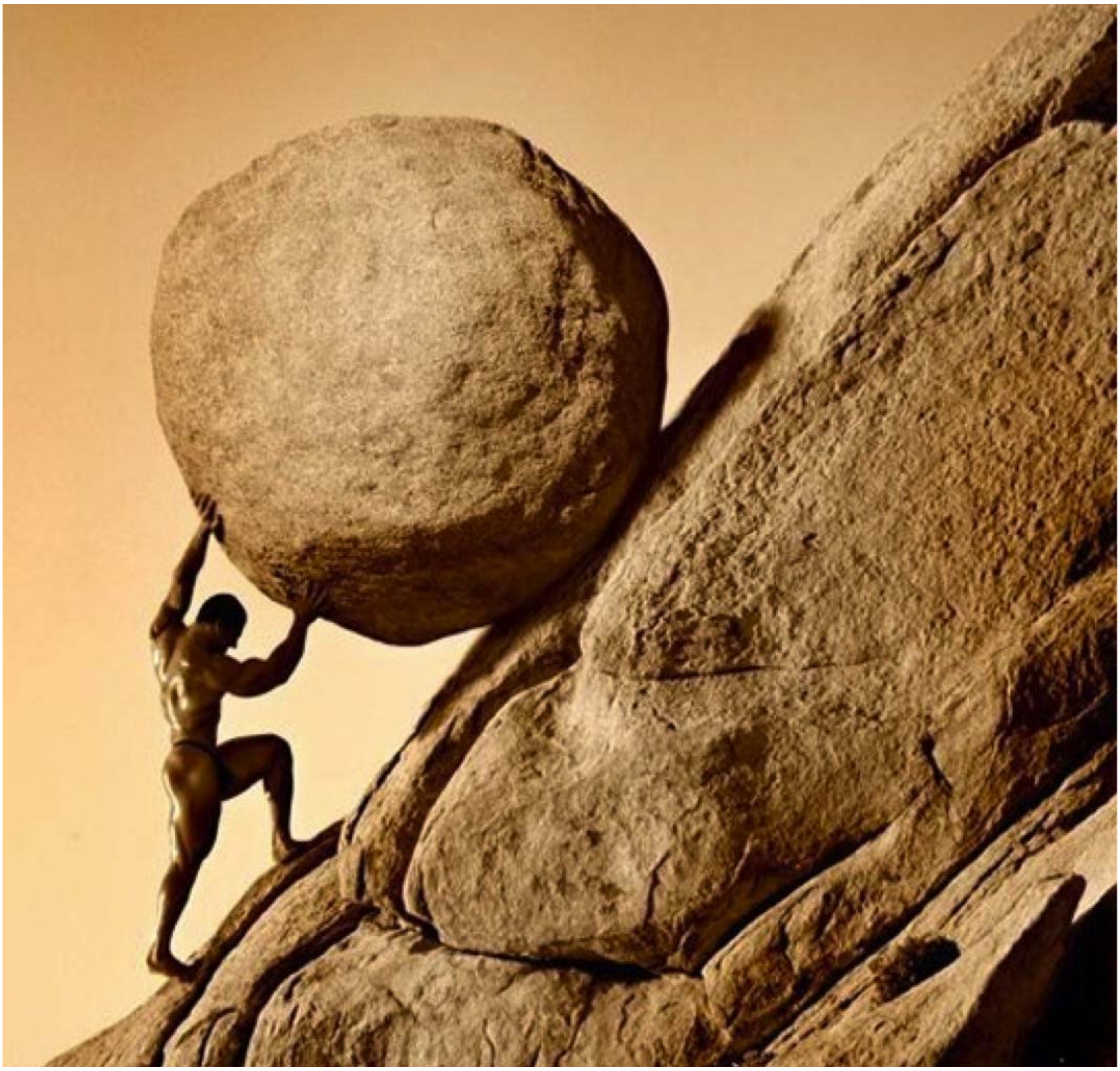

CVA Capital Charges: A comparative analysis

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Introduction

The aftermath of the global financial crisis has led to much stricter regulation and capital requirements for banks. There has been a significant effort around the issue of counterparty credit risk and CVA (credit value adjustment) as key negative forces and catalysts during the crisis. This has led to a completely new capital charge for the volatility, or value-at-risk (VaR) of CVA. At a time when CVA charges themselves are driving pricing dynamics within OTC derivative markets, it is inevitable that, approaching Basel III implementation in 2013, such effects will be amplified due to CVA VaR requirements[1] under the Basel III regime.

Due to the significantly different sizes and sophistication of global banks, capital requirements do not tend to follow a single methodology but rather allow different choices of varying sophistication. This is the case with CVA VaR where two methods, standardised and advanced, may be used depending on the existing regulatory approvals that a bank has. A bank with IMM (internal model method) and specific risk approvals must use the "advanced approach" whilst other banks would use the more basic "standardised formula".

The regulatory landscape has changed swiftly over the last few years and banks and clients are still digesting the implications of new regulations such as CVA VaR. In this paper, we explain the background, the differences between standardised and advanced approaches and also examine the potential capital relief achievable through hedging. We note that CVA will be assumed to be defined with respect to market parameters, which is a growing trend and supported by future accounting standards (IRFS 13) and Basel III regulation. We will focus all arguments around the current Basel III capital requirements[2] and not take into account any changes that may be applied by local regulators. Finally, we will not discuss funding costs or funding value adjustment (FVA) components.

CVA – the standardised approach

The Basel III standardised approach can be most simply derived as follows. Assume that there is an exposure to a netting set[3] which is hedged with a certain amount of single name CDS protection and denoted by E_i. The sensitivity of this hedged exposure to a move in the underlying credit spread is v_i. Assume that this credit spread is driven by a standard normal variable X_i so that the change is then given by $E_i.v_i.X_i$.

Suppose that offsetting each exposure is a number of index hedges which have notional B_{ind} and sensitivity v_{ind}. The index positions change by an amount $B_{ind}v_{ind}X_{ind}$, where X_{ind} is a standard normal variable (which is the same for all index positions). Finally, the relationship between the exposures and index hedges is defined in CAPM-style by a single correlation parameter ρ with $X_i = \rho X_{ind} + \sqrt{1-\rho^2}\epsilon_i$ with ϵ_i being another independent standard normal variable. Under these assumptions, the standard deviation of the overall change in CVA would be:

$$\sqrt{\left(\sum_i \rho.E_i.v_i - \sum_{ind} B_{ind}.v_{ind}\right)^2 + \sum_i (1-\rho^2).E_i^2.v_i^2}.$$

To achieve the Basel III formula we now assume:

- The sensitivity of the single name hedged position is defined by $E_i.v_i = w_i\left(M_i.EAD_i^{total} - M_i^{hedge}.B_i\right)$ where weights w_i represent the credit spread volatility of each counterparty which are defined depending on the counterparty rating[4], EAD_i^{total} is the total exposure to a counterparty and B_i is the notional of the single-name hedges[5]. Lastly, M_i and M_i^{hedge} represent maturity factors for the exposure and hedges respectively[6].
- The sensitivity of the index hedges is $w_{ind}.M_{ind}.B_{ind}$ where w_{ind} is a similar weight defined via the same mapping to the average rating of the index, M_{ind} is the maturity (or notional weighted maturity) of the index hedges and B_{ind} is the notional of the index position. No distinction appears between different indices and counterparties as all such correlations are assumed to be 50%.

[1] We note that there are potential exemptions for CVA VaR such as the European Sovereign exemption and a possible non-financial exemption. At the time of writing, such potential exemptions add uncertainty to the future impact of capital charges.

[2] Basel III: A global regulatory framework for more resilient banks and banking systems - revised version June 2011. http://www.bis.org/publ/bcbs189.htm

[3] A netting set contains a number of trades that may be legally netted. There may be more than one netting set with a given counterparty.

[4] For AAA, AA, A, BBB, BB, B and CCC ratings the respective weights are 0.7%, 0.7%, 0.8%, 1.0%, 2.0%, 3.0%, 10.0%.

[5] This quantity should be discounted according to $\left(1-exp\left(-0.05 \times M_i^{ind}\right)\right)/\left(0.05 \times M_i^{ind}\right)$.

[6] For IMM banks M_i is the effective maturity whereas for non-IMM banks it is the notional weighted average maturity. If there is more than one single-name hedge then the sum of the $M_i^{hedge}B_i$ terms must be calculated.

- The correlation between the index hedge and each counterparty is assumed to be 50% since in the Basel formula the terms ρ and $(1-\rho^2)$ appear as 0.50 and 0.75 respectively. The correlation between different counterparties would be implicitly assumed to be ρ^2=25%.
- A confidence level of 99%[7] and time horizon (defined in Basel III as h) of one-year.

Under normal distribution assumptions this gives the Basel III standardised capital charge for CVA VaR.

CVA – the advanced approach

In the so-called advanced approach, a bank can use their own VaR model to calculate the capital charge via the CVA VaR directly. This must be done at a 99% confidence level and for a 10-day time horizon and CVA must be defined by the following formula:

$$CVA = LGD_{mkt} \sum_{i=1}^{T} \max\left(0; \exp\left(-\frac{s_{i-1}t_{i-1}}{LGD_{mkt}}\right) - \exp\left(-\frac{s_i t_i}{LGD_{mkt}}\right)\right)\left(\frac{EE_{i-1}D_{i-1}+EE_iD_i}{2}\right) \quad (1)$$

where LGD_{mkt} is the loss given default, s_i the CDS spread, EE_i the expected exposure and D_i a risk-free discount factor with the formula calculated across some time grid $[0, t_1, \dots, t_T]$. The expected exposure (EE) must be defined as the *maximum* value calculated from normal and stressed calibrations. Note that the above formula denotes an explicit dependence on credit spreads s_i rather than any reliance on real world default probabilities of any sort. In terms of dealing with spreads that cannot be directly observed in the market, the BIS state "*Whenever such a CDS spread is not available, the bank must use a proxy spread that is appropriate based on the rating, industry and region of the counterparty".* Hence, banks will need to have mapping approaches in order to determine each required credit spread. Such approaches do not necessarily have to be the same as those used for calculating the CVA itself (for example for accounting purposes or pricing trades). There are other reasons why the regulatory CVA may differ, in particular with DVA (debt value adjustment), common in accounting and trade pricing, needing to be ignored under Basel III capital definitions.

The advanced CVA VaR calculation is required to simulate both general and specific changes in the credit spreads but not any variability of the EE. It must also be calculated separately from the standard market risk VaR. Finally, as with market risk VaR, there is a requirement to calculate the CVA VaR twice, once with normal parameters and once with parameter including a period of stress (in additional to the use of stressed EE already mentioned). The total capital will be based on the *sum* of the normal and stressed calculations with the usual VaR multiplier of (at least) three applying also.

As with the standardised charge, capital relief can be achieved from credit hedges such as single-name and index CDS positions[8] but not from any market risk hedges (e.g. interest rate, FX or volatility related).

Comparing the standardised and advanced approaches

Both the standardised and advanced approaches are based on a basic need to quantify a worst case variability in CVA at a 99% confidence level at a pre-specified time horizon to produce a capital requirement. They share some common drawbacks, such as the lack of recognition of market risk hedges which actually creates an increased capital charge due to a split hedge issue[9]. However, our aim is to compare the approaches and gain intuition on which will be the most conservative under different circumstances. In this respect, the obvious differences are:

i) Multipliers

In the standardised approach, a multiplier of 2.33 is interpreted as corresponding to a 99% confidence level for a normal distribution, whilst the time horizon is assumed to be 1-year. This leads to an overall multiplier of 2.33. In the advanced approach, a 99% confidence level must still be assumed, the relevant time horizon is 10-days and the standard multiplier of for VaR (minimum of three) is also applied. This leads approximately to an overall multiplier of $2.33 \times \sqrt{10/250} \times 3 = 1.40$[10].

[7] $\Phi^{-1}(99\%) = 2.33$

[8] And any other similar hedges such as contingent CDS.

[9] Meaning that the "non-eligible" hedge would have to be put in the standard VaR calculation and would therefore cause an increase in capital.

[10] Note that this considers a normal distribution approximation for the advanced approach. The impact of non-normal assumptions is considered in the next point.

ii) Distribution assumptions

The advanced approach will capture non-Gaussian behaviour such as fat tails and skewness in credit spreads tending to lead to a higher capital charge.

iii) Exposure at default (EAD)

Banks using the standardised approach will likely (but not necessarily) be using simple methods such as the current exposure method (CEM) or the standardised approach to define the EAD. Such approaches are generally (although not always) conservative in terms of their representation of trade exposure and the risk mitigating benefit from netting and collateral. Even if a bank can quantify EAD via their IMM model[11] then it will still be treated conservatively as the product of EEPE and the alpha multiplier[12]. Advanced banks can use the EE profile directly as in equation (1) which is likely to lead to lower exposures[13] and therefore smaller capital numbers.

iv) Spread volatility

In the standardised approach, credit spread volatility is essentially introduced via the weights per rating category which do not appear especially severe in current market conditions. For example, the annual volatility of a triple-B credit is assumed to be 100 bps. In the advanced approach, the credit spread volatility must be modelled explicitly and the capital charge will be the sum of the normal CVA VaR and that calculated including the stressed period. The sum of normal and stressed numbers may be expected to lead to a higher volatility than in the standardised approach.

v) Spread correlation and portfolio effect

The standardised approach implicitly assumes the spread correlation between counterparties to be $\rho^2 = 25\%$ which is determined by the 50% chosen for index correlation in a single factor approach. It is likely that in the advanced approach spread correlation would be significantly higher. However, whilst this will clearly give an advantage in terms of index hedging being more beneficial, there is a disadvantage from the loss of portfolio diversification.

vi) Delta hedging impact

Under the standardised approach, the maturity adjusted hedge notional can be directly subtracted from the maturity adjusted EAD. As noted already, the calculation of EAD is necessarily crude under approaches such as the CEM and even the IMM generated EAD involves use of EEPE and multiplication by the alpha factor[14]. Hence, it is likely that the notional of CDS protection purchased by a CVA desk to delta hedge will be likely smaller than the notional required to exactly offset the regulatory EAD. Due to the conservativeness of the standardised regulatory formulas, it is likely that delta-neutral CVA hedges provide only moderate capital relief and that full capital relief would only be achieved via systematic over-hedging.

Under the advanced approach, the alignment between hedges and capital relief should be better due to the direct reference to the CVA formula in equation (1), which should align more directly with the CVA formula used by the CVA desk. Aligning the loss given default (LGD) and spread terms (s) in this formula would appear to be relatively easy. However, aligning the last expected exposure (EE) term is more problematic due to real world vs. risk neutral parameters, requirements over stressed calibrations and tail effects. Even under the advanced approach, a bank will not be able to align CVA hedging and capital relief perfectly.

vii) Index hedging impact

Index hedges suffer from the same problems as single-name hedges discussed above. Furthermore, there is the question of what correlation is permitted between the counterparty spread and the index used for hedging. In the standardised approach, this correlation is assumed to be 50%. Under the advanced approach, higher index correlations are possible and banks using this approach are therefore likely to argue that, driven by their mapping

[11] It is possible for a bank to have IMM approval but not specific risk approval in which case they would have to use the standardised method.
[12] Effective expected positive exposure (EEPE) is derived via a non-decreasing constraint on exposure and the alpha multiplier is generally 1.4. Both are likely to be conservative compared to the advanced approach which uses the exposure profile directly.
[13] Although there is the need to consider stressed EE which is described below.
[14] This is perverse as alpha is a correction for a portfolio effect that exists on residual (unhedged) counterparty risk and should not therefore impact the hedging strategy itself.

procedures, counterparty – index correlations are high. However, they must also be aware that "*If the basis is not reflected to the satisfaction of the supervisor, then the bank must reflect only 50% of the notional amount of index hedges in the VaR.*". There is therefore a need to use a correlation that is high enough achieve reasonable capital relief but not so high that the supervisor invokes the above clause. As mentioned above, higher correlations also reduce portfolio diversification.

viii) Procyclicality

Finally, it is important to consider the likely changes of CVA VaR through the cycle. Higher credit spreads tend to be more volatile (in absolute terms) which would tend to lead to the advanced CVA VaR increasing during widening spread periods and being smallest when spreads are tightest (in early 2007, for example just prior to the start of the crisis). This is likely to produce procyclicality although the use of stressed data is likely to dilute this effect somewhat. The standardised formula, where credit spread volatility is essentially introduced via the static weights, will not behave in this fashion.

The eight differences identified above between standardised and advanced approaches are summarized in Table 1.

	Standardised	Advanced	Change
Time horizon, confidence level, other multipliers	1-year, 99%, no other multiplier = 2.33	10-days, 99% and the standard VaR multiplier of 3 $2.33 \times \sqrt{10/250} \times 3 = 1.40$	↓
Distributional assumptions	Gaussian	Empirical / Non-Gaussian	↑
Exposure at default definition	Impact of crude approaches (e.g. CEM) and alpha factor in IMM	Use of EE directly should be smaller and give better alignment with CVA	↓
Credit spread volatility	Introduced via the weights per rating category	Actual empirical data including stressed spreads may produce higher volatility	↑
Spread correlation / portfolio effect	Counterparty spread implicitly assumed 50% idiosyncratic. Intra spread correlation implicitly assumed as 25%	Higher correlation likely leading to a worse portfolio effect due to undiversifiable systematic risk	↑
Delta hedging capital relief	Likely under-hedge due to conservative definition of EAD	Regulatory definitions better aligned with CVA producing better capital relief	↓
Index hedging capital relief	Correlation is assumed to be 50%	Higher correlations can be used if they can be justified	↓
Procyclicality	Spread parameters fixed through time	Spread parameters will change through the economic cycle	↑↓

Table 1. *Comparison of standardised and advanced CVA capital charges. The change represents the expected increase (↑) or reduction (↓) of the advanced compared to the standardised approach.*

Examples

We now show some examples[15] comparing capital charges for various methodologies for different assumptions and analysing the impact of various conditions. In the base case scenario, we will consider a single 100m 5-year interest rate swap with a single counterparty with a rating of single-A and a credit spread of 200 bps[16]. We will compare the CVA and capital charges under various different approaches as outlined in
Table ***2***.

Def Capital (CEM)	The default risk capital charge under the current exposure method (CEM)
Def Capital (IMM)	The default risk capital charge under the internal model method (IMM)
CVA	The CVA excluding any DVA component.
CVA VaR (CEM)	The standardised CVA capital charge using CEM generated exposure
CVA VaR (IMM)	The standardised CVA capital charge using IMM generated exposure
CVA VaR (Adv)	The advanced CVA capital charge

Table 2. *CVA and capital charges compared. DVA is not included but can be considered as a potential mitigant to CVA.*

i) Comparing CVA and default and CVA capital charges

The calculated values for the base case example are given in
Figure ***1***.

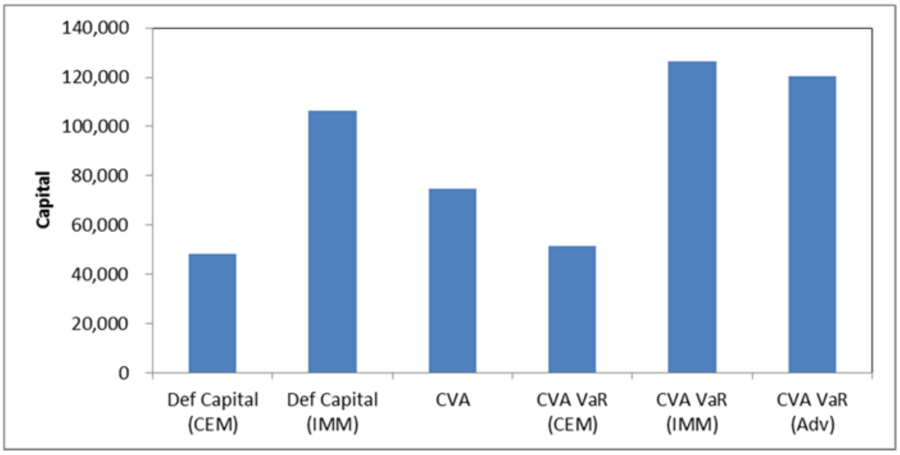

Figure 1. *Comparison of capital charges and CVA for a 100m 5-year interest rate swap with a single-A counterparty with a credit spread (CDS premium) of 200 bps.*

In this example, we firstly see that the CEM gives a lower default risk capital requirement than the IMM. This is largely due to the fact that CEM add-ons are granular and the swap falls at the top of the 1-5 year bucket and attracts a relatively low add-on of 0.5% of notional. Another important aspect making the IMM default risk capital charge higher is the alpha multiplier and the requirement to use stressed data. The standardised CVA VaR (CEM and IMM) numbers not surprisingly show a similar trend. The advanced CVA VaR is almost as high as the worst standardised number. The most obvious explanation for the relatively high advanced value is the requirement to sum the normal and stressed VaR calculations.

ii) The impact of netting

In the above example, the CEM approach seems favourable but this is not always the case. In the next example, we consider 5-year and 7-year swaps that are partially offsetting (different currencies). We furthermore assume the portfolio has a negative mark-to-market (the 5-year swap rate is 20% below the market rate). The results are shown in
Figure ***2***.

[15] These examples have been generating using Solum's proprietary CVA and capital calculator. This has been benchmarked against bank calculations with good agreement easily within the bounds of the subjective parameter assumptions. More details on the results obtained can be obtained on request.
[16] More details on parameters used can be given on request.

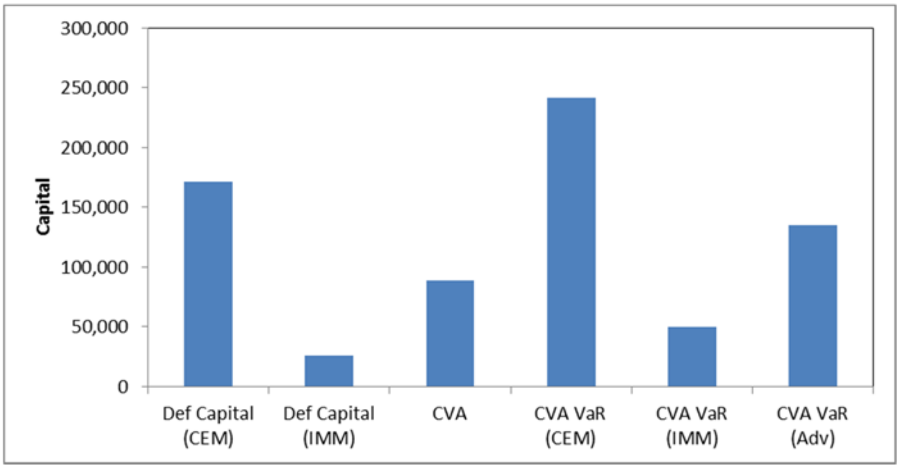

Figure 2. *Comparison of capital charges and CVA for an off-market portfolio of two trades. In this case, the CEM approach appears very conservative due to the understatement of netting, the larger add-on for the 7-year trade and the inherent conservativeness of add-ons for representing off-market portfolios. The IMM standardised method gives the lowest CVA VaR capital charge which is largely due to the cap on the effective maturity[17].*

iii) Impact of maturity

We now consider the impact of maturity on capital charges for the base case swap as shown in Figure ***3***, with the left and right figures showing the situation for a bank without and with IMM approval[18] respectively. Increasing maturity creates an exponentially increasing CVA since both exposure and default probability increase for a longer maturity instrument. The CEM and IMM default risk capital charges do not follow the same increasing shape, mainly due to the maturity cap applied. The CVA VaR calculation under the standardised method also shows a relatively small sensitivity with respect to maturity again largely a result of the maturity cap. On the other hand, the advanced CVA VaR capital charge shows the same exponential sensitivity as CVA itself, leading to relatively high charges for long-dated transactions.

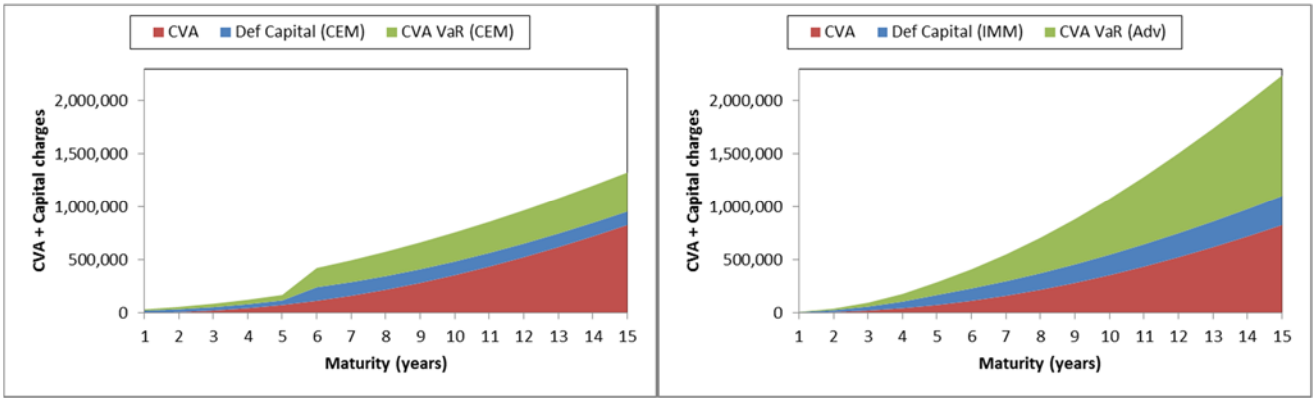

Figure 3. *Comparison of non-IMM (top) and IMM (bottom) capital charges and CVA for a single swap as a function of maturity.*

We also show the above analysis extended to return on capital (RoC) considerations. Figure ***4*** shows the CVA component, which is a required hurdle, above which a transaction is profitable. Also shown is the *additional* component required to achieve a RoC of 20% on top of the CVA charge[19]. It is clear that the additional charge for capital is comparable with the CVA number. It is important to note that DVA can potential reduce the CVA charge but not the associated component related to achieving a defined RoC.

[17] As noted in the Basel III FAQ, the effective maturity should not have the usual cap but will be capped at the maximum maturity in the netting set (which is 7-years). Since the portfolio has a negative mark-to-market, the EEPE is rather small and the cap on the effective maturity creates a rather small capital charge.

[18] In the latter case also assuming approval for specific risk allowing the advanced approach for CVA VaR to be used.

[19] We assume a linearly amortising capital requirement over the lifetime of the trade and no other costs.

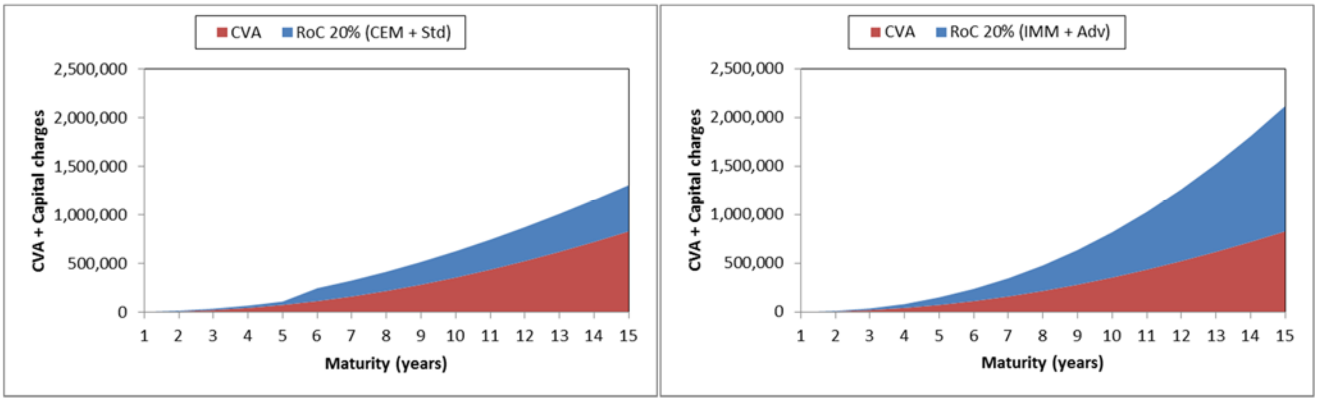

Figure 4. *Comparison of CVA and the additional charge required to achieve a RoC of 20% for standardised and advanced approaches for the base case swap as a function of maturity.*

iv) Impact of hedges

For the remaining examples, we consider the exposure of a 6-year swap as in this case the capital charges for a single counterparty for both standardised and advanced methods are rather similar and so a fairly direct comparison can be made.

Figure ***5*** shows the impact of hedging with an eligible 5-year single-name CDS on the overall capital charge for the standardised and advanced approaches. Also shown is the delta hedge corresponding to a small move in credit spreads. Ideally, a delta-neutral position should produce the greatest capital relief. However, neither the standardised approach (due to the conservativeness of the EAD definition) nor the advanced approach (due mainly to requirements over stressed parameters) gives a perfect alignment.

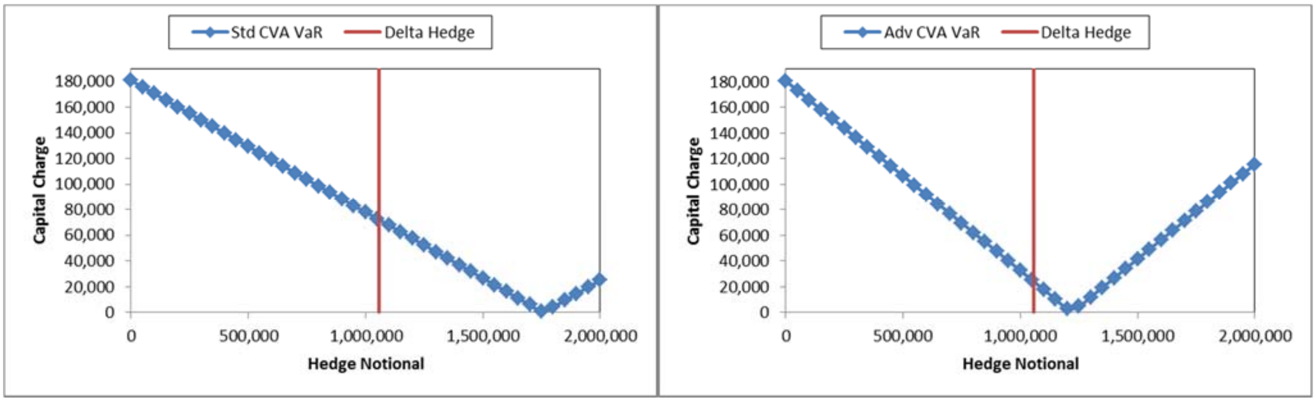

Figure 5. *Comparison of the impact of single-name CDS hedges on standardised (left) and advanced (right) CVA capital charges for a single 6-year swap. Also shown is the notional corresponding to a delta neutral CVA hedge.*

Figure ***6*** shows the impact of index hedges on the capital for the 6-year swap. The index hedge is assumed to be 5-year maturity and the correlation between index and counterparty spread is assumed as 50% (standardised) and 80% (advanced). This imperfect correlation makes the hedging benefit less efficient.

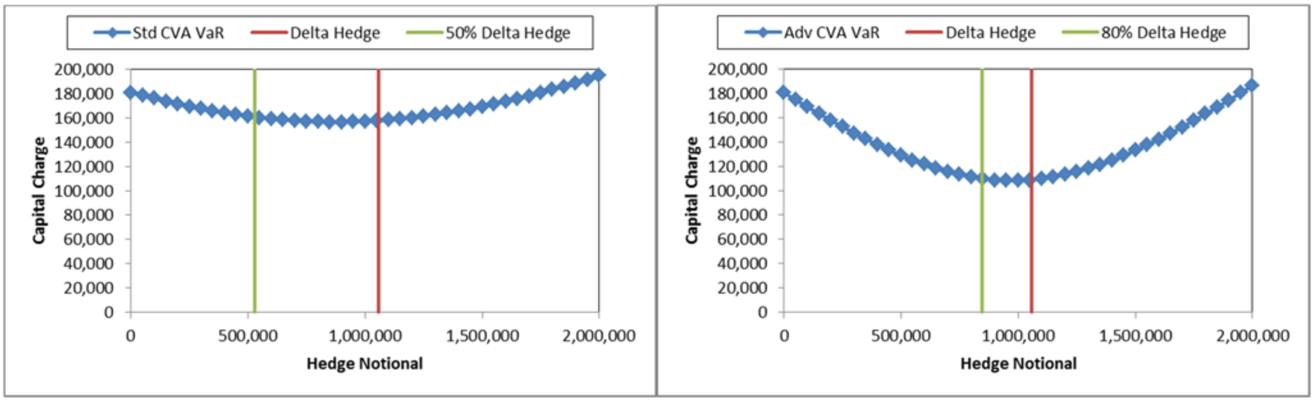

Figure 6. *Comparison of the impact of index CDS hedges on standardised (left) and advanced (right) CVA capital charges for a single 6-year swap. The correlations between the index and counterparty spreads are assumed to be 50% (standardised) and 80% (advanced).*

In the advanced CVA VaR approach, in terms of the modelling of spread correlation, there is a balance between the portfolio effect and the effectiveness of hedging which is illustrated in
Figure **7**. An increase in counterparty – index spread correlation improves the capital relief from hedging but has a negative impact on the portfolio effect due to the implicit assumption of more non-diversifiable systematic risk.

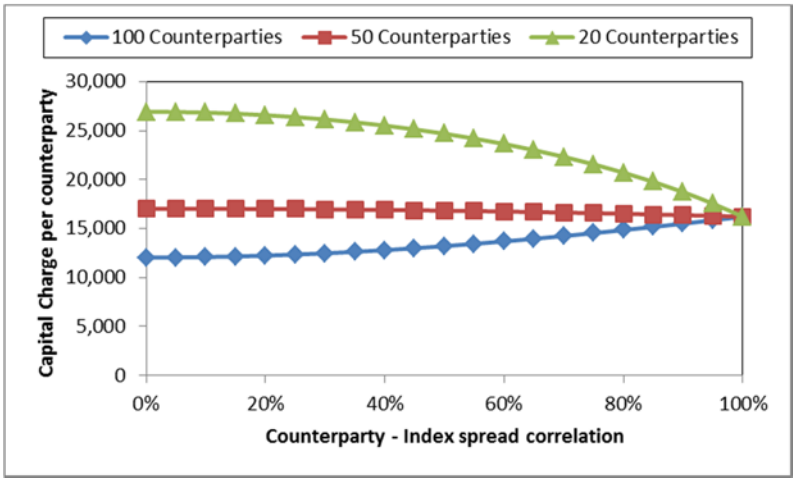

Figure 7. *Comparison of advanced CVA VaR capital charge as a function of the correlation between counterparty and index spreads for different sizes of portfolio. Each counterparty exposure is driven by a single 6-year swap and assumed to be delta hedged with the optimum amount of index hedge.*

Conclusion

In this paper, we have discussed capital charges for counterparty credit risk, looking in particular on the capitalisation of CVA volatility via so-called CVA VaR. We have focused on the differences between the two methods, standardised and advanced, by which a bank may calculate CVA VaR. Some important conclusions are:

- Under Basel III, counterparty credit risk and CVA capital numbers will be comparable in magnitude to CVA (where CVA calculated with market implied default probabilities). This is true when comparing CVA and capital directly or if capital is viewed in relation to a specific return on capital.
- The advanced CVA VaR methodology gives *generally* higher capital charges than the standardised formula. The most obvious driver of this is the need to sum the CVA VaR from normal and stressed calculations.
- Single-name hedging can be beneficial but there is a misalignment between capital relief and minimisation of PnL (delta hedging by a CVA desk) which is particularly acute in the standardised approach.
- Viewed at the single counterparty level, capital relief via index hedging is, not surprisingly, more beneficial under the advanced approach. However, for a large portfolio the comparison between standardised and advanced methodologies in not so clear due to diversification effects.

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