and $100,000 from Bank A's account to Bank B's account. This action means that six transactions with a gross value above $18 million were settled by transferring only $200,000, which results in the increase of efficiency and reduction of risk.

Central counterparties may also increase market efficiency by offsetting redundant transactions before settlement. One example is a situation where at the end of the day, after the netting of transactions, A owes $1m to B and B simultaneously owes $1m to C. The central counterparty will increase efficiency by settling the two unrelated transactions by just one money transfer of $1m from A to C.

Clearing of OTC derivative contracts is more sophisticated than clearing of spot transactions (Glass, 2009). The central counterparty in a derivative market stands in the middle of the transaction using the novation (clearing) legal figure, which means that the original derivative contract between the two counterparties A and B is transformed into two contracts. In the first contract, the CCP buys from A and in the second contract the CCP sells to B. The CCP has no market risk since both contracts are netted. However, it now has the CCR risk of the two counterparties. In fact, the CCP carries the risk of all transactions it is clearing, which implies an enormous amount of risk concentration on the CCP.

In sum, CCP stands between the participants in a transaction. As a result, the effect of an insolvent counterparty spreads among all participants, instead of concentrating on its direct counterparties, thus virtually eliminating CCR for market participants as the risk is concentrated on the CCP. However, systemic risk would arise if the CCP became insolvent.

2.5 Empirical Studies

A report by the Bank for International Settlements (2009) calculates the notional value of derivative contracts to be $693.5 trillion. However, studies about counterparty risk have mostly focused on research related to credit default swaps (CDS). Although this category of derivatives attracts the attention because of the particularity of exposing the buyer to a binary large jump risk exposure (Deutsche Bank, 2009), it represent less than 15% of the market exposure (Comptroller of the Currency Administrator of National Banks 'OCC,' 2009).

Chan-Lau and Li Lian (2007) derive a methodology based on vector auto regression which estimates relative CCR exposure in the CDS market. Institutions are ranked by relative sensitivity but no absolute exposure value is calculated. Barclays Bank (Barclays, 2008) studies the credit derivatives market, estimating that losses could range from $36 to $47 billion. They point out however that these results are not to be extrapolated to other categories. Segoviano and Singh (2008) model cascade effects after a default for the whole spectrum of the derivatives market. They propose a 'Distress Dependence Matrix' to estimate CCR exposure. Their approach is to calculate a weighted average of exposure value by the probability of occurrence, and estimate that the total loss after a cascading effect is in the region of $1.5 trillion.

Two papers provide interesting insights on netting and central counterparties. Some research by International Swaps and Derivatives Association Inc (ISDA) explores the importance of close-out netting for the OTC derivative markets (Mengle, 2010). Based on data from the Bank for International Settlements they estimate that the loss of netting would mean an increase of exposure in the order of $22 trillion. Their estimate is based on a comparison of gross market value to netted credit exposure. They focus specifically on bilateral netting and no estimate of the benefits of central counterparties is made. Duffie and Zhu (2010) present a model which estimates the efficiency of central counterparties in reducing CCR in the derivatives market. They show that as the number of central counterparties increases, the efficiency of the central counterparty as a protector of financial markets decreases. As such, they suggest that the optimal number of central counterparties operating in the derivatives markets is one.

3 Data and Methodology

3.1 Data

One of the objectives of the research was to gather information from data sources that provided an adequate standard. The first criterion was to use information to be publicly available on a periodic basis. The second criterion was to use data published by government or regulated bodies. When information was not directly available from government sources, reports from financial institutions submitted to regulatory bodies (e.g., annual financial reports) were used.

Major clearing-houses were targeted as possible sources of market information. For the US financial markets, the International Derivatives Clearing Group was contacted. For Europe, LCH.Clearnet was contacted, and for Asian markets, HKEX based in Hong Kong. However, public available information from these sources was very limited and most of the historical statistics are available to members only. Therefore, it was not possible to use the valuable data from these companies. Nevertheless, HKEX did provide broad extensive information on daily operation volumes (HKEX, 2010). These data were used for estimating volumes in Asian markets. Values for the OTC market on futures, swap, and option derivatives were taken from the reports from the BIS (BIS, 2009) and (BIS, 2010). The classification of contract types used in this paper is based on the categories defined by reports from the Bank for International Settlements. These data was compared to figures published by the International Swaps and Derivatives Association Inc (ISDA) and Comptroller of the Currency Administrator of National Banks (OCC).

When considering data from different sources, values are not directly comparable since every source uses different grouping categories. Therefore, discretional grouping of some categories needed to be performed. For example, values for swaps and futures were grouped together. The comparison shows that overall, values do vary across different sources however differences are normally less than 10%. This range of differences was to be expected, since each source has a different set of reporting entities and the reporting period is not the same for all institutions (Comptroller of the Currency Administrator of National Banks 'OCC,' 2010; BIS, 2010; International Swaps and Derivatives Association Inc 'ISDA,' 2010).

Data used for the European market is based on the reports from the Bank for International Settlements (BIS, 2010) and historical reports from the International Swaps and Derivatives Association Inc (ISDA, 2010). Data used for the America market is based on the Federal Financial Institutions Examination Council (FFIEC, 2010), Comptroller of the Currency Administrator of National Banks (OCC, 2010), and the K-10 & Q-10 reports filed by major financial institutions in the US.

3.2 Methodology

The objective of this analysis is to estimate the benefit that netting provides for the overall CCR in the markets, using real world data processed under three different scenarios. The analysis was directed towards the following cases:

1. The benefit derived from a situation where close-out netting is available, compared to a situation where close-out netting is not available to the participants;
2. The benefit derived from a situation where close-out netting is available but there is no CCP, compared to a situation where close-out netting is available and there is a unique CCP that concentrates all contracts.

The measurement of CCR used in this paper builds on Duffie and Zhu (2010) and the document on Credit Risk by JP Morgan (1997). The model from Duffie and Zhu (2010) is especially useful when aggregating the risk of exposure under no netting situations. The interpretation of overall market exposure is based on their definition. A reasonable measure of the overall CCR in a market structure is the sum, across entities, of the total expected absolute counterparty exposures. The document on Credit Risk by JP Morgan (1997) presents a model for risk exposure based on the correlation of the underlying assets. Principles of this model are incorporated in this study for modeling CCR exposure in situations where close-out netting is possible, and therefore the efficiency benefits of correlations across assets are possible. Duffie and Zhu (2010) also discuss central counterparties and present a model that provides evidence that efficiency benefits from central counterparties could be lost due to a fragmentation of clearing services. This work follows the same principles of their methodology and applies it to the latest available data, considering one central counterparty only.

Model. Consider that the market is composed of *N* participants. The financial industry is highly concentrated, with the biggest 14 participants accounting for more than 95% of all transactions of the market (BIS, 2010). Assume that each of these entities is able to engage in transactions with any of the other *N-1* participants, so there are no geographical restrictions. Divide the asset classes in *D* different categories of transactions. Two transactions are classified in the same category if they share the same risk profile. To share the same risk profile the transactions must satisfy the following conditions:

i. The underlying asset should belong to the same asset class

ii. High correlation of assets prices

iii. Similar functional relation between underlying asset price movements and risk exposure

Suppose that participant *i* has a contract *k* that belongs to category *d* with entity *j*. The expression *bre(i,j,k,d)* is the *basic risk exposure* of entity *i* to *j* (from *N* participants), due to the specific contract *k* that belongs to the transaction category *d* (from *D* different categories of transaction). In other words, the amount that *j* owes *i* due to the *k*th agreement in the transaction category *d*. '*bre*' is thus the basic unit of CCR exposure across the participants in the market. If the value of the contract were negative for *i*, such that on a specific date participant *i* owes *j*, the basic risk exposure *bre(i,j,k,d)* would be negative.

Each of the *bre(i,j,k,d)* has an uncertain value because the level of exposure that would exist on a typical trading day cannot be known with anticipation. To deal with this uncertainty, the analysis will be done by modeling each exposure as a random variable following the normal distribution. In the situation where all contracts belong to the same transaction category, say transaction category *d*, the random variables will be driven by the same parameters. As a result, assume that the correlation of the random variables that describe the exposure for the same transaction category will be equal to 1. From the definition of *bre* it can be seen that the expression is symmetrical between the counterparties of the operation, and as such it can be assumed that *E[bre(i,j,k,d)] = 0*. Under these assumptions, the exposure will be related to the standard deviation of the random variable. The measure of the overall CCR in a market structure would be the sum, across the *N* participants of the total counterparty risk exposures *CR(i)*.[1]

Scenario with bilateral close-out netting with no CCP. In situations where close-out netting is possible across all contracts the total exposure can be expressed as the direct sum of the basic risk exposures of all contracts. The aggregate exposure will be relevant only if the value is positive, otherwise it is considered nil. Let *R(i,j,d)* be the *total exposure* due to all *K* contracts within transaction category *d*:

$$R(i,j,d) = \max\left(\sum_{k=1}^{K} bre(i,j,k,d), 0\right) \qquad (1)$$

In the case of close-out netting across all contracts it is possible to net obligations across all types of contracts with the same counterparty. However, obligations with different counterparties would still not be netted. The expression for the *aggregate consolidated risk exposure for counterparty i,CR(i),* is:

[1]The model disregards collateral and data on bilateral counterparty relationships due to availability issues.

$$CR(i) = \sum_{j=1\ j\neq i}^{N} \max\left[\left(\sum_{d=1}^{D}\sum_{k=1}^{K(i,j,d)} bre(i,j,k,d)\right),0\right] \quad (2)$$

The expression to be evaluated for this scenario does not include the maximization function within the inner sum. However the maximization is still present within the last sum. For this situation the framework based on the standard deviation of the random variable was used. Let *NV* represent the *notional value* of the contract, then the exposure can be formulated as the multiplication of this number by the random number *X*. In that case:

$$E[R(i,j,d)] = \max\left(E\left(\sum_{k=1}^{K} NV(i,j,k,d)\times X(i,j,k,d)\right),0\right) = \max\left(\sum_{k=1}^{K} NV(i,j,k,d)\times E[X(i,j,k,d)],0\right) \quad (3)$$

As previously discussed, the exposure will be related to the standard deviation of the random variable. The *aggregate expected risk exposure r(i,j,d)* across the same transaction category *d* is thus:

$$r(i,j,d) = \max\left(c(d)\times\sigma_X\times\left(\sum_{k=1}^{K} NV(i,j,k,d)\right),0\right), \quad (4)$$

Where *c(d)* is the proportionality constant for transaction category *d*; σ_X is the value of the standard deviation of the random variable *X*; *NV(i,j,k,d)* is the notional value of the exposure to transaction category *d* between counterparties *i* and *j*.

It can be seen that for modeling scenarios where netting is possible across different groups of contracts with the same underlying risk, the expected value of the *CCR is proportional to the gross value of the contracts*. Following Duffie and Zhu (2010) who cite BIS data, it is assumed that the net exposures in all asset classes are in the region of 15% of the gross credit exposures, which was found for the derivatives markets. The parameters of the volatility vector and the correlation matrix may be estimated using financial market historical data. With these parameters and information on the notional value of the outstanding deals in the market, an estimation of the overall credit exposure for every market participant is possible.

When netting is allowed, the standard deviation can be approximated using the methodology described in the Credit Metrics document (JP Morgan, 1997). Specifically, the volatility of the overall exposure can be expressed as a linear combination of the standard deviation of the individual variables and correlations between them. Generalizing to *D* different transaction categories the expression can be written as a matrix product. The first component of the matrix product would be the column vector *A* composed of the product of the notional values, the proportionality constants (15%), and the standard deviations. The second component would be a *D*×*D* square matrix *C* with the correlations among the different asset classes (JP Morgan, 1997). Specifically,

$$CCR = [(\mathrm{C}\times\mathrm{A})'\times\mathrm{A}]^{1/2} \quad (5)$$

Scenario with no close-out netting. The calculation of *R(i,j,d)* depends on the netting alternatives. When netting is not possible the exposure is equivalent to the gross amount owed, and this amount is not offset by obligations towards the counterparty (Woods, 2007). If there is no netting every contract is independent of the others and the same is true of the obligations for each contract. This situation can be modeled using the *rre(i,j,d,k) relevant risk exposure* expression:

$$rre(i,j,k,d) = \max(bre(i,j,k,d),0) \quad (6)$$

And *R(i,j,d)* is thus given by:

$$R(i,j,d) = \sum_{k=1}^{K} rre(i,j,k,d) = \sum_{k=1}^{K} \max(bre(i,j,k,d),0) \quad (7)$$

It can be seen that $R(i,j,d)_{\text{WithoutNetting}} \geq R(i,j,d)_{\text{With Netting}}$.

The expression for the *aggregate consolidated risk exposure for counterparty i,CR(i),* is:

$$CR(i) = \sum_{j=1\ j\neq i}^{N}\sum_{d=1}^{D}\sum_{k=1}^{K(i,j,d)} \max(bre(i,j,k,d),0) \quad (8)$$

This expression was used when establishing the aggregate exposure amount when no possibilities of netting are assumed (Duffie and Zhu, 2010). Excluding close-out netting the expression for aggregate exposure includes the maximization function within the sum, so the expected value cannot be factored out from the expression. For this situation the expression derived from the expected absolute value of the random variable was used. Using the same assumptions of the previous section, *rre(i,j,k,d)* can be expressed as:

$$rre(i,j,k,d) = c(d)\times NV(i,j,k,d)\times X(d) \quad (9)$$

Let *X* represent the random variable and *NV* the notional value of the contract. The expected value of the exposure would be given by the sum of the maximization function of the exposure and *0*. The *aggregate expected risk exposure r(i,j,d)*across the same transaction category d can be represented by the conditional expression:

$$r(i,j,d)=E\left[\sum_{k=1}^{K}\begin{cases}NV(i,j,k,d)\times X(i,j,k,d) & ,if\ (NV\times X)>0\\ 0 & ,if\ (NV\times X)\le 0\end{cases}\right] \quad (10)$$

Assuming symmetry of the probability distribution of X then:

$$E[X>0]=E[X<0]=\frac{1}{2}E[|X|] \quad (11)$$

And $r(i,j,d)$ can be represented by:

$$r(i,j,d)=\frac{1}{2}E[|X|]\times\sum_{k=1}^{K}|NV(i,j,k,d)| \quad (12)$$

It can be seen that when close-out netting is not allowed across different groups of contracts, the expected value of *CCR is proportional to half the gross value of the contracts*.

The exposure can be calculated using the result for the central absolute moments of the distribution. The central absolute moments of the normal distribution are given by:

$$E\left[|X-\mu|^{p}\right]=\sigma^{p}\times(p-1)!!\times\begin{cases}\sqrt{2/\pi}, & if\ p\ is odd\\ 1, & if\ p\ is even\end{cases} \quad (13)$$

Where ‘$(p-1)!!$’ denotes double factorial of $(p-1)$, i.e., the product of every odd number from $(p-1)$ to 1. The first moment can thus be computed as:

$$E[|X|]=\sigma\times\sqrt{2/\pi} \quad (14)$$

In the general case of a no-netting scenario, a closed-form analytical solution is not possible. The assumption is that the aggregate result for say two random variables, a and b, has a lower bound given by:

$$r(i,j)(a,b)\ge\frac{1}{2}\sqrt{\frac{2}{\pi}}\sigma(Sa)+\frac{1}{2}\sqrt{\frac{2}{\pi}}\sigma(Sb) \quad (15)$$

This expression stands for the *aggregate expected counterparty credit exposure* of two transaction types. In order to evaluate the exposure to more transaction types, an iterative use of the equation may be applied. Notice that in this case the correlation between the asset classes has no effect on the final value. Generalizing the expression to all D assets gives the *aggregate expected risk exposure r(i,j):*

$$r(i,j)=\frac{1}{2}\sigma\times\sqrt{\frac{2}{\pi}}\times\sum_{d=1}^{D}|NV(i,j,d)| \quad (16)$$

And CCR is given by the sum of all $r(i,j)$ exposures.

Scenario with close-out netting and a CCP monopoly of the market. The central counterparty activity within the market can be modeled as a new participant N+1. The CCP is engaged in transactions with all the other counterparties. In this case, through the novation of existing contracts between every two counterparties A and B, each previous contract will be transformed into a pair of contracts. In the first one the central counterparty is say the buyer to counterparty A and in the second one the central counterparty is the seller to counterparty B. For the CCP it is not possible to use the close-out bilateral netting to offset its exposure across the counterparties because each is a different counterparty. However for the rest of market participants, all contracts previously agreed with different counterparties are now grouped in a unique set of contracts with only one counterparty, the central counterparty.

According to Duffie and Zhu (2010), the average counterparty i expected exposure in the presence of one CCP for one class of assets (derivatives) has two components. Firstly, the expected exposure to the other N-1 counterparties for the remaining K-1 asset classes. Secondly, the exposure to the CCP for the K contracts in category D novated to the CCP. In this case where all contracts and categories are novated by the same CCP the overall CCR is given by the CCP exposure:

$$CCR=\sum_{i=1}^{N}\max\left(\sum_{j=1\,j\neq i}^{N}\sum_{d=1}^{D}\sum_{k=1}^{K(i,j,d)}bre(i,j,k,d),0\right) \quad (17)$$

The framework for the computation will be based on the expected absolute value of the random variable, similarly to the no close-out netting scenario.

4 Results

4.1 Data Analysis

CCR in financial markets is mostly driven by derivative transactions, essentially because derivative contracts have longer maturities than spot contracts. Correspondingly, greater changes in the underlying asset prices may drive the value of the contracts away from equilibrium. When the value of the contract is not zero, or the value to replace an existing contract is not zero, one of the counterparties (the one with the positive value of contract) is exposed to CCR from the counterparty with negative value.

Data gathered for the aggregate global market in the last quarter of 2009 is presented in Table 1. The information is divided by contract type and also by the OTC or Exchange Markets. The value of the overall gross notional amount of contracts, including those traded on the most relevant Exchanges is $701.4 trillion. Although the OTC market has the biggest share of the overall market, in some cases the distribution is fairly equitable, e.g., option contracts on equity are almost evenly distributed. For this type of contracts the Exchange market share is 50.2% while the OTC share is 49.8%. Another example is with option contracts on commodities, where Exchanges have a clear advantage on the market share with 69% of the $2.7 trillion commodity options market. However these are the only two exceptions. The dominance of the OTC market over the Exchange market is evident. This situation may also be seen as a source of concern, since most Exchanges incorporate the figure of a central clearing house to mitigate CCR risk. However, values show that most transactions concentrate on OTC, the riskier environment.

Table 1. Gross value of transactions exposed to CCR (Q4 2009) (Thousands of Dollars)

Underlying Asset	Contract Type	Gross OTC Value	Exchange	Total
Interest Rate	Futures and Swaps	400,485,000	20,628,000	421,113,000
Currency	Futures and Swaps	39,638,298	164,000	39,802,298
Equity	Futures and Swaps	1,829,872	965,000	2,794,872
Commodity	Futures and Swaps	2,098,091	360,000	2,458,091
Interest Rate	Options	48,807,609	46,429,000	95,236,609
Currency	Options	9,558,071	3,610,000	13,168,071
Equity	Options	4,761,575	4,807,000	9,568,575
Commodity	Options	845,923	1,880,000	2,725,923
Bonds	Repo Agreements	8,350,000	-	8,350,000
Bonds	Credit Protection	32,692,694	-	32,692,694
Various	Other	73,456,382	-	73,456,382
		622,523,515	78,843,000	701,366,515

Sources: Office of the Comptroller of the Currency in the US, Bank for International Settlements, Central Banks

The table shows that most of the derivatives market transactions are concentrated in derivative contracts related to interest rates. These contracts represent nearly $450 trillion of the outstanding gross volume in the OTC market, or 72.2%. These contracts also account for a big share of the transactions in Exchanges amounting to nearly $67 trillion, representing 85.1% of the Exchange market derivatives. There is however a difference on the specific type of contract that dominates across markets. In the case of the OTC markets, the main contract type is related to Interest Rate Swaps (IRS). IRS makes for 89% of the total interest rates related contracts. On the other hand, in the Exchanges the main contract type is tied to options on interest rates, representing 69% of the total volume.

Detailed information on the derivative exposure from OTC and Exchange Traded contracts for each specific participant is only available from the Office of the Comptroller of the Currency in the US. The Bank for International Settlements provides data on OTC derivatives exposures of dealers in the most relevant asset classes. Though the information does not incorporate the add-on exposure implications of marking to market, it still gives an approximate value of outstanding volumes. The overall gross exposure amount is calculated before netting and collateral, and grouped by each of the basic underlying asset classes (transaction categories).

Information for the exposure to the Repo market was collected from Central Banks websites in different countries. In the US the market capitalization for the Repo market has an estimate value of around USD $5 trillion, which is slightly above 30% of the US GDP. While the US Repo market is dominated by US Treasuries as the main collateral, other collaterals are also actively used such as bonds issued by government-sponsored agencies, agency mortgage-backed securities (MBS), and corporate bonds.

In Europe, the Repo market has been growing to reach more than $3 billion of market capitalization: 66% of collateral comes from central government bonds from the Euro area countries, 16% from other Euro area entities, and 12% from other OECD countries. German collateral represents 25% of the market, followed by Italian and French collateral.The UK Repo market is substantially smaller than its overseas equivalent in the US, with an estimated size of about $450 billion. In this case, gilts are the main collateral. Whereas maturities are evenly concentrated among shorter and longer than 1 month, repo markets turnover of deals are highly concentrated in short maturities, with only 5% being longer than one month.

For the derivatives contract analysis, information from the US market was grouped into the same categories of major underlying assets used by the BIS. The analysis was performed using information for the US five biggest banks and a Dummy Bank, which summarizes the positions from the rest of US participants. Since US banks are the only ones with detailed information per transaction category, the model for non-US participants was modeled based on assumptions extrapolated from the US banks. The procedure was to spread the difference between the values for the whole world and the values for the US markets. The values for banks outside the US were spread across another five big dealers though they were not evenly distributed to each non-US dealer. Instead, the distribution followed the same ratios of the US banks. Using these assumptions all ten banks and the Dummy Bank were included in the model.

Therefore, the world exposure is assumed to be concentrated on the top ten dealers (banks) in the financial markets, with the remaining exposure being fragmented across the rest of the market participants. Table 2 shows the summary of the assumed market share per transaction for the 11 modeled entities.

Table 2. Assumptions on gross exposures of market participants (Millions of Dollars)

Underlying Asset	**Contract Type**	**Bank 1**	**Bank 2**	**Bank 3**	**Bank 4**	**Bank 5**	**Bank 6**
Interest Rate	Futures and Swaps	51,007	30,197	35,188	23,176	2,275	60,128
Currency	Futures and Swaps	9,143	5,557	117	4,439	1,137	628
Equity	Futures and Swaps	361	633	192	144	64	75
Commodity	Futures and Swaps	324	3	6	27	33	526
Interest Rate	Options	9,852	3,260	4,330	6,143	426	15,290
Currency	Options	766	253	337	478	33	2,656
Equity	Options	1,020	338	448	636	44	1,509
Commodity	Options	399	132	175	249	17	331
Bonds	Repo Agreements	1,000	1,000	1,000	500	500	853
Bonds	Credit Protection	5,998	3,946	809	2,281	181	1,841
Various	Other	7,346	7,346	7,346	7,346	7,346	7,479
Underlying Asset	**Contract Type**	**Bank 7**	**Bank 8**	**Bank 9**	**Bank 10**	**Other**	**Total**
Interest Rate	Futures and Swaps	36,308	34,435	31,312	8,311	108,776	421,113
Currency	Futures and Swaps	379	360	327	87	17,628	39,802
Equity	Futures and Swaps	45	43	39	10	1,188	2,795
Commodity	Futures and Swaps	317	301	274	73	575	2,458
Interest Rate	Options	9,233	8,756	7,962	2,114	27,870	95,237
Currency	Options	1,604	1,521	1,383	367	3,770	13,168
Equity	Options	911	864	786	209	2,804	9,569
Commodity	Options	200	190	173	46	814	2,726
Bonds	Repo Agreements	515	488	444	118	1,932	8,350
Bonds	Credit Protection	1,112	1,055	959	255	14,257	32,693
Various	Other	4,516	4,283	3,895	1,034	15,520	73,456

Sources: Table 1 and authors' calculations

Volatility of the underlying assets was calculated using historical information of financial markets available from Bloomberg. A common characteristic of the analyzed indices was that the standard deviation (the statistical measurement of the volatility) was not uniform across time. Furthermore, during periods of financial distress, volatility drastically increased relative to periods of no distress. For example, Figure 3 shows how the CDS index volatility evolved during the financial turmoil of 2007 and 2008. The graph shows an increase of nearly 300% compared to the same period in the previous year and nearly 600% when compared to historical levels observed from 2005 onwards. From these numbers, the relevant observation is that the CCR exposure has a natural tendency of dramatically increasing at times of distress. This claim follows from the observation that in periods of distress volatility increases, and therefore the exposure to counterparties also increases due to wild swings in prices of the underlying securities.

Figure 3. CDS spreads for Government debt since 2004

Source: Bloomberg 19/08/2010

An estimation of the amount of CCR that transactions originate is based on the daily fluctuations of price of the underlying assets. A common statistic to characterize fluctuations is given by the standard deviation of the historical differences. The standard deviation is especially useful with fluctuations that follow the normal distribution, since this type of distribution may be described by this parameter. However, many financial variables show other types of distributions, and estimates near extreme values using the standard deviation approximation are not appropriate. For the extreme cases, a better approach is to use high percentiles based on the historical variation. The aim of this paper is to establish a value for the benefit from netting in financial markets. A reasonable assumption is that when a counterparty defaults the market gets into a distress situation. Therefore, instead of using the standard deviation as an input parameter for the calculations, the value used was based on the top 99% percentile of variation of the indices. Table 3 shows the result for the volatility (standard deviation) of the main assets used in the model.

Table 3. Volatilities for main underlying assets of derivative contracts

Asset	Volatility	95% Percentile	99% Percentile
Bonds	0.14%	0.22%	0.37%
GBPUSD	0.67%	1.10%	1.57%
EURUSD	0.63%	1.01%	1.62%
Commodities	2.10%	2.98%	3.26%
Equity	1.18%	1.93%	3.45%
Repo (Bond 30 days)	0.77%	1.20%	2.03%
Interest Rate	1.55%	1.94%	4.21%
Equity 6 month	12.40%	19.20%	29.30%
Bonds 6 month	2.00%	5.63%	7.55%
Commodities 6 month	13.30%	19.20%	24.00%
Currency	8.01%	12.80%	15.70%
CDS spreads	6.64%	8.33%	20.30%

Source: Bloomberg

4.2 CCR Estimates

For the scenario assuming no netting, the result for the overall exposure was calculated using the equations presented in the Methodology Section of this paper. In this case, the estimate for the lower bound of overall exposure was $22.173 trillion. Most of the risk is concentrated in interest rate related products, followed by currency related products, and exotic products.

The estimate for the scenario with bilateral netting assumes that close-out netting is available across all different asset classes. Since this is not always the case, the calculated value yields a figure for an optimized scenario that includes more netting benefits than the current situation. However, it reflects an estimate of the possible efficiencies that could be achieved by pure netting without the participation of central counterparties. For the described scenario where bilateral netting is possible the expected exposure is of $5.019 trillion. The scenario was modeled with an average correlation across assets of 0.2. The last crisis showed that during a distress situation, asset classes can behave in a more correlated way than in other times.

Comparing with the no netting scenario, it can be seen that the benefit from netting is of over $17 trillion, thus equivalent to 77% of the exposure under bilateral netting. In other words, if netting were suppressed, CCR exposure would increase by 77% as a consequence.

Sensitivity analysis shows that the aggregate exposure may vary from $3.756 trillion, assuming no correlations across assets, to an exposure of $6.466 trillion for a correlation of 0.5. In either case, the gain due to the possibility of bilateral netting is evident.

The final scenario that was modeled is the one including a unique CCP. For the calculation, the assumption is that the central counterparty would inherit all the outstanding contracts from the previous scenario. This is a best-case scenario, mostly theoretical, since in the real world a holistic central counterparty would not be feasible (Chance, 2010). However, the scenario may be examined as a reference to establish benefits from the use of a single central counterparty.The obtained value of CCR exposure with the central counterparty is $2.997 trillion. This value is 9% below the value with direct bilateral exposure.

Figure 4. CCR exposure under the three modeled scenarios (Trillions of Dollars)

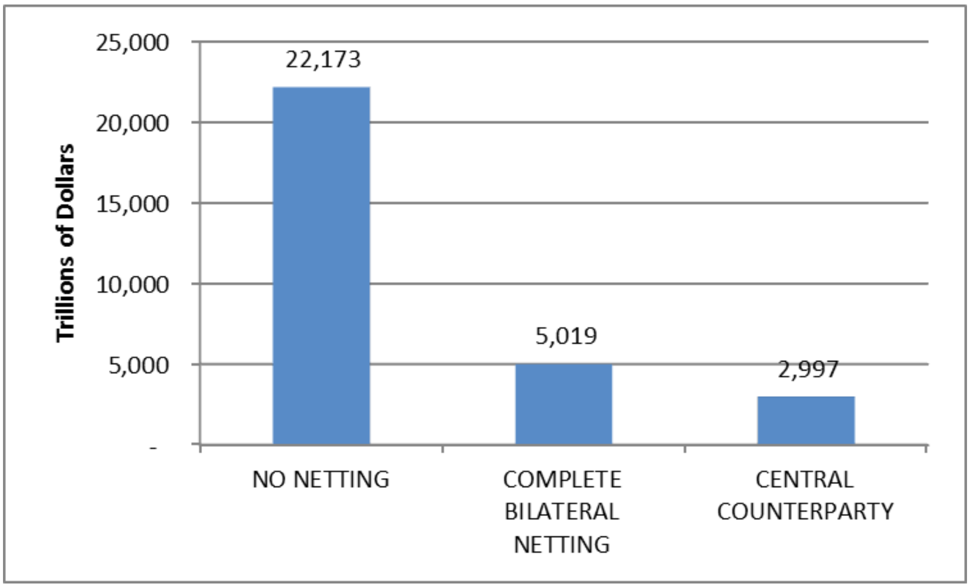


Figure 4 presents a summary of the results under the three scenarios. The lowest exposure is achieved with the CCP and close-out netting. The highest exposure is the one with no netting. Relative to the ideal scenario, the CCR increased exposure when shifting to a scenario with no netting is over $19 trillion.

5 Conclusions

This paper provides an estimate of the effect that close-out netting has on the counterparty credit exposure in financial markets. Results show that in a situation where bilateral netting would not be available as a tool to offset obligations between counterparties, CCR would increase by 77% compared to the netting situation, i.e., an increase of over $17 trillion compared to the current situation.

The paper also develops a theoretical scenario where all market transactions are cleared through one central counterparty. The objective is to capture the effect of increased netting possibilities across different counterparties due to the novation of all contracts between market participants to a CCP. The results suggest that further efficiencies would reduce the current exposure by approximately 9%.

The results suggest that current and future policies that encourage the use of central counterparties are beneficial towards decreasing the amount of counterparty risk exposure. The context of this paper is related only to Central Counterparty efficiencies introduced by enhanced netting across market participants. Results of this research provide a broad estimate on the overall benefit that a central counterparty can bring into decreasing counterparty risk. Besides these specific results, central counterparties generate additional benefits for financial markets such as increasing transparency, improving information on transactions, and adding liquidity to markets (Segoviano and Singh, 2008).

Additionally, cross-margin and netting possibilities across product silos could be fostered. For example, allowing cross-compensation across market participants for the CDS, Repo, and other types of contracts. It is therefore important to foster a legal framework that enables cross-netting. At the same time, the technical details of pricing and margin adjustments across contract silos have to be further improved by market participants.

Despite the benefits that a compulsory use of a central counterparty can bring, some negative issues should also be carefully addressed. Irrespective of the efficiency achieved by centralized clearing of contracts, the resulting concentration of obligations on the same counterparty (the central counterparty) would be much higher than in normal circumstances. A central counterparty defaulting would immediately generate a domino effect. The biggest the central counterparty, the worse effect it could have. It is clear from the beginning that truly central counterparties would be born ‘too big to fail.’ Adequate structure, governance, regulation, and control of these institutions would be as important as financial and risk models.

Margining requirements for out-of-the-money contracts are the first line of defense for a clearing house to manage its risk. Contracts need to be marked to market prices daily (or even intraday under volatile situations) to guarantee that participants post the required collateral when the contract’s value has declined. Careful attention should be devoted to the mechanisms and models to guarantee the adequate margining levels for all participants.

An adequate legal framework is the foundation for the benefits of netting or central clearing. Forward looking policies should strive to preserve and enhance the benefits of netting. For example, seeking standards across different legal jurisdictions that protect international market participants from legal gray zones or requirements seeking to encourage OTC activity to clearing houses support this path. On the other hand, policies that compromise benefits of netting could end up increasing systemic risk. For example, some authors suggest a review of legislation attempting to drive derivative transactions to be subject to the traditional bankruptcy procedures (Roe, 2010). These initiatives might end up making it difficult to enforce netting in some jurisdictions, thus increasing the systemic risk in the financial system.

Efforts to increase the use of clearing houses for settlement of OTC derivatives are welcomed. Much of the emphasis has been directed specifically at credit protection products, e.g., Credit Default Swaps. As an example, the ICE Trust funded in March 2009, is a clearing house sponsored by the major dealers that specializes in CDS products. Following Duffie and Zhu (2010), central clearing efforts should however be extended to all derivative types, increasing the overall efficiency and providing a safer trading environment for the financial system.

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