WHITE PAPER

OPTIMISING CAPITAL REQUIREMENTS FOR COUNTERPARTY CREDIT RISK

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Introduction

The objective of this research paper is, first, to bring some clarity on how to deal with Counterparty Credit Risk (CCR) in the current financial environment by detailing some of the multiple aspects and challenges involved. Secondly, the goal is to study the conditions for the effective risk management of CCR. This will be achieved by detailing and comparing capital requirements, identifying inconsistencies in prudential regulations and applying the various capital approaches on some typical portfolio strategies observed within financial institutions.

What is CCR?

CCR is the risk that a party, usually to an OTC derivative contract, may fail to fulfill its obligations, causing replacement losses to the other party. This is similar to the standard definition of credit risk in the sense that the economic loss is due to the default of the obligor. However, it differentiates itself because of the uncertainty around the exposure at default. More specifically, the amount of exposure is uncertain due to the random nature of the contract's pay-offs. Additionally, CCR has a bilateral nature, since depending on the point in time and the situation of the market, the exposure after close-out netting can either be positive (an asset) or negative (a liability).

Why measure CCR?

Counterparty credit risk (CCR) is currently one of the most complex topics for financial institutions. This complexity comes from many different sources but is primarily related to the multiple definitions and uses of CCR. Therefore, the first question to ask yourself before modeling CCR is why do you want to measure it?

Business Purpose

You want to determine the market value of your counterparty risk, which corresponds to the difference between the risk-free price of your exposure and the price including the credit risk of your counterparty. This is typically referred to as the Credit Value Adjustment (CVA) and can be considered as an exotic credit option. This computation is rather complex and has to integrate many features, including:

- **Expected Exposure**: The computation of what is expected in terms of future exposures, for all the deals with the counterparty, and given changes in market factors;
- **Credit Risk Parameters**: The drivers of credit risk, meaning the Probability of Default (PD), usually based on a term structure of hazard rates implied from CDS prices, the Recovery Rate (RR) and the different correlations, like Wrong-Way Risk (WWR) or systemic correlation;

- **Bilateral CVA**: The final price of a derivative should integrate the CVA from the two sides of the deal (the risk that the other counterparty defaults and the risk of your own default). The adjustment due to your own PD is usually called Debit Value Adjustment (DVA);
- **Netting Agreements**: Legal agreement that allows compensation between positions inside a netting pool with the same counterparty;
- **Credit Support Annexes (CSA)**: Collateral agreements that help limit CCR in an OTC transaction by forcing counterparties to post collaterals on a regular basis (usually daily);
- **Hedging**: Hedging the credit risk can be achieved, totally or partially, through the use of contingent credit derivatives or credit indexes such as the CDX or the iTraxx. It is important to note that the hedges themselves include CCR;
- **Funding Value Adjustment (FVA)**: The additional cost of having to fund a position at a higher rate than the applicable risk-free rate (e.g. OIS rate vs. own cost of funding);
- **Incremental CVA**: One of the key issues for financial institutions is that for each new "incremental" trade with a counterparty, they have to reconsider all the positions with that specific counterparty, in the same netting pool of the ISDA master agreement.

Accounting Purpose

You want to integrate CCR estimates in your profit and loss account, according to accounting standards applicable to your institution. Under International Accounting Standard (IAS 39), banks are required to account for the fair value of OTC derivatives trades, which includes the recognition of fair-value adjustments due to counterparty risk. In addition, it will be required by IFRS 13, as of 1st January 2013, to record DVA for fair value measurement.

Regulatory Requirements

You want to know the cost of capital for bearing CCR. In order to compute this amount, you should refer to the Basel requirements. This regulation differentiates between two types of CCR capital charges: one for the default risk and one for the market risk (usually referred to as CVA capital charge).

- **Default risk charge**: is the capital charge to cover losses in case the counterparty defaults on its obligations and corresponds to a "hold-to-maturity" or banking book strategy.
- **CCR market risk charge**: is the capital needed to cover losses from changes in the market value of counterparty risk, i.e. the volatility of the counterparty credit spread that can negatively impact the value of the contract.

The default charge was first proposed by Basel II. However, due to the major losses during the financial crisis, related to the creditworthiness of derivative counterparties, Basel III has introduced the market capital charge. Each of these capital requirements proposes different solutions, with increasing level of complexity.

Here is a summary of these approaches:

FIGURE 1: Basel III capital requirements approaches

Regulatory requirements regarding CCR can be found both in Basel II and Basel III. These requirements are explained in detail in the Appendix of this paper.

Risk Management

You want a global and integrated view of the risks your institution is facing regarding CCR. For this reason, it is necessary to go beyond the regulatory requirements. Indeed, the objective of the capital requirements is to ensure that institutions can withstand major shocks in CCR. However, these regulatory models are developed on a "fit-for-all" basis and only focus on solvency: they do not provide sufficient information for proper risk management. Some topics that should be further investigated are:

- Economic Capital Models for CCR: To go beyond the regulatory formulas, institutions need to develop their own models to assess the capital needed for CCR, which should account for:
  - Correlation between credit spreads and market factors, since the regulatory VaR model is restricted to changes in the counterparties' credit spreads and does not model the sensitivity of CVA to changes in other market factors (i.e. interest rates);
  - Consistent treatment of recovery component that is fixed arbitrarily for market charge and calibrated on Loss Given Default (LGD) internal models for default CCR;
  - Modeling of the portfolio behavior until time horizon, considering for example management actions or constant level of risk assumptions;
  - Modeling of seniority effects, guarantees and parent support;
  - Proper integration of rating migration, that could be captured both by Incremental Risk Charge (IRC) models and using Basel II maturity adjustment multiplier;
  - Consistency in quantile estimation on the loss distribution (usually around 99.95% for ECAP models) and no use of multiplication factors on VaR and stressed VaR;
  - Stressed parameters in Basel III distort the impact of the hedging, but also the stressed exposures do not correctly cover WWR;

- – Assumptions regarding margin period of risk (other than the 10 and 20 days appearing in Basel III) can be further challenged;
- – Better integration of market (CVA) and credit (default charges) components to avoid the potential double counting effect currently observed in the regulation;
- – Develop both consistent point-in-time CCR measures that react consistently and dynamically to changes in the market (for monitoring and immediate action), and through-the-cycle CCR measures that avoid procyclical and unstable behaviours (for capital computation).

- Stress Testing Scenarios: Since the future cannot be entirely forecasted based on past behavior, sound risk management should develop forward-looking stressed scenarios to better understand what could potentially negatively affect CCR. Possible scenarios are:
  - – Price runs with massive increase in credit spreads and later downgrades;
  - – Insufficient eligible collateral after increased haircuts on posting of collaterals;
  - – Dry-up of collateral liquidity with subsequent collateral value decrease;
  - – Default of a central counterparty for derivatives (CCP).
- Model Risk: Given their high level of complexity, CCR models have to be regularly reviewed in order to assess, and possibly measure, the underlying model risk. In order to minimise this risk, the following tasks should be performed:
  - – Review by independent parties to ensure correctness of implementation and soundness of model assumptions;
  - – Regular backtesting of model outcomes;
  - – Monitoring and update of model parameters, like WWR;
  - – Benchmarking on alternative modeling approaches.
- Communication: One of the key factors for the successful treatment of CCR is transparent communication regarding major aspects of the model and portfolio such as:
  - – Detailed reports on counterparties with the highest concentration of CCR;
  - – Sensitivity of exposures to changes in market and credit variables;
  - – Transparent communication of model assumptions, limitations and weaknesses.
- Active Management:
  - – CCR should be integrated in the top-down risk appetite framework of the institution, i.e. at least in its tolerance for deterioration of solvency ratio(s), accounting profit and liquidity ratios: and pro-actively managed by contingency plans if plausible adverse scenarios imply risk tolerance to be exceeded;
  - – CCR retained from trading or credit portfolio management activities are limited by capital, earnings volatility and concentration limits. It is generally transferred to a specific CVA desk (different from the credit trading desk) for passive pricing per trade, but also for active mitigation and diversification at portfolio level.

What are the key challenges of modeling CCR?

Defining the motivations for measuring CCR is an important step towards understanding its complexity. However, in order to achieve a successful implementation, many challenges need to be addressed. Below are some of the potential issues of modelling CCR:

- **Implementation**: In order to measure CCR, institutions need to implement a model that can work together with many different databases and interfaces. The model has to consider market data, front office systems (e.g. implied volatilities or yield curves), LGDs, CSA data, counterparty data, netting agreements, etc.;
- **Efficiency**: Measuring CCR, and more specifically CVA, requires advanced technology and significant engine power since simulations apply not only to one deal, but to all the deals with the same counterparty each time it is computed (incremental CVA). Therefore, speed-up approaches are used like grid computing, semi-analytical solutions, algorithmic differentiation or random sampling;
- **CVA Management**: It is only since around 2007 and the financial crisis that most institutions have started to actively manage their CVA positions by creating CVA desks specialising in P&L management, hedging, valuation, pre-trade pricing, etc. Two options are usually considered, either a centralised desk with a unified vision on the risk or several decentralised desks specialised by asset and product types.

What are the current CCR hot topics?

After the 2007 crisis, CCR was identified as one of the major causes of turmoil in the financial market, and mostly materialised through downgrades and loss in value, more so than actual defaults.

Hot topics relating to CCR in 2012 include:

Are CCPs the optimal answer to managing counterparty risk or are they creating more issues than they solve?

The systemic risk relating to the probability of CCP default would be highly contagious to the financial markets. In some ways, regulators may be creating an even higher "too big to fail" problem. Moreover, modelling part of that risk becomes extremely complex because exposures cannot be identified for the other institutions dealing with the CCP. Other typical issues are related to moral hazard, netting across asset classes, operational risks, and the maturity level of the models in place.

When should institutions apply risk neutral probabilities, and when should they use real world probabilities for measuring counterparty credit risk?

There is a recurring question on the nature of CVA: should the default probability measure applied to CCR be risk neutral (e.g. extracting the term structure of the default probability from market CDS prices) or should it be real world (e.g. based on internal or external ratings)? The regulation currently leaves the choice open to the institution. In that regard the right answer depends on the strategy of the institution itself. If the institution is capable of actively managing its CCR, which means to properly manage and measure risk in real time, market implied probabilities should be used. In advanced institutions, with mature CVA desks, CVA would in most cases be market based computed and complemented by real world risk measures. For less advanced institutions, the use of real world CVA may be considered.

How can an institution optimise its use of CSA, what should be the nature of SCSA and is it going to fully replace traditional CSA?

Another key discussion is on FVA and how it should be measured and possibly optimised in regards to Credit Support Annexes (CSAs). FVA can be considered as the sum of the expected costs (FCA) and benefits (FBA) obtained from the funding over the life of a trade. However, to obtain a correct measure of it, the collateral to be posted or received as defined by the CSA needs to be clarified. Many experts take the position that this issue should be resolved in the long term by the use of Standard CSA (SCSA) following the work currently achieved by the International Swaps and Derivatives Association (ISDA).

Should institutions recognise benefits due to their own credit deterioration, and how can adverse effects be mitigated?

Another recurring topic is the recognition of a Benefit in the form of the DVA in an institution's P&L. This means that the higher the default probability of the institution, the lower the fair value of its current debt, since it will cost the institution more to borrow money on the market. Therefore, a higher CDS spread can translate itself in direct accounting benefits. This effect is controversial since it is considered a "reward" to institutions from a worsening of its credit quality.

What are the main sources of WWR, how can they be measured and managed, specifically for systematically important institutions and in adverse situations?

Potential acceleration effects, identified as Wrong-Way Risk (WWR), can materialise when exposure at risk increases the same time the credit quality of the counterparty deteriorates The issue is then to correctly identify and model these effects. The first effect is the specific WWR related to the structure of the transactions at the netting set level. The second effect includes contagion and macroeconomic effects that can be difficult to model, specifically for systematically important counterparties

How do you best integrate margin periods of risk when modelling counterparty credit risk?

This relates to the correct application of the margin period of risk for EAD valuation models handling netting sets (5, 10 or 20 business days). As existing models that are designed to assess CCR are already extremely complex, the addition of this dimension of risk can be particularly resource consuming.

Will CVA capital requirements be effectively introduced for all counterparty types as designed by Basel III?

There are currently discussions, both in the US and in Europe, regarding a full implementation of Basel III. However, one of the key issues relates to the negative spiral effect induced by CVA hedging which may lead to higher volatility of credit spreads on the market. Basically, this occurs when the credit spread of a counterparty widens, therefore increasing the CVA charge, increases the CVA charge, which then has to be compensated by additional hedging with CDS contracts that themselves put pressure on the credit spread of the counterparty.

Therefore, the European Parliament is poised to defend a CVA exemption for trades with corporate end-users, pension schemes and sovereign entities championed by the Council. This CRD IV negotiation is currently entering its final stage (November 2012). Also, in the US, banking leaders are currently defending a strong pushback of the Basel III regulation.

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Portfolio Strategies

Portfolio strategies for counterparty credit risk management can vary substantially depending on the institution's business models.

To capture these variations, we calculated CVA for three different portfolios, with different collateral management strategies, and counterparty profiles. The aim was to represent three different types of business strategies.

FIGURE 2: CCR business strategies

	A Retail Bank	**B** Commercial Bank	**C** Investment Bank
Derivatives purpose	ALM hedging in home currency; no trading	ALM hedging and trading for clients	Trading for clients and propriety purposes
Product diversity and complexity	Low: Mainly interest based swaps and options	Medium: Depending on client's needs (interest, currency,etc.)	High: Multiple underlying's, currencies and exotic structured derivatives
Customer types	ALM	ALM,SME's and corporates	Large corporate and financial institutions
	No ISDA, no margin calls	Limited ISDA and margin calls	ISDA and daily margin calls
Market Counterparties	High grade banks	High grade banks	Counterparties with low average rating
	ISDA	ISDA	ISDA
	Monthly margin calls	Weekly margin calls	Daily margin calls

A is a typical retail bank (households and self-employed persons), using interest rate swaps and some interest rate options to mitigate the interest rate gap between asset and liabilities. All the business is performed in the same currency (€), and derivatives products are not offered to clients through trading desks.

B is a universal bank with significant activity in IR derivatives for ALM purposes, as well as trading books to service SME and Corporate clients via currency swaps and vanilla options. Business is performed in a few currencies and trading positions are mostly closed at the end of the day.

C is an investment bank with limited vanilla IR or FX derivatives, but a significant amount of equity, exotic and structured derivatives products. Business is performed in multiple currencies and trading is executed for clients and for proprietary purposes. Clients are mostly corporate, banks and any type of financial institution with a lower rating.

These portfolios are key inputs for the research work and all of the results are comparetively based on them.

Testing Results

This section reviews the test results for the three portfolios described previously. It analyses how CCR capital requirements are affected by changes in the nature of the portfolios and provides insight into how it can be effectively managed.

Critical components of CCR capital requirements for various institution types and possible optimisation techniques are also explored in this section. Components such as the number and types of counterparties, the types of products, the maturity of the portfolios or the credit quality of the counterparties will be looked at. Additionally, risk mitigation features like collateralisation are also considered and their impact measured.

Computation Methodology and Base Case Results

Calculation assumptions

Different assumptions and methodologies were used throughout our calculations. They are listed below:

- CVA recovery is assumed to be at 40% for all counterparties and LGD is 60%;
- Real CDS spreads are used for CVA and CVA advanced calculations, all with recovery 40%;
- PD's in RWA calculations were implied from S&P 1981-2011 historical default rates tables, based on counterparty rating and location;
- Coefficient "alpha" which is reflecting wrong-way risk in IMM and CEM is set at 1.4;
- For Advanced CVA we used real spread shifts from one-year most recent period and one-year stressed period, we also assumed that exposures during stressed period did not change;
- Full netting is assumed;
- In base case we considered zero collateral. For fully collateralised scenario, margin call period is set at 20 days;
- Calculations for all metrics which require advanced method – internal model method (IMM) for RWA and CVA capital, Advanced method for CVA capital charge – were performed in a full-revaluation Monte Carlo model;
- For modelling interest rates we utilised the BGM model with volatility structure calibrated to market caps and swaptions and modelled FX as lognormal forward process with volatilities calibrated to FX options;
- In all tests we assumed no wrong-way risk.
- The following results were produced: CEM and IMM default capital charges, Standardised CEM and Standardised IMM CVA capital charges and Advanced CVA capital charges. For comparison purposes, total CVA for each portfolio is also provided
- Three combined total CCR capital charges were calculated (see Appendix for details).

Real Portfolio

In line with the previous description of portfolio strategies, three portfolios were set up, all with different number and credit quality of counterparties. Though total notional of each of the portfolios is the same, set at $10 bn, they have quite a different structure in terms of number and types of trades. The following table includes the structure and general characteristics of each portfolio:

FIGURE 3: Portfolios structures and general characteristics

	Retail	Wholesale	Propriety
General Characteristics			
Rating	AA–	AA–	BBB
Total Notional	$10.000.000.000	$10.000.000.000	$10.000.000.000
Num Trades	51	76	103
Num Counterparties	8	10	16
Average CPY Rating	AA–	AA–	BBB
Min CPY Rating	A	A	BB
IR Swaps			
Total Notional (bln)	8,7	6,9	5,2
Num Trades	25	26	35
Cross-CCY swaps			
Total Notional (bln)		1,9	3,3
Num Trades		19	28
European IR swaptions			
Total Notional (bln)	0,7	0,5	0,6
Num Trades	13	11	13
Cap/Floors			
Total Notional (bln)	0,6	0,5	0,7
Num Trades	13	13	17
FX forwards			
Total Notional (bln)		0,2	0,2
Num Trades		7	10

Main sources of differences between the approaches

Before reviewing the test results, one can compare equations for CVA capital charges as provided in the Appendix. As shown, though it is not mentioned explicitly in a Basel document, Standardised formula can be interpreted as 99% CVA VaR on a number of specific portfolios. Advanced formula is defined in the Basel document as 99% VaR. More precisely, it is a sum of two 99% VaRs. However, assuming that spread shifts for all counterparties and indices can be scaled by the same ratio, then the formula is very similar to the one presented by equation (5.1), which allows for approaches to be compared analytically.

One interesting conclusion of such a comparison is that the correlation between counterparties in Standardised formula is assumed to be 25%, while in Advanced formula it is implied by historical shifts. Another interesting conclusion is that the worsening of counterparty credit and corresponding widening of credit spreads has a greater effect on the Advanced method compared to the Standardised approach, except when a counterparty is simultaneously significantly downgraded. The reason being that credit quality in Standardised formula is only reflected in a rating-based weight (see Appendix) while in the Advanced formula it is almost proportional to spread widening.

Tests presented in the next section confirm the above conclusions.

Base case - comparison of the results obtained from the different portfolios

The table below shows that in terms of Default Capital Charges, IMM is always less punitive than CEM. It is well recognised that the IMM approach is more sophisticated and results in significant RWA savings relative to the CEM approach. This is because the IMM approach provides full netting of future exposures while CEM allows netting benefits for the add-on amount of up to 60%. CEM is also considerably more punitive for in-the-money trades.

FIGURE 4: Default and CVA capital charges for a base case

	Base Case					
	Default Capital Charge			CVA Capital Charge		
	CVA	CEM	IMM	Stand CEM	Stand IMM	Advanced
Retail	(3.087.720)	8.961.155	4.359.627	7.215.199	5.814.989	2.059.956
Wholesale	(16.341.321)	18.381.819	12.851.028	16.105.908	27.380.981	13.496.462
Propriety	(19.604.451)	28.943.436	15.640.906	29.918.119	31.197.962	15.048.240

Regarding CVA capital charges, one can immediately see that advanced CVA requires significantly less capital than either of the standardised formulas. Furthermore, by adding Default and CVA capital charges to produce combined CCR capital charges (see Table below), the advantage of implementing IMM and obtaining CVA advanced approval is even greater.

An unexpected result is the strong increase in CVA capital charge between the Standardised CEM and the standardised IMM approach for the Wholesale strategy. One explanation for this is that the Wholesale portfolio is strongly concentrated on a counterparty with large exposure. Whereas for RWA we simply add across counterparties as Standardised IMM CVA formula assumes only 25% correlation between counterparties, therefore concentration for CVA capital charge is penalised. However, the combined capital increase from CEM to IMM, for Wholesale portfolio, is only 17%, whilst for two other portfolios IMM performed significantly better.

FIGURE 5: Base case

Base Case			
Combined CCR Capital Charges			
	IMM + Adv CVA	IMM + Std CVA	CEM + Std CVA
Retail	6.419.583	10.174.616	16.176.354
Wholesale	26.347.490	40.232.009	34.487.727
Proprietary	30.689.146	46.838.867	58.861.555

Scenarios test results and portfolio effective risk management

Collateralisation

To understand how Default and CVA capital charges evolve when collateral is applied, we considered the case of full collateralisation. The results are shown in the table below.

FIGURE 6: Scenario 1

Scenario 1 – Fully Collateralized						
	Default Capital Charge			CVA Capital Charge		
	CVA	CEM	IMM	Stand CEM	Stand IMM	Advanced
Retail	(60.557)	873.031	191.137	708.496	257.801	48.601
Wholesale	(202.972)	2.448.053	339.213	2.146.376	462.833	162.558
Proprietary	(282.465)	3.979.722	452.943	4.231.813	584.537	238.008

Note that because of a 20-day margin period, even full collateralisation does not completely alleviate expected loss. Therefore we still have non-zero Standardised IMM and Advanced CVA capital charges, which are both based on positive exposure. Obviously the CEM method results in significantly higher Default and CVA capital charges. This is a well-known drawback of CEM as it only uses current collateral held, while IMM methodology allows future collateral to be projected based on contract terms.

Spread widening

To capture the sensitivity of portfolios, to changes in the credit quality of the underlying counterparties, we considered doubling of CDS spreads with simultaneous downgrade of all counterparties (from AA to A, A to BBB, etc). Note that historically implied PD's were recalibrated consistently with the new rating.

FIGURE 7: Scenario 2

Scenario 2 – Double Credit Spreads, One-notch Downgrade						
	Default Capital Charge			CVA Capital Charge		
	CVA	CEM	IMM	Stand CEM	Stand IMM	Advanced
Retail	(5.767.765)	13.179.535	6.833.960	8.491.731	7.022.581	3.532.258
Wholesale	(29.871.361)	27.875.705	19.260.448	19.626.979	33.481.647	22.483.410
Proprietary	(35.683.707)	42.565.940	23.406.188	37.190.589	37.974.695	24.464.765

As we expected, CVA values increased almost by two and as a result Advanced CVA capital charge increased 60-70%. However, the increase for Standardised capital charge is only around 20%. This is because credit quality in Standardised formula is only reflected in a rating-based weight (see Appendix), which in the case of AA-to-A or A-to-BBB downgrade only increased by 14% and 25% respectively.

Collateralisation and Spread

This section considers a combination of the two previous tests.

FIGURE 8: Scenario 3

Scenario 3 – Fully Collateralized + Doubled Credit Spreads, One-notch Downgrade						
	Default Capital Charge			CVA Capital Charge		
	CVA	CEM	IMM	Stand CEM	Stand IMM	Advanced
Retail	(114.552)	1.282.466	320.781	835.917	318.113	84.705
Wholesale	(377.875)	3.707.710	562.402	2.613.469	568.766	275.252
Proprietary	(521.821)	5.896.350	713.857	5.264.876	719.525	401.044

It is interesting to see that collateralisation appears to be a relevant strategy against a counterparty downgrade.

Concentration

In this section, the objective is to understand how a strategy based on the maturity or duration could potentially impact the different capital measures. In this test, maturities of Interest Rates and Cross-CCY swaps were modified so that their 5-year difference was halved, i.e. 3 year maturity changed to 4 year, 7 year to 6 year, and no change for 5 year. Similarly FX Forwards, originally short-dated, were concentrated around 3-months. Note that this scenario does not alter an average maturity.

FIGURE 9: Scenario 4

Scenario 4 – Doubling Concentration (FX Forwards – around 3 m, IR swaps and others around 5yr)						
	Default Capital Charge			CVA Capital Charge		
	CVA	CEM	IMM	Stand CEM	Stand IMM	Advanced
Retail	(4.073.921)	13.490.413	5.802.096	11.641.819	8.275.283	3.697.340
Wholesale	(18.512.425)	25.441.180	14.403.798	25.149.627	30.212.957	15.378.878
Proprietary	(20.796.540)	33.480.033	16.048.872	34.456.117	31.189.243	15.316.000

As we expected, because dependency of exposure and CVA on maturity is not linear and provides more weight to lower maturity, CVA and all related metrics increased. An additional contribution to RWA increase can be explained by the fact that, while average maturity is kept constant, because of 5-year cap on effective maturity, increased concentration around 5 years means that total effective maturity went up.

Interestingly, across all portfolios, the impact of the CEM approach is much greater when compared with the more advanced approaches (IMM, Standardised IMM and Advanced IMM). This provides a very clear message to institutions, with low sophistication, of the need to optimise their concentration. Also, there is minimal impact for the proprietary strategy when using advanced approaches, indicating that institutions should not be too concerned about concentration for optimising their capital requirements.

Potential acceleration effects, identified as Wrong-Way Risk, can materialise when exposure at risk increases the same time the credit quality of the counterparty deteriorates.

Conclusion and Next Steps

CCR started essentially as a valuation issue, more than ten years ago. Slowly, market practice and standardised tools have emerged, for example the use of CVA desks. However, during the recent crisis, another issue came to prominence, the significant losses that CCR can cause if not managed properly. In response to this pressing matter, regulators have developed a number of alternative approaches to measure this new type of risk, including both standard default risk and market risk, leading to various types of capital requirements. The purpose of this paper has been to assess the impact of these different methodologies on some typical portfolio strategies. This is of critical importance in understanding the potential incentives of moving from one approach to the other, and the necessary solutions to manage and possibly mitigate capital requirements.

Nevertheless, in the event of another credit crisis, simply realising what is required will not be sufficient in avoiding major losses. What is also required is sound and active risk management. Financial institutions should develop their own internal models to deal with regulatory inconsistencies, complemented with forward looking measures (not only referring to past historical data), and take appropriate actions to mitigate CCR. For all these reasons, it is necessary to have reliable and transparent models that not only provide reporting information, but also enable risk managers to assess the potential impact of their decisions.

Progressing in the direction of active CCR management requires a clear vision of all the aspects and challenges involved. In this paper, we have summarised some of these elements to help risk managers grasp the depth and complexity of the topic.

Another interesting conclusion is that worsening of counterparty credit and corresponding widening of credit spread has a greater effect on the Advanced method compared to the Standardised approach, except when a counterparty is simultaneously significantly downgraded.

Appendix

CCR Default Charge

Introduced by Basel II, the concept of the CCR default charge relies on the notion of loan equivalent Exposure at Default (EAD). This means that for each netting set, an artificial exposure to CCR is defined and then be considered as a standard EAD for computing Risk Weighted Capital.

$$RWA = K \times Risk\ Weight \times Outstanding\ EAD$$

It is important to note here that the Outstanding EAD is not the EAD as a whole; it needs to be understood with the deduction of the CVA. Therefore, computation of the CVA should precede the computation of the default risk charge.

$$Outstanding\ EAD = EAD - CVA$$

The Risk Weight to be used is the one for corporate, sovereign and bank exposures and is therefore equal to 12.5. As for K, the capital requirement, it is equal to

$$(K) = \left[LGD \times N\left[(1-R)^{-0.5} \times G(PD) + \left(\frac{R}{1-R}\right)^{0.5} \times G(0.999)\right] - PD \times LGD\right] \times (1 - 1.5 \times b)^{-1} \times (1 + (M - 2.5) \times b)$$

With b being equal to the maturity adjustment, and R equal to the correlation

$$b = (0.11852 - 0.05478 \times \ln(PD))^2$$

$$R = 0.12 \times \left(\frac{1 - e^{-50 \times PD}}{1 - e^{-50}}\right) + 0.24 \times \left[1 - \left(\frac{1 - e^{-50 \times PD}}{1 - e^{-50}}\right)\right]$$

In order to compute the EAD for counterparty credit risk, three possibilities exist: CEM, SM and IMM.

Current exposure method (CEM)

CEM is the most straightforward measure of the EAD

$$EAD_{CEM} = Current\ Exposure + Netting\ Factor \times Add\text{-}on$$

Current Exposure (CE) is the larger of netted contracts and zero, with value reduced by the current market value of the collateral (C), subject to a haircut which accounts for the volatility of C. Haircuts can be regulatory set (Basel II, art. 151) or estimated internally.

$$CE = max\left(\sum_i MtM_i - C_i, 0\right)$$

The netting factor is equal to the weighted average of the gross add-on and the gross add-on adjusted by the ratio of net current replacement cost to gross current replacement cost (NGR).

$$Netting\ Factor = 0.4 + 0.6 \times NGR$$

$$Netting\ Factor = 0.4 + 0.6 \times \frac{max(\sum_i MtM_i, 0)}{\sum_i max(MtM_i, 0)}$$

The add-on is equal to the notional of the exposure multiplied by the add-on factor. The add-on factors are determined by the transaction remaining maturity and the type of underlying instrument, as depicted on the following figure:

$$Add\text{-}on = \sum_i Notionnal_i \times Add\text{-}on\ factor_i$$

FIGURE 10: Netting factors following instrument type and maturity

	Interest Rates	FX and Gold	Equities	Precious Metals Except Gold	Other Commodities
One year or less	0.0%	1.0%	6.0%	7.0%	10.0%
Over one year to five years	0.5%	5.0%	8.0%	7.0%	12.0%
Over five years	1.5%	7.5%	10.0%	8.0%	15.0%

To conclude, the equation's product allows for only 60% of the netting benefit to be accounted for in the adjustment for future exposure. The final equation is

$$EAD_{CEM} = max(\sum_i MtM_i - C_i, 0) + \left(0.4 + 0.6 \times \frac{max(\sum_i MtM_i, 0)}{\sum_i max(MtM_i, 0)}\right) \times \sum_i Notionnal_i \times Add\text{-}on\ factor_i$$

Standardised method (SM)

The SM approach is somewhat more advanced than the CEM, as it takes into account additional factors such as hedging and wrong-way risk.

$$EAD_{SM} = \beta \times max\left(\sum_j MtM_j - C_j, \sum_k \sum_j Net\ Risk\ Position_{k,j} \times \sum_k Credit\ Conversion\ Factor_k\right)$$

β represents the supervisory scaling parameter and is set at 1.4. It is supposed to take into account wrong-way risk and model risk effects. C_j is the current market value of collateral positions assigned against the netting set.

The net Risk Position (RP), at the level of a netting set k, is the difference between the risk position in a transaction (RPT_i) and the risk position in collateral (RPC_l). A net risk position is contained in a hedging set (k), which in turn is contained in a netting set. A hedging set is defined as risk positions with the same risk factor.

$$\sum_k \sum_j Net\ Risk\ Position_{k,j} = \sum_k \left(\sum_j RPT_{k,j} - \sum_j RPC_{k,j}\right)$$

The Credit Conversion Factor (CCF) is fixed by the supervisor and depends on the asset class, as detailed in the next figure:

FIGURE 11: Credit conversion factors following asset class

Asset Class	CCF
Interest Rate	0.2% for interest rate derivatives 0.3% for credit derivatives 0.6% for debt instruments
Exchange Rate	2.5%
Electricity	4.0%
Gold	5.0%
Equity	7.0%
Precious Metal excl. Gold	8.5%
Other Commodities	10.0%
Other Derivatives	10.0%

As a summary, the EAD under the SM approach is obtained as

$$EAD_{SM} = 1.4 \times max\left(\sum_j MtM_j - C_j , \sum_k \left(\sum_j RPT_{k,j} - \sum_j RPC_{k,j}\right) \times \sum_k Credit\ Conversion\ Factor_k\right)$$

Internal Model Method (IMM)

For default CCR charges the IMM approach is the most advanced as it allows banks to use their own internal models for PD, Effective Maturity, Correlation and EAD. Two possibilities exist for IMM, either Foundation Internal Rating Based (F-IRB) or Advanced Internal Rating Based (A-IRB). The difference relates to the computation of the LGD, fixed by the regulator in F-IRB and based on own model for A-IRB.

$$EAD_{IMM} = \alpha \times max(Stressed\ EEPE, EEPE)$$

The parameter α accounts for model inaccuracies, like wrong-way risk; it is set by default to 1.4. The parameter can also be estimated by the institution and should correspond to the ratio of economic capital from a full simulation of counterparty exposure across counterparties (numerator) and economic capital based on EPE (denominator).

The Effective Expected Potential Exposure (EEPE) is obtained as follows

- Computation of the Expected Exposure (EE), measured as the mean of a distribution of exposures at a future date (usually obtained using Monte Carlo simulations)
- Computation of Effective Expected Exposure (EEE), measured as the non-decreasing EE
- Computation of EEPE as the weighted average over time of EEE

EEPE is calibrated on either market implied data (risk neutral probabilities) or current market data with at least three years of historical data (real probabilities). The same alternatives apply to calibration of Stressed EEPE, however, the data should reflect a period of stress in the data. Also, stress calibration should not be applied on a counterparty by counterparty basis, but on a total portfolio level.

Additionally, if the original maturity of the longest dated contract is greater than one year, the formula for M is the following:

$$M = \frac{\sum_{k=1}^{t_k \le 1year} Effective\ EE_k \times \Delta t_k \times df_k + \sum_{t_k > 1year}^{maturity} EE_k \times \Delta t_k \times df_k}{\sum_{k=1}^{t_k \le 1year} Effective\ EE_k \times \Delta t_k \times df_k}$$

Where df_k is risk-free discount factor for future time period t_k.

With regards to collateral, the IMM approach may also capture future collateral movements for margined counterparties. However, to the extent that a bank recognises collateral in exposure amount or EAD via current exposure, the bank would not be permitted to recognise the benefits in its estimates of LGD.

CCR Market Charge

In addition to the CCR default charge, Basel III requires banks to compute the CCR market charge (also referred to as CVA risk capital charge). This charge can be computed according to either the standardised method or advanced method.

Standardised CVA

When a bank does not have the required approvals to use the advanced CVA capital approach, it must calculate a portfolio capital charge using the following formula:

$$K = 2.33.\sqrt{h}.\sqrt{\left(\sum_i 0.5.w_i.(M_i.EAD_i^{total} - M_i^{hedge}.B_i) - \sum_{ind} w_{ind}.M_{ind}.B_{ind}\right)^2 + \sum_i 0.75.w_i^2.(M_i.EAD_i^{total} - M_i^{hedge}.B_i)^2}$$

Where:

- h is the one-year risk horizon;
- EAD_i^{total} represents all the exposures of the counterparty summed across its netting sets and consistently with the default risk charge model applied (CEM, SM or IMM);
- Mi is the effective maturity of the transaction. It is not capped to five years and for non-IMM banks, the weighted average maturity should be used together with the explicit maturity adjustment;
- $B_{i/ind}$ is the notional of purchased single name/index CDS hedges;
- $M_{i/ind}^{hedge}$ is the maturity of the single name/index CDS hedges;
- For non-IMM banks, a discounting factor $(1\text{-} \exp(-0.05xM_i))/(0.05xM_i)$ should be applied to EAD_i^{total},B_i and B_{ind};

- w_i is the weight applicable to counterparty 'i' and must be mapped on external ratings;
- w_{ind} is the weight applicable to index hedges. Mapping is based on the average spread.

FIGURE 12: Weight applicable to index hedges

Rating	Weight wi
AAA	0.7%
AA	0.7%
A	0.8%
BBB	1.0%
BB	2.0%
B	3.0%
CCC	10.0%

Analysis of Standardised CVA

This section explains that for a portfolio of normally distributed assets with specific volatilities and correlation structure the Standardised Capital charge formula has the meaning of 99% one-year VAR.

Note that in the Standardised CVA formula the value of h is set at 1

$$X_i = w_i \cdot \left(M_i \cdot EAD_i^{total} - M_i^{hedge} \cdot B_i\right) \qquad X_{ind} = w_{ind} \cdot M_{ind} \cdot B_{ind},$$

it can be rewritten as:

$$K = 2.33 \cdot \sqrt{\sum_i X_i^2 + 0.5 \cdot \sum_i \sum_{j<i} X_i \cdot X_j - X_{ind} \cdot \sum_i X_i + X_{ind}^2}$$

Let us consider a set of normal random variables N_i's, each with 0 mean and volatility σ_i, i.e. $Ni \sim N(0,\sigma_i)$ and assume that they are all correlated with single correlation $\rho = correl(N_i,N_j)$. Consider now another normal random variable $N_{ind} \sim N(0,\sigma_{ind})$ which is correlated with N_i's with single correlation $\rho_{ind} = correl(N_i,N_{ind})$. Finally, consider random variable $Y = \sum_i N_i - N_{ind}$.

Then $Y \sim N(0,\sigma_Y)$ where:

$$\sigma_Y = \sqrt{\sum_i \sigma_i^2 + 2 \cdot \rho \cdot \sum_i \sum_{j<i} \sigma_i \cdot \sigma_j - 2 \cdot \rho_{ind} \cdot \sigma_{ind} \cdot \sum_i \sigma_i + \sigma_{ind}^2}$$

Assume that we want to find the 99% percentile of Y $\alpha_{0.99}$, then:

$$\alpha_{0.99} = N^{-1}(0.99) \cdot \sigma_Y = 2.33 \cdot \sqrt{\sum_i \sigma_i^2 + 2 \cdot \rho \cdot \sum_i \sum_{j<i} \sigma_i \cdot \sigma_j - 2 \cdot \rho_{ind} \cdot \sigma_{ind} \cdot \sum_i \sigma_i + \sigma_{ind}^2}.$$

comparing this with eq. (5.1), one can see that the Standardised Capital Charge has the meaning of a 99% percentile of the sum of random variables $Y = \sum_i N_i - N_{ind}$, where N_i's have 0 expectation and volatility X_i and are intra-correlated with $\rho = 0.25$ and N_{ind} have 0 expectation and volatility X_{ind} and its correlation with N_i's is $\rho = 0.5$

Therefore, though it was not specified explicitly in the Basel document, we show that this capital charge can be interpreted as the 99% confidence interval for a portfolio of normally distributed assets with some specific variance matrix. More specifically, the volatility of the i-th asset is $\sigma_i = w_i \cdot (M_i \cdot EAD_i^{total} - M_i^{hedge} \cdot B_i)$, volatility of index is, correlations between each pair of assets are assumed to be 25%, and their correlations with the index is implied to be 50%.

As a conclusion, the standardised formula for CVA can be interpreted as the 1-year 99% CVA VaR under normal distribution assumptions for the portfolio of netting sets (with individual hedges included) with additional index hedges applied to the whole portfolio.

Advanced CVA

The advanced method for computing CVA is directly related to the VaR model in place in the institution.

$$K = 3 \times \left(VaR_{current}(\Delta CVA) + VaR_{stressed}(\Delta CVA)\right)$$

With ΔCVA equal to the difference between the CVA computed at a 10 days horizon and the CVA at the time of the computation. This value is generated a number of times by the VaR model in place, and the worst ΔCVA at the 99th quantile is used. Also, calibration is done both on current market data and on stressed market data including a stress period. The initial CVA value (at time zero) is computed as follow:

$$CVA = (LGD_{MKT}).\sum_{i=1}^{T} Max\left(0; e^{\left(-\frac{s_{i-1} \cdot t_{i-1}}{LGD_{MKT}}\right)} - e^{\left(-\frac{s_i \cdot t_i}{LGD_{MKT}}\right)}\right).\left(\frac{EE_{i-1}.D_{i-1} + EE_i.D_i}{2}\right)$$

Where:

- t_i is the time of the i-th revaluation time bucket, starting from $t_0 = 0$;
- t_T is the longest contractual maturity across the netting sets;
- s_i is the credit spread of the counterparty at the tenor t_i;
- LGD_{MKT} should be based on the spread of a market instrument of the counterparty;
- EE_i is the EE to the counterparty at revaluation time t_i and should include collateral and
  eligible hedges;
- D_i is the default risk-free discount factor at time t_i.

It is important to note that EE profiles are fixed when doing the VaRcurrent and the VaRstressed. Indeed, the VaR model only simulates the counterparty credit spread.

Total CCR Capital Charge

The Basel III regulation requires banks to sum up CCR market and default charges. The following possibilities exist:

1. Banks with IMM approval and market-risk internal-models approval
   Total CCR K = Max(IMMcurrent, IMMstressed) + Adv CVA K
2. Banks with IMM approval and without Specific Risk VaR approval for bonds
   Total CCR K = Max(IMMcurrent, IMMstressed) + Std CVA K
3. All other banks
   Total CCR K = (CEM or SM) + Std CVA K

This means, that there are actually four possible outcomes for the total CCR capita charge.

Regarding CVA Capital charges, one can immediately see that advanced CVA requires significantly less capital than either of the standardised formulas.

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