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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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Counterparty credit risk and the effectiveness of banking regulation*

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Abstract

We investigate how counterparty credit risk influences the prices of over-the-counter CDS contracts using confidential transaction level data for practically all Dutch trades. We confirm our prior of a significant negative relationship between the credit worthiness of the CDS seller and the price of the CDS contract. We find that an increase of 100 basis points in the credit spread of the seller, decreases the price of the CDS contract by 7.2 basis points. Also, the larger the size of the CDS contract the lower the price of the CDS contract. Finally, we find that regulatory exemptions have a statistically significant but economically negligible impact on CDS pricing: Transactions exempted from banking capital requirements for Credit Valuation Adjustment risk – mostly banks transacting with non-financial institutions, sovereigns and pension funds – trade 0.14 basis points lower, all else equal.

Keywords: OTC market, counterparty credit risk, credit default swap.
JEL classifications: G10, G12, G14, G20, G23.

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1. Introduction

Counterparty credit risk emerged to be a key contributor and driver of a significant portion of the losses during the global financial crisis. This type of risk is characteristic to over-the-counter derivative markets, which at that time were opaque and difficult to monitor, encouraging the build up of concentrated positions.

When Lehman Brothers defaulted in 2008, the direct effect of counterparty credit risk (CCR) on its counterparties became visible. Concerns about systemic defaults increased the credit spread of large dealer banks up to extreme values, even as high as 500 basis points. Since the default of a dealer bank became a conceivable possibility, the value of credit protection sold by these banks dropped significantly causing losses to buyers. These losses are the materialization of Credit Valuation Adjustment (CVA) risk, and have caused a quarter of the trading book losses of British banks (EBA (2015)).

The financial crisis gave rise to many discussions about the large impact of OTC derivatives markets on financial stability and systemic risk and therefore several regulatory initiatives followed. In 2009, the G20 Leaders agreed to reforms that increase transparency and market discipline. The Dodd-Frank Act and the European Market Infrastructure Regulation framework (EMIR) followed in the US and Europe, respectively. These reforms introduced requirements for mandatory clearing of standardized OTC contracts and mandatory reporting of all OTC transactions to trade repositories. As a result of these reforms, all OTC transactions in Europe started to be reported to trade repositories (TRs) in February 2014.[1]

As for the capitalisation of CCR by banks, the Basel Committee on Banking Supervision (BCBS) strengthened the banking capital requirements for the default of a counterparty (also known as the CCR charge) and introduced a new capital charge for the Credit Value Adjustment to ensure higher capital requirements for non-centrally cleared derivatives. These banking risks have become two of the highest profile risks faced by banks active in the over-the-counter financial markets.

The European implementation of the Basel CVA rules diverges from the Basel

[1] Currently six TRs are in operation, namely CME Trade Repository Ltd., DTCC Derivatives Repository Ltd., ICE Trade Vault Europe Ltd., Krajowy Depozyt Papierów Wartościowych S.A., Regis-TR S.A., and UnaVista Limited.

rules in terms of coverage. From the various types of counterparties that are trading OTC derivatives, corporates, sovereigns and pension funds have been exempted (CRR (2013)). At the time of drafting the regulation, one of the reasons to allow for exemptions was to avoid an increase in the price paid by these entities for the derivatives they bought. The EU implementation of the Basel CVA standard is however “not compliant” because its scope deviates significantly from the scope covered in the Basel Accord. The BCBS Regulatory Consistency Assessment Programme (RCAP) findings conclude as much (BCBS (2013)).

The exemptions are, however, not expected to last forever. The European Banking Authority, for instance, notes: "Overall, the EBA is of the opinion that EU exemptions on the application of CVA charges should be reconsidered or removed, since they leave potential risks uncaptured" (EBA (2015)). Our analysis studies the impact of the regulatory exemptions in the CDS market and this analysis can be useful in the policy debate on the impact of the removal of the exemptions.

Research on how counterparty credit risk is priced is scarce, and none of it uses European data. This is due to a lack of granular data available at transaction level. The newly available derivatives data set gathered by trade repositories allows us to study CCR. Our paper aims to understand whether and how markets price CCR when selling CDS contracts bilaterally. In addition, we also take a close look at the impact of regulation on pricing for transactions with counterparties that are exempted by the EU regulation.

We use a data panel set containing banks active in the European market in 2016 to understand whether prices of single name CDS contracts sold are influenced by the credit risk of their seller. This would be proof that the markets price in the CCR risk. Our empirical approach is to estimate the transaction spread of the same single-name CDS contracts, traded on the same day, bought by the same buyer, but sold by different sellers which differ in term of credit worthiness.

In line with previous US studies, we find that CCR is priced in the value of credit derivatives. In our study, however, CCR has a larger impact than in the previous studies. Furthermore, the size of the contract influences pricing; the CDS contract trades 2.65 basis points lower if the notional increases by €1 million. What is truly novel, is that regulatory exemptions have a significant impact on the price of CDS contracts which trade 0.14 basis points lower than those contracts with counterparties that are not exempted.

Our paper is structured as follows. In Section 2 we explain how our research relates to the existing literature followed by an overview of the post-crisis developments in the CDS market in Section 3. In Section 4 we present the data and hypothesis we use. In Section 5 we present the methodology, followed by the results in Section 6, robustness tests in Section 7 and, finally, conclusions in Section 8.

2. The CDS market and counterparty credit risk

2.1. Existing literature

There is limited but growing literature studying the effects of counterparty credit risk on derivative markets. An early study by Segoviano and Singh (2008) on CCR in the over-the-counter derivatives market emphasises the importance of CCR losses and is the first to discuss policy changes that should follow the global financial crisis. Specifically for the CDS market we are aware of three publications.

Arora et al. (2012) were the first to analyse CDS transaction data obtained from an US asset manager. They find that counterparty credit risk is priced although the magnitude of the effect is extremely small, almost negligible in size. The authors point out that an increase of 100 basis points in the credit spread of dealer translates to a 0.15 basis points decrease in the price of the credit protection. Our analysis on a much more recent, European data set, reveal a 64 times larger larger effect: an increase of 100 basis points in the seller's credit spread would already translate to 7.2 basis point decrease in the price of the CDS.

Du et al. (2015) analyse a granular CDS data set with US transactions and also find that counterparty risk has an effect on the pricing of CDS contracts: 100 basis points increase in the sellers credit worthiness results in a decrease of 0.6 basis points in the CDS price. The authors also study the effect of CCR on the choice of counterparties. Du et al. (2015) conclude that counterparty credit risk is managed mostly by choosing the right counterparty. Their evidence shows that dealers search for counterparties with high credit worthiness and low correlation to the underlying of the CDS contract. In other words, buyers of protection try to avoid wrong-way risk. They also find that transaction spreads of centrally cleared trades are significantly lower compared to the spreads of uncleared transactions.

Moreover, when controlling for past trading relations and the identity of the buyer and seller, they find that relations do not have an effect on transaction spreads.

A recent contribution using OTC CDS data as well is Iercosan and Jiron (2017). The authors show that the execution cost of a CDS transaction can partially be explained by the trading relationships, counterparties' trading activity level and trading networks. Their paper uses CDS data from DTCC as well and focuses on analyzing the effect of counterparties' matching and negotiation abilities on the terms of trade of CDS contracts, under incomplete information about market liquidity and quotes.

Hau et al. (2017) investigate the OTC FX market and find out that less sophisticated clients pay higher spreads on FX contracts. The authors make a case for moving FX OTC trading to multi-dealer request-for-quote platforms because they eliminate discriminatory pricing and thus introduce competitive spreads regardless of the sophistication of the clients.

2.2. Assumptions and background on how CCR works

Counterparty credit risk is the risk that a counterparty in a financial derivative contract will default prior to the expiration of the contract and/or will fail to make future payments. Counterparty risk concerns both parties in an over-the-counter (OTC) derivatives contract for all asset classes. Financial institutions, whilst making use of risk mitigation factors such as collateralisation and netting, will still be exposed to a significant amount of counterparty risk which needs to be managed and priced appropriately. Since the financial crisis, financial institutions have built up their capabilities for handling counterparty risk and active hedging has also become more common, largely in the form of buying credit default swap (CDS) protection. Nowadays, most banks have a dedicated counterparty risk management unit which will charge a premium to each business line to bear the counterparty risk of a new trade, taking advantage of portfolio level risk mitigation factors such as netting and collateralisation (Gregory (2013)). Such risk management has several important features detailed below.

First, we do not observe the contractual terms of the CDS contracts and – similar to other studies – we cannot study the effect of (cross asset class) netting sets and collateralisation. We therefore maintain the assumption that collateralisation cannot mitigate counterparty credit risk completely. This is especially true in times of stress when netting and collateral is not enough to cover potential losses from counterparty credit risk that arise from sudden increases in derivatives negative exposures.

Second, during the time period of our data sample, central clearing of CDS contracts was not mandatory and thus not yet a feasible option to mitigate counterparty credit risk in Europe. In our sample, only a limited number of transactions are centrally cleared – i.e. only 1% of the 20,000 transactions in our sample. In Europe, mandatory clearing of index CDS contracts is enforced only since February 2017 and only for certain types of counterparties that are already clearing members. [2]

Third, Acharya et al. (2016) show that financial institutions tend to purchase more protection on a dealer as reference entity when exposed to that dealer through counterparty risk. Buying a CDS contract referencing the counterparty to which an institution has a large derivative exposure to, is the most straightforward manner to hedge CCR. These hedges are not perfect because they introduce risk by increasing the sensitivity of the profit and loss account to other risk factors (i.e. market risk factors) and they are generally costly to put in place. This is why in practice CCR hedging is executed mostly by large dealers banks. Our working assumptions regarding hedging is that most counterparties do not pursue hedging CCR on a large scale. This assumption is in line with the findings of Oehmke and Zawadowski (2017) who investigated the motivations for trading in CDS markets and the economic function these markets perform. They find that speculative trading concentrates in the CDS market, and hedging is motivated mostly by high volumes in bonds and CDS markets.

Fourth, another method to reduce CCR is to actively choose counterparties that have a low correlation with the underlying of the CDS contract. For example, an institution could actively avoid buying a CDS contract on a Dutch underlying from a Dutch counterparty. In this way, decreasing the correlation between the counterparty and the underlying entity increases the odds that the insurance pays off in case the underlying actually defaults.

Fifth, counterparty credit risk can be reflected in the price of the derivative via

[2] See https://www.esma.europa.eu/regulation/post-trading/otc-derivatives-and-clearing-obligation

the credit risk adjustment. The CVA is the difference in the intrinsic value of the derivative that is CCR free and the derivative value when counterparty credit risk is present. This is why the CVA is also known as the price for bearing the CCR – it does not address CCR. In that sense, it can be seen as a premium. Only additional capital held by the institution against CVA can absorb potential losses arising from value changes caused by changes in the credit worthiness of the counterparty. Logically it follows that CVA losses are smaller than CCR losses.

Sixth, to diversify counterparty credit risk and limit building up large concentrated positions to one counterparty, it is common market practice to split large tickets into smaller trades and execute them with several counterparties. This means that a counterparty will purchase a CDS contract with the same features and underlying from several counterparties at the same time or trading day. Besides avoiding concentration risk, this type of trading behavior is also encouraged by the European Market Infrastructure Regulation (EMIR) that requires non-financial counterparties to maintain their positions beneath a threshold of €15 million in order to avoid clearing and daily margining.

And finally, a method to reduce exposure to CCR is the newly available tool of portfolio compression. In a nutshell, portfolio compression is a post-trade operation that reduces market gross notional without affecting participants' net market risk positions. It accomplishes this by netting out opposing trades and replacing them with a new contract. Multilateral compression can impact counterparty credit risk since more than two counterparts are involved and the net exposure among them can change (D'Errico and Roukny (2017)).

3. Post crisis developments in the CDS Market

3.1. Standardisation of CDS contracts

With the aim to standardise the market and increase liquidity, the International Swaps and Derivatives Association (ISDA) adjusted the standardised documentation for single name CDS contracts in its *Big Bang* of April 2009. Both the regular coupon payments made by single-name CDS and the default-contingent payments became standardised, making CDS contracts easy to compare, price, and trade.

The standardisation of coupon payments was achieved by the introduction of a limited set of standard coupon rates. In combination with standard contract sizes, these fixed the size of coupon payments, which were already paid on standard dates (the 20^{th} of March, June, September and December). Counterparties now settle the differences between the appropriate premium and the chosen standard coupon rate through an upfront payment. The final goal of having standard coupon rates and standard contract sizes is to equalise cash flow payments.

The *Big Bang* also standardised default-contingent payments, harmonising the triggers of credit events and their consequences for all CDS contracts and reducing the scope to disagree about whether credit events have occurred. This also helped harmonise payments for different contracts on the same reference entity, which are now established via an auction system. Overall the Big Bang protocol ensures that all protection sellers transfer the same amounts to the protection buyers and that all outstanding contracts are affected by the same credit events. For a comprehensive overview of credit default swaps, including their regulatory development we refer to a survey by Augustin et al. (2014).

3.2. Market trends

The notional amount of outstanding credit default swaps grew rapidly to a peak of almost $60 trillion at the end of 2007, but then declined sharply to just over $31 trillion in the middle of 2010. Vause (2010) argues that the decline did not occur because the CDS market lost its appeal in light of continuing market unrest because trading volumes have continued to rise. Instead, he argues that the sharp drop in the volume of outstanding CDS reported in the BIS statistics is due to post trade compression of CDS transactions. This results in the reduction of the notional and therefore the reduction of banks' exposure to counterparty credit risk (cf. Aldasoro and Koch (2017)).

Since 2009, CCPs also contribute to the reduction of CDS gross nationals and therefore the reduction in CCR exposure. The table below provides an overview of the decreasing trend of outstanding OTC CDS exposures since the financial crisis in terms of notional and market value from 2010 onwards, as reported by the BIS. At the end of June 2016, the level of single-name CDS notional was close to $6.7 trillion.

Table 1: The global OTC CDS market

Amounts outstanding, in billions of US dollars

	Notional amounts outstanding			Gross market value		
	end-June 2010	end-June 2013	end-June 2016	end-June 2010	end-June 2013	end-June 2016
Credit derivatives	**31,416**	**24,845**	**11,991**	**1,708**	**732**	**351**
Forwards and swaps	31,331	24,497	11,881	...	...	...
CDS	31,057	24,469	11,861	1,694	728	346
Single-name instruments	18,920	13,211	6,681	1,012	432	219
Multi-name instruments	12,136	11,258	5,180	681	296	127
Index products	7,500	10,163	4,836	...	...	...
Options	85	348	110	...	...	...

Source: BIS (2016)

3.3. Regulatory Developments

The significant losses caused by derivative portfolios led the G20 and the Basel Committee to propose several regulatory reforms. These reforms aimed to strengthen the resilience of the banking system and to enhance the transparency of the OTC markets.

Banking capital reforms

The Basel Committee has strengthened the capital framework for banking institutions to increase banks' resilience. The financial crisis has revealed new risks that banks were not capitalising for and the need to increase capital for some of the risks that were already addressed by the Basel framework but for which the existent capital levels were insufficient to cover trading losses in times of financial turmoil. The Basel Committee has therefore amended the Market Risk and Counterparty Credit Risk frameworks to better capture tail risks and asset correlations in turbulent times. For example, the Market Risk capital charge for trading assets has been increased three fold.[3]

[3]To be precise, it has increased by 223% according to the *Analysis of the trading book quantitative impact study* conducted by the Basel Committee (See BCBS (2009)).

The Basel Committee has also introduced a new risk category to be addressed by banks with additional capital buffers: the Credit Valuation Adjustment (CVA) capital charge. This capital charge is meant to absorb losses from a bank's derivative book that is traded bilaterally and the market value of these books is sensitive to the volatility of the credit spread of the bank's counterparties. This is the market price of counterparty credit risk. In practice, if the credit spread of the counterparty in a derivative transaction increases then the value of the derivative decreases and the bank needs to take the equivalent loss through their P&L account. These losses are deducted from the bank's shareholders equity and therefore, if the loss is larger than the bank's equity position, the bank would be insolvent.

Losses from CVA risk can be partially mitigated if a bank receives collateral from its counterparties, preferably margining their trades daily. When this is the case, then the CVA capital charge becomes very small depending on the amount of collateral available. Derivatives that are traded via an exchange or are cleared do not pose CVA risk because the counterparty (i.e. the clearing counterparty) does not pose default risk for the bank and therefore it does not have a volatile credit spread that could impact the valuation of the derivative position. Such exposures do no attract capital requirements for banks.

The European legislation implementing the CVA capital charges for banks also includes additional exemptions from CVA capital requirements. Derivatives transactions between banks and specified types of counterparties are exempted from CVA banking capital charges, and these are:

- Transactions with non-financial counterparties where the notional amount of the transactions does not exceed the €1 billion clearing threshold for credit derivatives under the European Market Infrastructure Regulation (EMIR);

- Intra-group transactions;

- Transactions with central or regional governments and public entities owned by sovereign entities;

- Transactions with Pension Plans. Transitional exemptions from CVA charges are in place until 16 August 2018 and an extension is currently under discussion.

OTC derivatives reforms

In addition to increasing the capital charges for banks, the G20 has recommended to increase the transparency of the OTC derivative markets to prevent market abuse and decrease systemic risk by imposing mandatory clearing and reporting standards. There is a mandatory reporting requirement to trade repositories for all counterparties involved in the OTC market for all OTC transactions as they occur starting 1 July 2013.

In Europe, a clearing obligation for most categories of OTC derivatives is also in place via the European Markets Infrastructure Regulation (EMIR (2012)). However, there is no mandatory clearing obligation for OTC single-name CDS contracts which are in the scope of this paper. For this reason most of the single-name OTC CDS contracts are not centrally cleared as described in the next section.

Were all the problems with the OTC derivatives markets that surfaced during the financial crisis tackled by the post crisis reforms? Roe (2011) argues that a broader rethink of the OTC markets is still required. He identifies an issue that weakens market discipline of parties involved in derivatives trading because they are not subject to the normal sequencing in bankruptcy proceedings. This enables banks to jump to the head of the bankruptcy repayment cue in ways that secured creditors cannot. Derivative counterparties are less concerned with credit risk because they can quickly recover their losses by liquidating collateral while all other creditors need to wait in line in bankruptcy courts. Roe (2011) considers this a de facto subsidy in the form of bankruptcy benefits for parties involved in derivative transactions and pleads for its repeal in order to improve market discipline and financial stability.

4. Data

We use data on OTC CDS transaction from DTCC, one of the six active trade repositories. The time range runs from 1 December 2015 until 31 December 2016. The transactions provided to us by DTCC fulfill either of two criteria: first, at least one of the counterparts is regulated by the Dutch Central Bank or, second, the underlying of the derivative contract is based in the Netherlands. For cleaning the data we follow Levels et al. (2018) who build on Abad et al. (2016).

4.1. Data sample

After the initial cleaning, we start with approximately 20,000 CDS transactions.[4] Further filtering of the data – detailed below – gets us down to a baseline data sample of 5959 transactions. Following Arora et al. (2012), we keep only the 5 year CDS contracts because these are the most liquid contracts; this filtering step removes 70% of transactions. We also eliminate centrally cleared contracts, which are only 1% of the sample, as they inherently do not have CCR and CVA risk. We also eliminate six transactions with negative spreads because they are difficult to explain from an economic perspective and spreads above 1000 basis points because these companies are obviously in distress (cf. Du et al. (2015)). In addition, we also drop transactions with missing upfront payment, currency type and recovery rate fields because these parameters are indispensable for correctly pricing a CDS.

4.2. CDS pricing model

To obtain our dependent variable, *CDS price*, we compute the CDS par spreads using the ISDA Standard Model. This is a pricing model that allows us to compute the par spread of the CDS contract post-trade (implemented the R package *creditr* (Kane et al. (2014))). From the *creditr* package we used the *upfront to spread* transformation, taking into account the standard coupon payment, the upfront payment, the transaction date, the maturity, the recovery rate and the currency as parameters. The outcome of the pricing model – the CDS par spread noted as the CDS_{price} – is used as dependent variable in our empirical model.

Without computing the CDS par spreads it is not possible to fully understand and analyse CDS pricing from the raw data. The coupon reported by institutions to the trade repositories does not reflect the actual spread of the CDS contract anymore. After the financial crisis the market has pursued standardising the CDS contracts in the so called "Big Bang" protocol and the coupons have been fixed at certain levels.

To settle the net present value of the coupon payments, market parties have started to exchange an upfront payment. If the spread of the CDS contract would be the same as the coupon chosen by the seller, then an upfront payment would

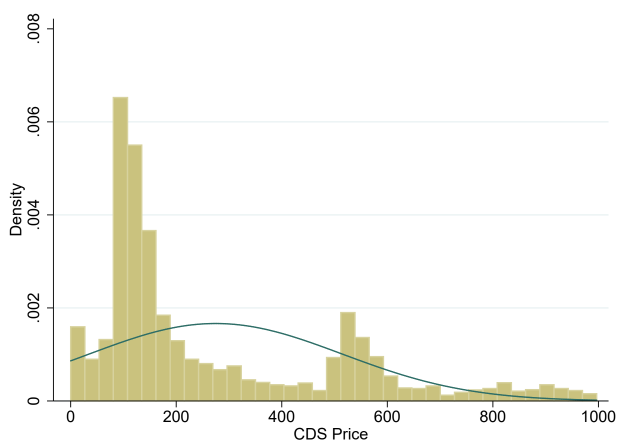
[4] The cleaning steps are detailed in Levels et al. (2018).

not be necessary. However if the coupon level is smaller than the spread of the contract agreed by the parties than the buyer of the CDS contract would make an upfront payment to the seller of the CDS contract. In this case the upfront payment is reported as a positive number. If the upfront payment is reported as negative then it means that the buyer of CDS protection receives from the seller of protection an upfront payment.

4.3. Variables

The dependent variable is the CDS_{price} and it is the par spread equivalent of the transacted CDS contract. Figure 1 plots the distribution of this variable which shows some clustering around 25bp, 100bp, and 500bp. Note that the distribution of the riskiness of the seller displays similar multi-modality (cf. Figure 2). This can be the outcome of the standardisation of the coupon payments around these values after the financial crisis which caused market segmentation.

Figure 1: Distribution of the CDS Price (in basis points)



We follow Arora et al. (2012) and use two main independent variables. First, we retrieve the CDS spread at the end of day before the transaction date from Bloomberg. This is our measure of the *Seller Riskiness* which represents the counterparty credit risk of the seller of the CDS contract. The distribution of *Seller Riskiness* is plotted in Figure 2 below. The second independent variable is the *notional* of the contract, retrieved from our data set, to test whether the size of the contract also impacts the price of the CDS. These two independent variables are not correlated.

Figure 2: Distribution of the CDS Spread of the Seller or *Seller Riskiness* (in basis points)

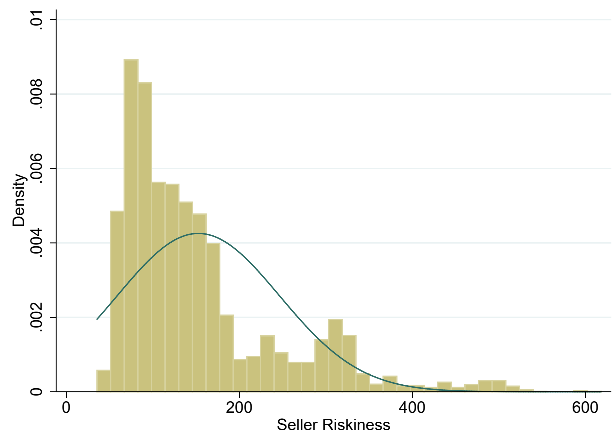


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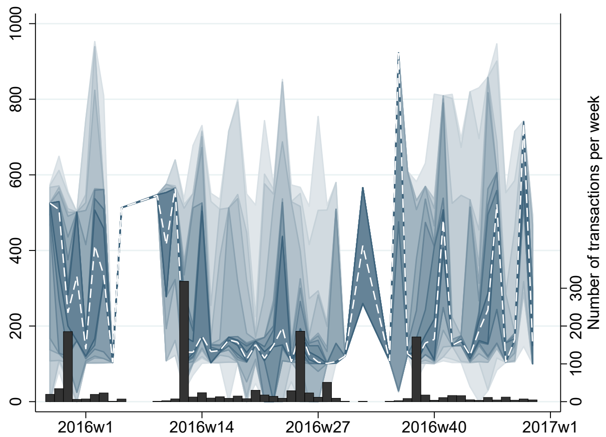
Figure 3 below shows, first, the concentration in trading and, second, the volatility in pricing. The bar charts at the bottom show the number of trades per week. Here a pattern of increased trading volumes towards the end of each quarter is visible. This pattern is caused by the standardization of the CDS starting dates on four specific dates each year: 20^{th} of March, June, September and December corresponding with weeks 8, 12, 24 and 51 of the year. The distribution of prices is shown by the range plot with varying shades of blue. The white dotted line in the middle shows the median while the increasingly lighter shades show the different percentiles. Given the limited number of transactions (around 6000), the number of observations is in many of the weeks insufficient to guarantee a smooth plot. Although there is some variation, there is no clear trend or bunching.

Finally, we include a dummy variable *Exempted* to study the impact of regulatory exemptions on CDS pricing. Banks are exempted from holding capital for CVA for transactions with corporates, sovereigns and pension funds. In our sample 26% of banks' total number of transactions involve such exempted counterparts. In terms of notional, 31% of transactions are exempted.

Figure 3: Evolution of the CDS prices and number of transactions per week



The distribution of CDS prices is shown with increasingly darker shades of blue starting at the 10th and 90th percentile. The dashed line shows the median value.

Table 2: Summary statistics

Variables	Obs	Mean	Median	Min	Max
CDS price	5,959	275	153	0	996
Seller riskiness	5,959	153	123	35.5	618
Notional	5,959	5,305,619	3,000,000	250	250,000,000
Upfront	5,959	190,626	37,506	-2,568,197	37,400,000
Exempted	5,959	.26	0	0	1

Note: values are in euro. Data from 1 December 2015 to 30 December 2016. *CDS price* is the spread of the CDS contract, computed with the ISDA Standard Model with parameters from our data sample provided by DTCC. *Seller riskiness* is the end-of-day CDS spread of the seller of CDS, from Bloomberg, the day previous to the CDS contract transaction. *Notional* is the face value of the CDS contract representing the amount of credit exposure that is insured in case of a credit event. *Upfront* is the payment made on the day of the transaction in order to set the market-value of the CDS to 0. *Exempted* is a dummy that separates the transactions that are exempted from capital requirements from transactions that are in scope of capital requirements.

4.4. Hypotheses

Our main question is whether transaction spreads decrease with the credit risk of the seller. To answer this question we pose the following three hypotheses.

Hypothesis 1: CCR is not priced. The null hypothesis is that the counterparty credit risk is not priced, implying that the slope coefficient β, in regression eq. (1) below, is zero.

Hypothesis 2: Regulatory exemptions do not influence the CDS price. To test this hypothesis we include a dummy *Exempted* to distinguish among transactions with non-exempted and exempted counterparties. Under the null hypothesis its coefficient γ in regression eq. (2) should be zero.

Hypothesis 3: The size of the CDS contract does not influence its price. To test this hypothesis we introduce the *Notional* of the contract as a control variable in regression eq. (3). Under the null hypothesis the coefficient η should be zero.

5. Methodology

Similar to Arora et al. (2012), we have simultaneous committed prices from multiple CDS trading banking institutions in the sample for each 5-year index CDS for each date t in the sample. Following their methodology we can test whether counterparty credit risk is priced using a panel regression of the price of the single-name CDS sold on the price of protection of the dealer itself at the end of the previous day $(Seller\ riskiness_{j,t-1})$. The distributions of the CDS_{Price} and the the *Seller riskiness* are skewed so we have to scale them using a natural logarithm function. To be consistent and allow *Notional* to impact the spread, we also incorporate the log normal of *Notional*.

Our model is in line with Arora et al. (2012) and estimates the transaction spreads (CDS_{price}) on the same contract, traded on the same day t, bought by the same buyer i, but sold by different sellers j, which are different in terms of credit worthiness. The most basic specification is as follows:

$$\ln(CDS_{price\ i,j,t}) = \alpha_{i,t} + \beta \ln(Seller\ riskiness_{j,t-1}) + \varepsilon_{i,j,t} \tag{1}$$

We then adapt the basic model to capture the effect of the regulatory exemptions on the price of the CDS transaction. As mentioned before, *Exempted* is a dummy variable that identifies those transactions for which the selling bank is exempted from CVA capital requirements, based on the type of buyer.

$$\ln(CDS_{price\ i,j,t}) = \alpha_{i,t} + \beta \ln(Seller\ riskiness_{j,t-1}) + \gamma Exempted_{i,j,t} + \varepsilon_{i,j,t} \quad (2)$$

We also run the following model specification to ensure that the results are robust. We add the size of the contract as a control variable.

$$\ln(CDS_{price\ i,j,t}) = \alpha_{i,t} + \beta \ln(Seller\ riskiness_{j,t-1}) + \gamma Exempted_{i,j,t} + \eta \ln(Notional) + \varepsilon_{i,j,t} \quad (3)$$

We use 3,595 transactions in which the selling entity is a bank. This sample translates into 1,023 panels where the same counterparty trades a CDS contract with the same underlying on the same day. The results are shown in Table 3 with each of the columns showing a more complete model.

We execute the Hausman test to identify whether fixed or random effects are appropriate. The $p-value$ is higher than 0.05 and therefore we can reject the null hypothesis of the test according to which both type of models are appropriate. The alternative hypothesis is that the model with fixed effects is appropriate and the model with random effects is not. This means that panel regressions with fixed effects are appropriate ($chisq = 0.17, p-value = 0.68$). Further, after executing an F test, we can conclude that time fixed effects are not appropriate ($F = 0.13632, p-value = 0.7123$). After testing the model performance with other types of fixed effects, we find that the best option is to run a panel regression with underlying fixed effects. Table 3 tabulates the results.

Table 3: Benchmark regression results with log variables: sellers are banks only

	(1)	(2)	(3)
Seller_riskiness	−0.0871**	−0.0810*	−0.0806*
	(0.0424)	(0.0420)	(0.0417)
Exempted		−0.0538*	−0.0602**
		(0.0291)	(0.0294)
Notional			−0.0609***
			(0.0163)
Constant	5.080***	5.051***	5.817***
	(0.207)	(0.205)	(0.332)
Observations	3,595	3,595	3,595
Number of panels	1,023	1,023	1,023
Underlying FE	Yes	Yes	Yes
r2 within	0.005	0.005	0.016
r2 between	0.725	0.725	0.729
r2 overall	0.591	0.592	0.595

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

6. Results

Is counterparty credit risk priced?

Our first finding is that the counterparty credit worthiness of the bank selling the derivative contract has a significant impact on the price of the CDS price. This is in line with earlier findings for the US.

To calculate the magnitude of the impact, we note that the level of the median transaction spread in our sample is 153 basis points and the median credit spread of the seller is 123 basis points. In this case the increase of the credit spread of the seller by 100 basis points will decrease the spread of the CDS by 7.2 basis points $\left(153X\left[\frac{(123+100)}{153}^{-0,0806}-1\right]\right)$.

This effect, is thus 12 times higher than what Du et al. (2015) find using US data. Arora et al. (2012) found a negligible effect using a limited data set from during the financial crisis. By comparison, our results show that the market is currently pricing in CCR which means that counterparties are basically charging a premium to bear counterparty credit risk. Note that we are abstracting from collateral due to data constraints.

How does the CVA regulatory capital exemption impact CDS pricing?

Our second finding is that having in place the European exemption on banking capital requirements for OTC derivatives transacted with non-financials, sovereigns and pension funds results in a significant and negative impact on the CDS price. It seems therefore that the exemption functions like a subsidy, making the CDS contract cheaper by 0.16 basis points compared to a similar contract that is not transacted with an exempted counterparty (the coefficient can be interpreted as follows: $e^{-0.0602}$).

However the difference of 0.16 basis points between the same CDS contract sold to an exempted counterparty and to a non-exempted counterpart is relatively small. This shows that the markets price in and expect compensation (in the form of risk premium) to bear the CCR regardless of whether they have to hold capital for CVA or not. This is in line with the assumption that markets price in all available information.

Does the size of the contract influence pricing?

We find that the size of the contract, in terms of notional, influences pricing. If we consider that the mean notional of the contracts in our sample is €3 million and that the mean CDS price is 153 basis points then our results can be interpreted as follows: the CDS contract trades 2.65 basis points lower if the notional increases by €1 million $\left(153X\left[\frac{(3.000.000+1.000.000)}{3.000.000}^{-0,0609}-1\right]\right)$.

7. Robustness

In our main specifications, discussed in the previous section, we focus on banks as sellers. They are the central intermediaries in this market and face regulatory charges in selling CDS to other banks. To examine whether our analysis is sensitive to this sample selection, we repeat the analysis for the entire sample of 5-year CDS contracts, including seller counterparties that are not banking institutions. This enlarges the sample from 3,595 to 5,959 observations and it translates into

Table 4: Robustness test: results of regression with log variables, all types of sellers

	(1)	(2)	(3)
Seller_riskiness	$-0.0802**$	$-0.0741**$	$-0.0736**$
	(0.0367)	(0.0365)	(0.0361)
Exempted		-0.0396	-0.0437
		(0.0279)	(0.0278)
Notional			$-0.0590***$
			(0.0115)
Constant	$5.047***$	$5.017***$	$5.759***$
	(0.179)	(0.178)	(0.252)
Observations	5,959	5,959	5,959
Number of panelID	2,138	2,138	2,138
Underlying FE	Yes	Yes	Yes
r2 within	0.003	0.003	0.006
r2 between	0.589	0.589	0.597
r2 overall	0.517	0.517	0.521

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

2,138 panels where the same counterparty trades a CDS contract with the same underlying, repeatedly, during the same day.

In the robustness test the significance of the coefficient of *Exempted* disappears. This could be explained by the fact that the sample is extended to sellers that are not banks which are also not influenced by banking capital requirements for CVA when trading among themselves. However the interpretation that the market prices in CCR even when there is a regulatory capital exemption remains valid.

All other coefficients preserve their significance as in the benchmark specification. The relationship between the sellers' credit worthiness and the CDS price remains significant and has a similar effect in terms of magnitude. The size of the contract continues to have an impact on the CDS price, similar in magnitude as in our benchmark specifications.

8. Conclusions

We have examined CDS pricing with a particular focus on whether the seller's credit worthiness is a relevant factor. For this analysis we have collected a unique data set including almost all single name CDS trades of all Dutch entities. In addition we have all trading of any European entity if the underlying reference entity is domiciled in the Netherlands. Using the roughly 200,000 daily positions we filter out those transactions where the buying party is transacting multiple times on the same day with multiple sellers. Since the buyer, the underlying, and the time are the same we can isolate the effect of the seller's riskiness on the prices recorded. We find that the counterparty credit risk of the seller is a significant factor in determining the price of credit derivatives contracts. Moreover, we find a markedly larger impact compared to studies conducted on US data.

From a policy perspective, our research can inform our thinking on the benefits of mandating central clearing-houses for CDS contracts. In practice, central clearing of credit derivatives reduces CCR risk, but it was uncertain whether CCR was a large concern for the markets by looking at previous studies. We show that CCR has a material impact on credit derivatives sold by banking institutions and therefore the possibility to clear single-name CDS contracts could be considered beneficial.

We also show that the regulatory CVA exemption in the EU has a significant but very low impact on CDS pricing. This proves that the markets expect a risk premium to bear CCR regardless of regulatory capital exemptions present in the European regulation. From a policy perspective, is it then prudent to continue to exempt banks from capital for CVA risk when markets already price it in the value of CDS contracts? This can lead to unintended consequences of regulation in the financial markets. Specifically, it can create preferential asset classes and increase risk taking with counterparts that are exempted.

A third conclusion of our analysis is that the size of the CDS contract influences pricing. We find a significant price discount for higher volume and potentially to compensate the credit protection buyer for concentration risk. The larger the CDS contract in terms of notional the smaller the price. In practice this means that the CDS seller will give the buyer of credit protection a discount if he purchases a larger contract. This can be motivated by the fact that with a larger contract the buyer would increase exposure to the seller and therefore increase their concentration risk.

All in all, this entire analysis was possible due to the G20 reforms on OTC derivatives. These reforms have increased the transparency of this previously opaque market and gave both market parties and regulators access to an impressive amount of financial transaction data.

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