



A Practical Guide to Fair Value and Regulatory CVA

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Training Scope

- **Introduction to CVA**

- Rationale and challenges
- Fair value vs. regulatory CVA

- **Understanding CVA**

- Methodology fundamentals
- Close out and gap risk in CVA
- Wrong way risk in CVA
- CVA hedging
- Regulatory CVA (Basel III CVA Capital Charge)

- **Understanding DVA and FVA**

- FVA vs. DVA



Introduction to CVA

Part I

Definitions: PFE vs. CVA

- **Potential Future Exposure (PFE)**

- PFE(T) is maximum loss due to counterparty default between time T and T+dt with a given confidence level (e.g. 95%)
- *Confidence level measure (like VaR)*
- *Reserve-like, not P&L like*

- **Credit Value Adjustment (CVA)**

- CVA is expected loss due to of counterparty default at any time before portfolio maturity
- *Expectation (like MtM)*
- *P&L, not a reserve*

Rationale to CVA

- **“CVA is not the problem. It is an imperfect solution to a problem” – *recent conference panel discussion participant***
 - CVA helps solve the problem of immediately recognizing the changes in expected credit losses in derivatives trading P&L
 - *However imperfect*, CVA is a major step forward compared to provisioning for credit loss
 - In any event, CVA is here to stay
- **With this positive motivation, on to CVA problems and challenges...**

CVA is not like issuer risk

- **Issuer risk**

- Defined at the level of individual bond position
- Simpler valuation, hedging, and stress testing

- **CVA**

- Depends on the entire portfolio of trades with the counterparty
- Depends on the nature of collateral posted or received by the counterparty and CSA details
- Cannot be valued or hedged easily
- Causes fundamental changes in how trading business is organized (e.g. CVA desk)

CVA creates new market risk

- **CVA creates new market risk**

- You are fully hedged to your market risk
- The next day you have negative P&L of \$50m
- You discover the cause: your counterparty reported weak numbers and their credit spread have widened - but there is little you can do about this if you are not trading credit
- OR because *your firm* reported strong numbers and its credit spread have narrowed, reducing the DVA – this does not even make sense, how did that become bad news for your business?

CVA complicates trading

- **You are running a OTC exotics desk**
 - If you were not trading credit before, now you are - and you might not have credit traders
 - Credit exposure cannot be hedged for the majority of counterparties – increasing the volatility of your P&L
 - Your counterparties want to charge you for CVA but determining its size requires a full tally of mutual OTC positions across all desks in both firms and a complex Monte Carlo calculation

CVA complicates quant modeling

- **CVA changes everything we know about derivatives valuation**
 - No such thing as fair value – deal value depends on the counterparty
 - No such thing as mark-to-market at deal level – depends on the rest of the portfolio
 - Invalidates essential assumptions behind risk neutral valuation – market completeness and hedge availability to create a riskless portfolio
- ***Model risk in CVA models is a serious concern for the enterprise***

CVA capital charge

- **Because CVA is part of trading P&L and is a source of market risk, Basel III includes capital charges for CVA**
 - The committee observed that during the financial crisis the majority of the trading losses were CVA related rather than default event related, motivating the CVA capital charge
 - How the CVA capital charge comes about:

*Credit loss (prob) → CVA(expectation)
→ CVA loss (prob) → CVA capital charge*

Fair value vs. regulatory CVA

- **Accounting standards and the Basel committee take radically different approaches with respect to CVA methodologies**
 - Accounting standards (FASB, IFRS) generally call for the “best practice” approach – similar to the requirements to derivatives pricing models
 - The Basel committee and local supervisors provide highly specific prescriptive methods, with method choice subject to regulatory approval

Fair value vs. regulatory CVA

- **The divergent approaches may cause problems when trading strategies become subject to both fair value and regulatory reporting**
- **Examples of problems (to be discussed)**
 - Inconsistent recognition of DVA
 - Fair value vs. regulatory model parameters such as probabilities of default (PD) and exposure at default (EAD)
 - Incompatibilities between hedging CVA P&L and hedging for CVA capital relief

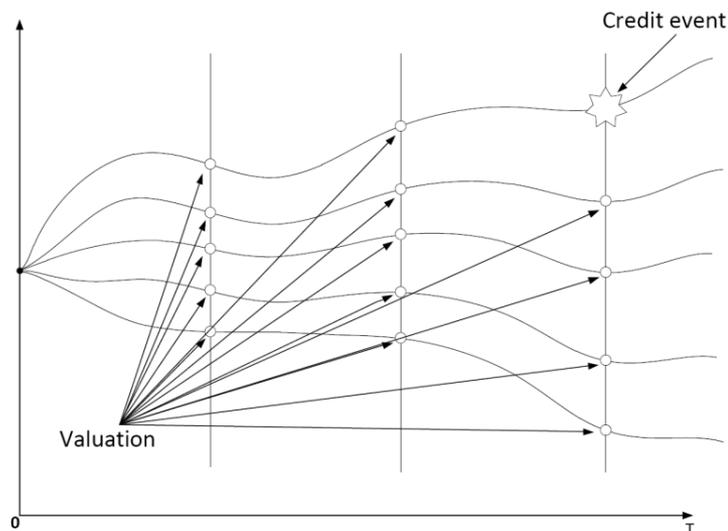


Methodology Fundamentals

Part IIa

First principles simulation of defaults

- **First principles (“brute force”) method involves full Monte Carlo simulation of default events**
- Not the optimal approach in most cases due to the excessive number of Monte Carlo paths required because of low probability of default



Using PD based method

- The probability of default (PD) based method is standard market practice:

$$CVA = (1 - R) \int_0^{\infty} EPE(t) PD(t, t + dt) dt$$

where

- PD(t,t+dt) is probability of default from t to t+dt
- R is recovery rate
- EPE(t) is expected positive exposure at time t ...

... **conditional on default**

What happens when cpty defaults?

- **Sequence of events which take place when counterparty defaults**
 - The counterparty disputes or otherwise does not make a margin call or does not post an OTC derivative payment
 - After a few days (or hours), you realize that the counterparty is defaulting
 - You attempt to replicate the portfolio with other counterparties or unwind the position.

The mechanics of netting

- **The effect of counterparty default on OTC transactions**

- If the counterparty owes money to your firm (positive exposure), they default and you get recovery value
- If your firm owes money to the counterparty (negative exposure), the creditors take over the position and no credit loss occurs
- This determination is done for each “netting set” –the group of transactions which may offset each other when exposure is computed for this purpose

The mechanics of netting

- **Why netting is important for CVA**

- In the absence of netting, your firm may suffer a massive loss on some trades while continuing to make similar sized payments to the counterparty's creditors on other trades
- Netting occurs based on a legal netting agreement in place between the parties ("ISDA")

- **Prevalence of netting**

- Between banks worldwide – almost always
- Client trades – in most cases but varies by location; prohibited in some jurisdictions and untested by the courts in others

The mechanics of collateral

- **Collateral agreement**

- Under a collateral (or margin) agreement, counterparties post collateral which may be used to offset credit loss in the event of default
- Collateral agreement may be unilateral (one counterparty posts collateral) or bilateral (both counterparties post collateral depending on whether the exposure is positive or negative)

Type of collateral agreements

- **ISDA Credit Support Annex (CSA)**
 - Permits posting one or several types of collateral with periodic rebalancing and interest paid by the receiving party based on collateral currency and type
 - Permits thresholds, minimum transfer amounts, and rounding (to reduce operational costs)
 - A new standard form of CSA (SCSA) is in development which will reduce the complexity due to the collateral type switch options embedded in traditional CSA

Collateral agreement and CVA

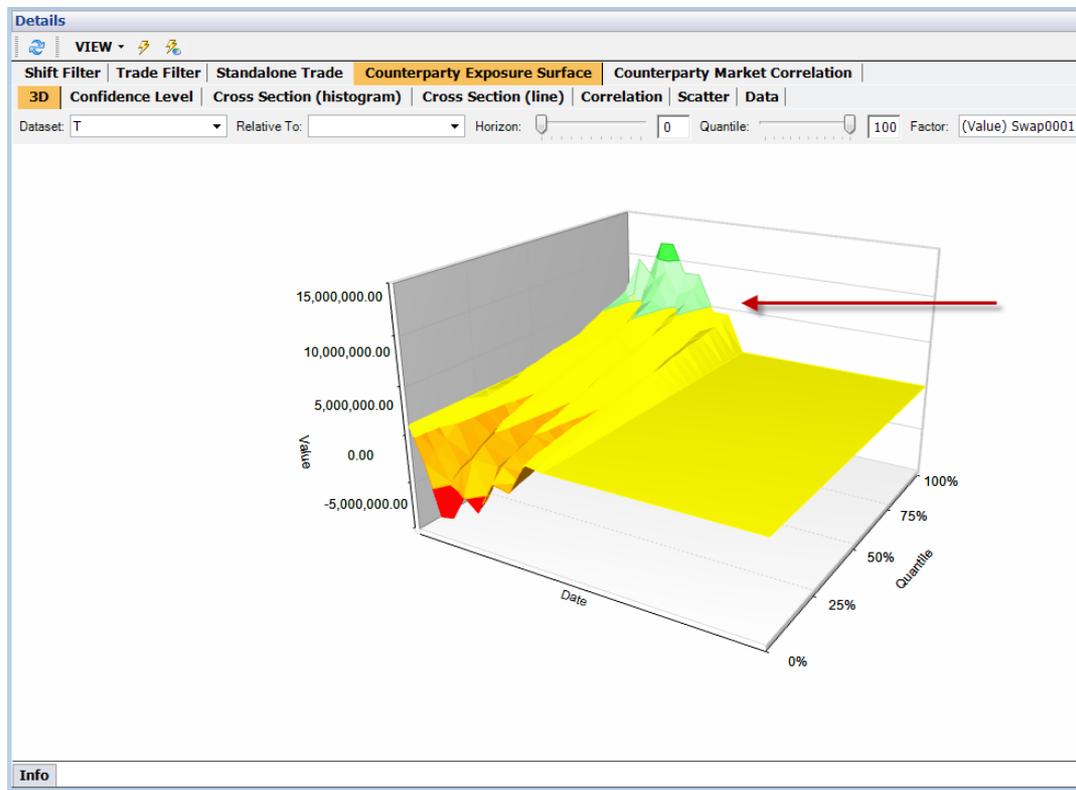
- **Collateral agreement reduces the exposure by the amount of collateral held as of the last rebalancing**
 - However the firm remains exposed to close-out risk – the difference between the exposure as of the last rebalancing and the actual cost of close-out or replication
 - Close out risk has an element of gap risk – the possibility of a market crash between the time the counterparty defaulted and the time when close-out is completed

Monte Carlo model for exposures

- **Fair value CVA uses risk neutral Monte Carlo simulation to compute exposure for multiple paths and timesteps**
 - The CVA Monte Carlo model must (at least) model risk factors for all trades with the counterparty, while a valuation Monte Carlo model needs to do that only for a single trade
 - Exposure is averaged over paths for each timestep to obtain expected positive exposure (EPE) and expected negative exposure (ENE)
 - Note that fair value and regulatory methods for both PD and EPE/ENE differ

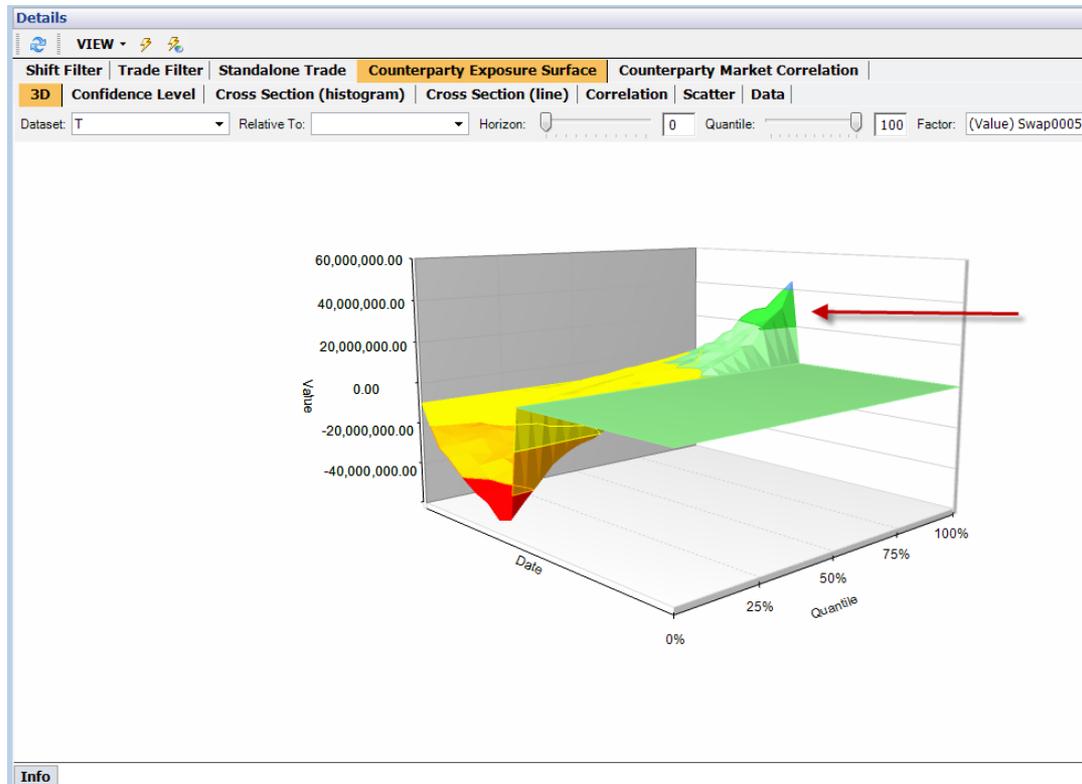
Exposure simulation - vanilla swap

- Exposure variation is the highest in the middle of trade timeline and reduces as fewer interest payments remain



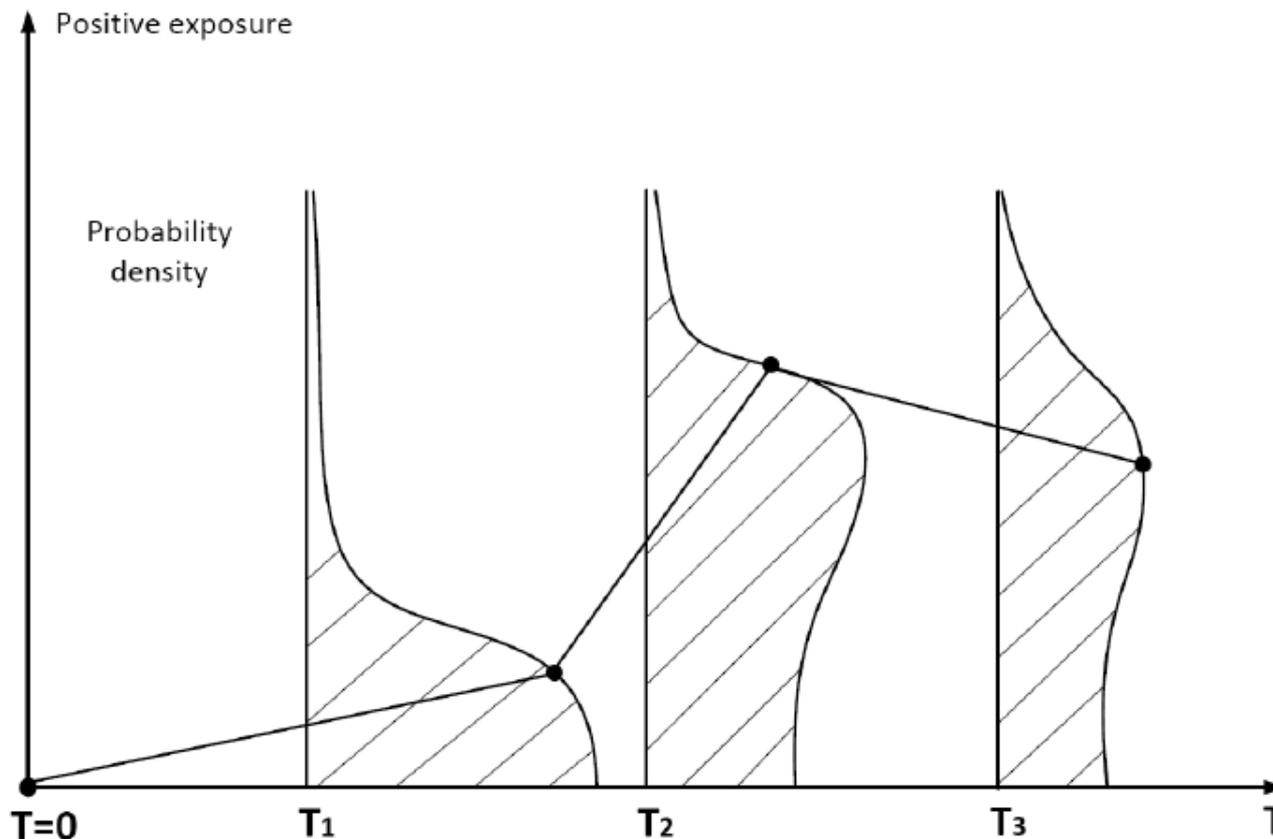
Exposure simulation – xccy swap

- Exposure variation is the highest at maturity because the largest contributor is the principal exchange



Computing EPE/ENE

- EPE is computed by averaging exposure over the shaded area



Computing probability of default

- **Probability of default (PD) calibration methods for CVA from best to worst**
 - From CDS spread (if CDS is traded)
 - From bond spread (if bonds are traded)
 - From rating transition matrix
 - From comparables (as a last resort)



Close-out and gap risk in CVA

Part IIb

CVA and collateralization

- **“My counterparties are fully collateralized and do not have CVA”**
 - Fully collateralized counterparty is counterparty with a “perfect” CSA – all thresholds, minimum transfer amounts, and rounding are zero, with daily rebalancing
- **Even in this case CVA is present**
 - After the counterparty defaults, but before positions can be closed out, position will move creating exposure

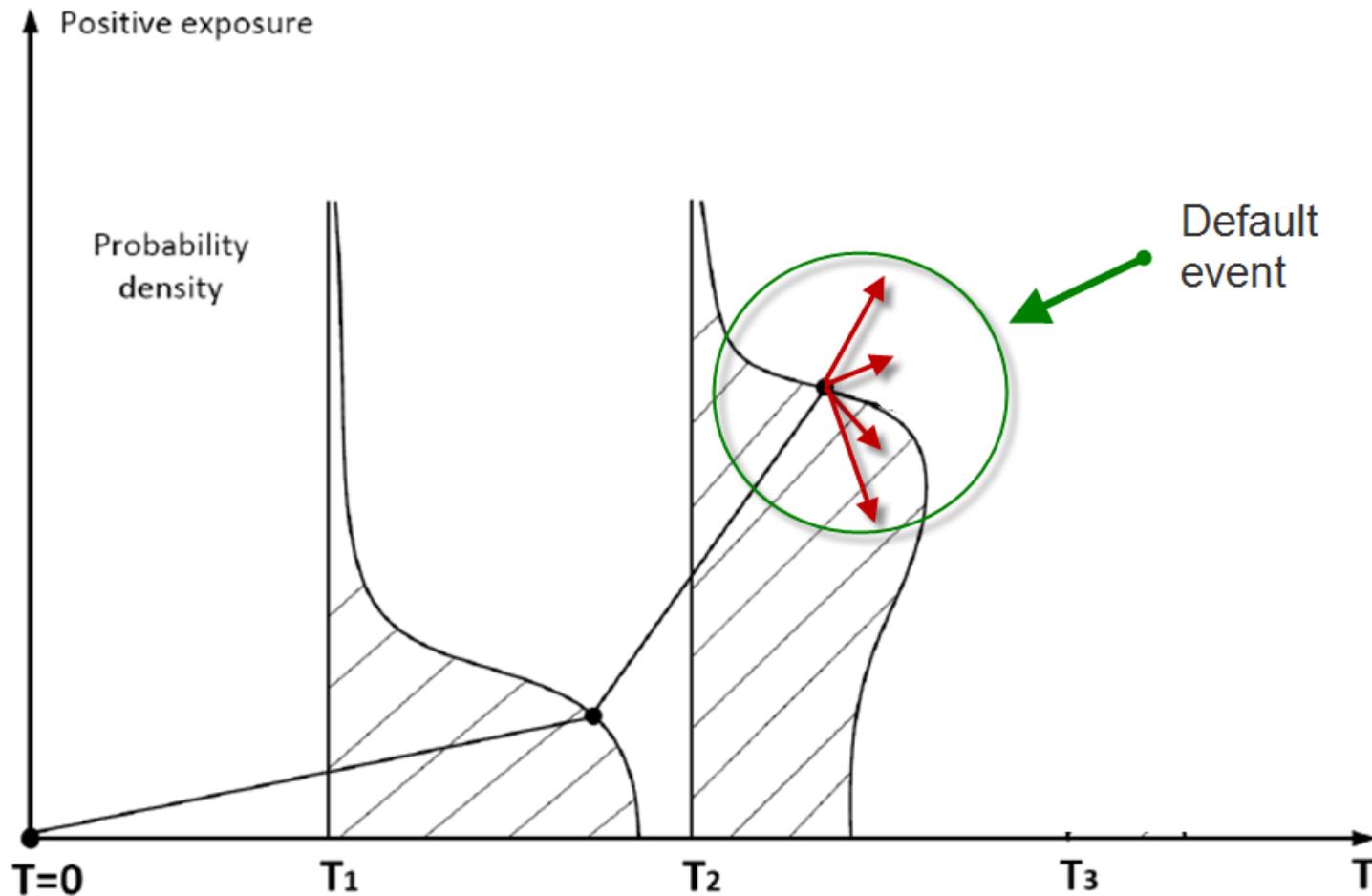
Margin period of risk model

- **Margin period of risk is the length of time between the default event and the time when positions with the counterparty are closed out**
 - Regulatory requirement is to assume the minimum of 2 weeks, and for more than 5000 positions 4 weeks
 - The default event becomes public knowledge at the beginning of the margin period of risk

Margin period of risk model

- **Modeling EPE conditional on default using two separate models**
 - Exposure model to compute potential future exposure surface not conditional on default
 - Margin period of risk model to compute short term dynamics over 2 or 4 weeks following the default
 - The second model may have different calibration (e.g. increased vol)

Margin period of risk model



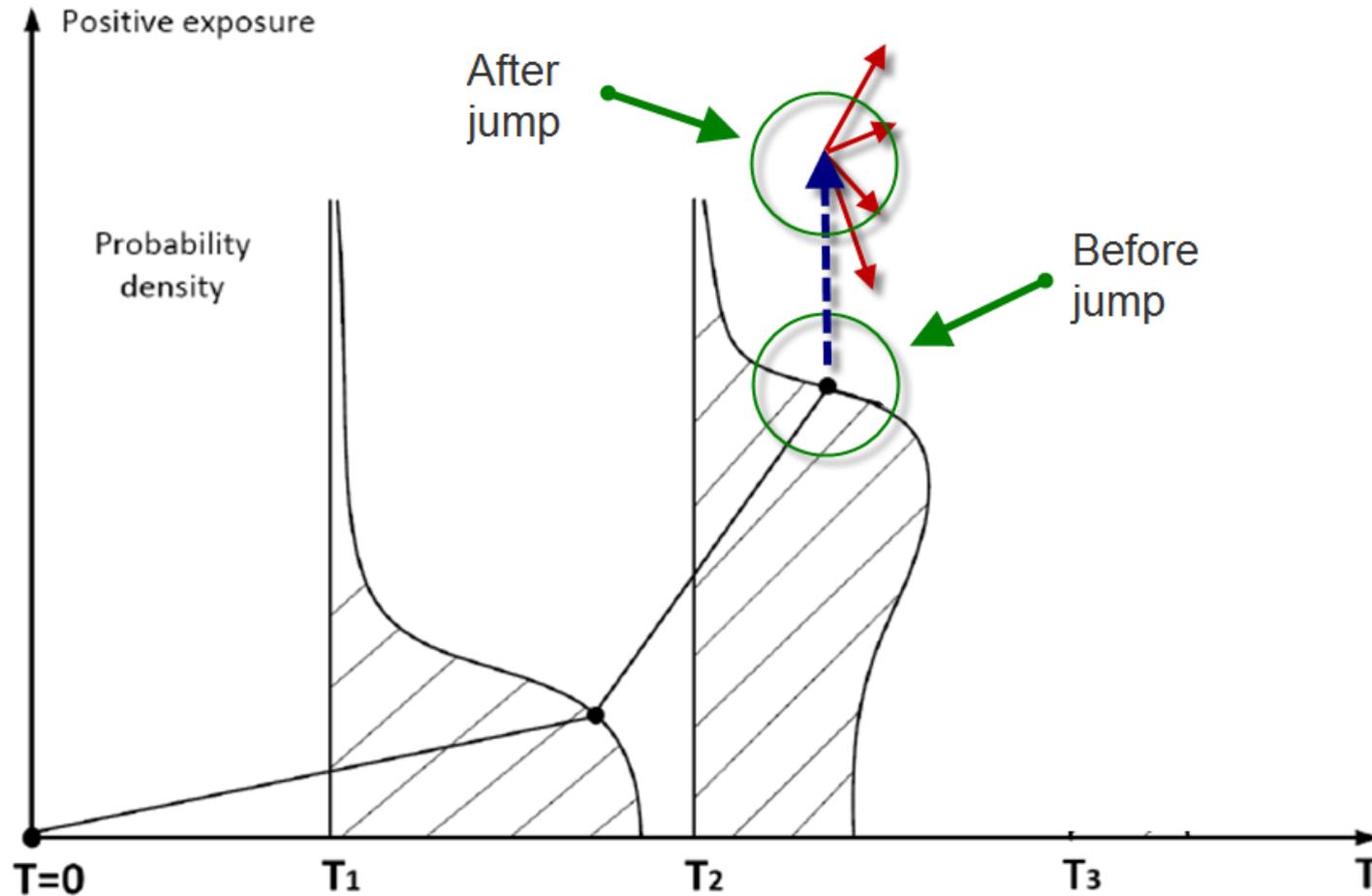
Modeling CVA of SIFIs

- **Lehman defaulted during a period of historically low LIBOR and credit spreads**
- **What the model predicted**
 - Modeling margin period of risk for Lehman with increased vol alone would have predicted increased probability of even lower spreads following default
 - **What really happened**
 - Spreads shot through the roof

SIFI margin period of risk model

- **A jump model for exposure conditional on default recognizes that following SIFI default we will always be unwinding in a crisis**
 - This is independent from the market conditions prior to dealer default
 - And holds both when the crisis is triggered by the default and vice versa
 - Case of default triggered by a slow motion crisis requires special treatment (Canabarro)

SIFI margin period of risk model



Jump model calibration

- **Historical calibration**
 - Data from the financial crisis
- **Counterparty importance ranking**
 - Rank importance according to jump magnitude in standard deviations of key market factors
- **Credit spreads**
 - Ehlers and Schonbucher (2006) found that quanto/domestic CDS spreads are driven by the expectation of FX jump following default
 - Correlation of sovereign and counterparty credit spreads



Wrong way risk in CVA

Part IIIc

Definition of wrong way risk in CVA

- **Wrong way risk (WWR) is the change in CVA due to correlation between counterparty exposure and its credit spread**
 - In 2008, it became very clear that traditional quant theory of the time did not do a good job modeling credit correlations
 - Wrong way risk was especially severe for monolines and single-strategy hedge funds, and was not recognized in most credit models

Objective of WWR modeling

- **Objective**

- Identify and price the risk of counterparties whose business strategy is “nobody ever defaults - let’s sell a lot of credit insurance and keep the carry”
- The key obstacle is that the market does not always know the details of the counterparty’s position based on publicly available data
- Modeling is possible to the extent some data is available

Modeling wrong way risk

- **Traditional approach**

- Model correlation of counterparty credit to all market factors – *assumes that the market knows about the wrong way risk*
- Large correlation matrix – cannot stress test every possible change

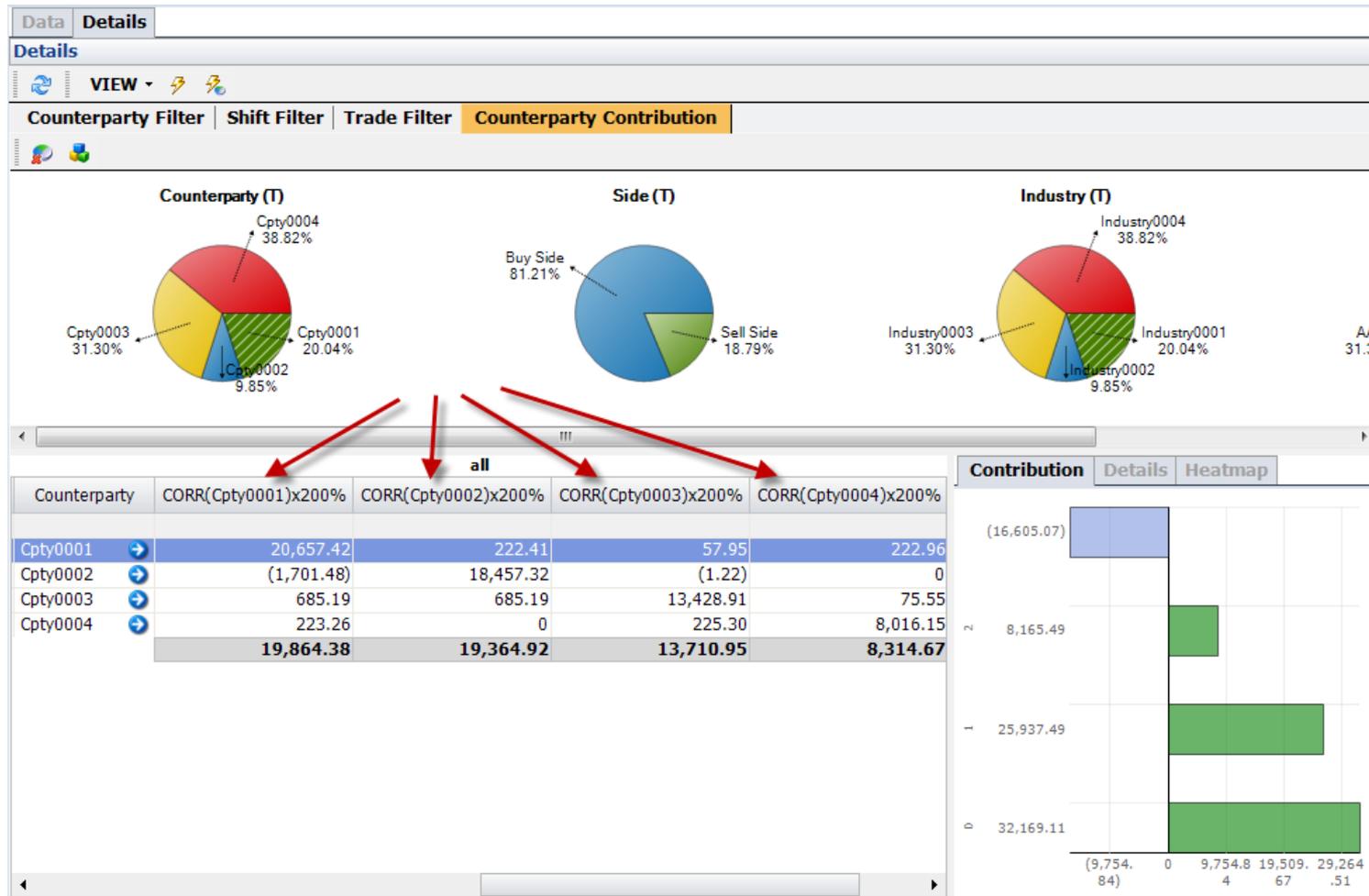
- **Single correlation number**

- Model credit spread as a function of exposure (Hull, White, 2011)
- Model exposure as a synthetic process correlated with spread (Rosen, Saunders; Cespedes et al; Sokol, 2010)

Overcoming the lack of data

- **Managing the lack of data for wrong way risk involves performing stress tests on the wrong way risk assumptions**
 - Single parameter models such as Hull-White, Rosen-Saunders, and Sokol are well suited for this type of stress test
 - The objective is to determine the range of variation of CVA for several stress scenarios of correlation

Wrong way risk stress test





CVA Hedging

Part IId

Objectives of Hedging CVA

- **Reducing the sensitivity**

- Avoiding CVA driven P&L when credit spread of the counterparty or your firm changes
- Protecting your CVA position for the duration of your trades with the counterparty

- **Reducing the exposure**

- Reducing your Maximum PFE at given confidence level (e.g. 95%)

These two goals are conflicting and cannot be achieved at the same time - balancing them is needed

Problems with static CDS hedging

- **Problems with static CDS hedging**
 - CDS will pay out the same amount if counterparty defaults, independently of the amount of your exposure
 - CDS will pay out every time while you will have positive exposure only some of the time
- **These problems can be solved by dynamic hedging – adjusting CVA position over time and depending on the amount of exposure you have today**

Problems with any CDS hedging

- **Problems with CDS hedging which cannot be solved by making hedging dynamic**
 - By making hedging overall sensitivity your objective, you have committed to a specific hedge position
 - This position is related to your CVA (expected exposure) and will only partially hedge your exposure at a given confidence level (PFE), e.g. 95%.

Single name vs. macro hedging

- **Single name hedging**

- More precise in case of bad news affecting a single firm rather than broad market moves
- Not available for most counterparties
- Not easily balancing sensitivity and exposure hedging

- **Macro hedging**

- The only option for most counterparties
- Not a hedge against bad news affecting a single firm

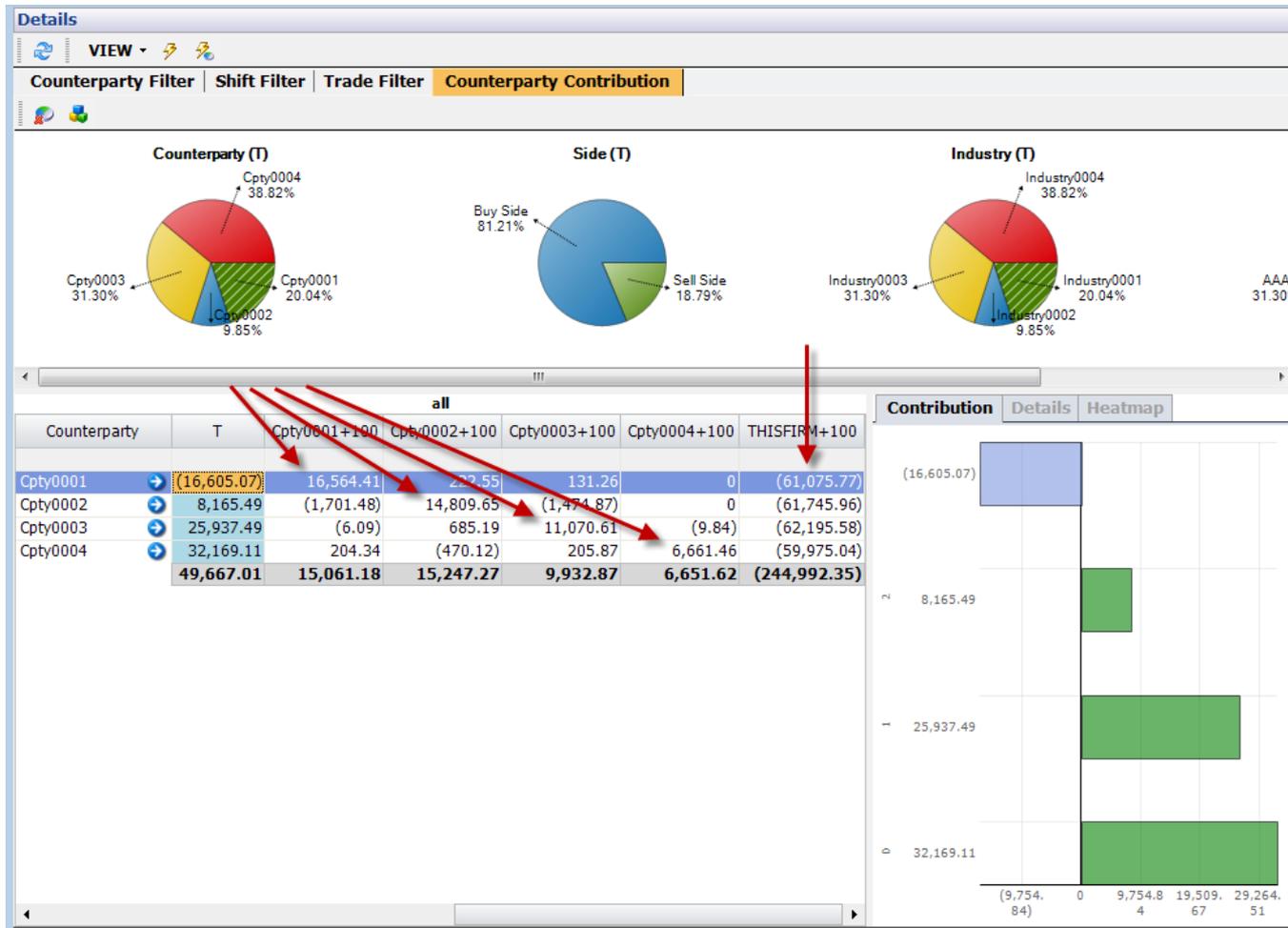
Contingent CDS

- **The issue with vanilla CDS hedging drives innovation in credit products such as contingent CDS**
 - A combination of vanilla CDS, foreign-denominated CDS, and contingent CDS is *on theoretical grounds* a better way to hedge your exposure profile
 - In practice, high cost of transacting in anything other than vanilla CDS offset some of the advantages in using these products

Traditional stress testing for CVA

- **Traditional stress testing for CVA is no different from stress testing a regular portfolio of OTC transactions**
- **Sensitivity with respect to**
 - Credit spreads
 - Interest rates
 - FX rates
 - Equity prices

Example of CVA sensitivities





Regulatory CVA

Basel III CVA Capital Charge

Part IIe

Standardized CVA capital charge

- Standardized method uses EAD and regulatory multipliers

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

Where

- h is the one-year risk horizon (in units of a year), $h = 1$.
- w_i is the weight applicable to counterparty 'i'. Counterparty 'i' must be mapped to one of the seven weights w_i based on its external rating, as shown in the table of this paragraph below. When a counterparty does not have an external rating, the bank must, subject to supervisory approval, map the internal rating of the counterparty to one of the external ratings.
- EAD_i^{total} is the exposure at default of counterparty 'i' (summed across its netting sets), including the effect of collateral as per the existing IMM, SM or CEM rules as applicable to the calculation of counterparty risk capital charges for such counterparty by the bank. For non-IMM banks the exposure should be discounted by applying the factor $(1 - \exp(-0.05 \cdot M_i)) / (0.05 \cdot M_i)$. For IMM banks, no such discount should be applied as the discount factor is already included in M_i .

Regulatory weights

- The following weights are prescribed by the committee for the standardized charge

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

Advanced CVA capital charge

- **Advanced charge vs. fair value CVA**

- Considers variability of spreads only but not exposures which are assumed constant
- Uses a simplified method for EAD

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

- The improvement over standardized method is that regulatory weights are not used, instead the model uses credit spreads and their volatilities making it more consistent with other VaR methods

Standardized vs. advanced method

- **The key difference between the standardized method and the advanced method is the use of regulatory weights W_i vs. the market spreads and their vols (Pykhtin 2012)**
 - This difference may cause a major change in CVA capital charges in either direction when the bank switches between the methods

Regulatory vs. fair value CVA

- **The major differences between both regulatory methods and the fair value methods are:**
 - Lack of recognition of DVA
 - Lack of recognition of exposure variability
 - Fair value and regulatory methods result in different CDS hedges for the same position, making it difficult to simultaneously hedge CVA P&L and achieve full regulatory CVA charge relief

Hedging the CVA capital charge

- **Basel III allows the possibility of hedging for regulatory relief**
 - Both the standardized and advanced methods expressly include single name and macro hedges
 - However the calculation of EAD (exposure at default) follows regulatory methodology with 1.4 multiplier and other differences causing a discrepancy between the optimal hedge of P&L volatility and of the capital charge (Pykhtin 2012)



Debt Value Adjustment (DVA)

Part IIIa

Definition and argument for DVA

- **When two firms are both including CVA in fair value of the new trade, they will not agree on the price unless they include the other firm's CVA as well**
 - The term debt value adjustment (DVA) has been adopted to mea the other firm's CVA

$$DVA = CVA_{other\ firm}$$

$$BCVA = CVA + DVA$$

Problems with DVA

- **The key problem seen with DVA is that it is only possible to monetize it in theory but not in practice**
 - DVA is the reduced value of your derivative payments obligations to the other party, which requires trades to be unwound to be monetized
 - It is a practical impossibility to unwind a complex derivatives portfolio prior to default
 - Furthermore, accounting principles require that fair value accounting is done on “going concern” basis – conflicts with DVA

The practical impact of DVA

- **Today, DVA in financial reporting is big business and is typically billions for a large bank**
 - In multiple instances following the financial crisis, DVA was the dominant factor in quarterly P&L reports for the enterprise (e.g. Citibank) swinging the firm from a loss to a profit on credit spread widening

Accounting status of DVA

- **Accounting status of DVA**

- Generally accepted and widely used to price new OTC derivatives trades based on both parties' credit risk
- Warily accepted with caveats but still widely used in P&L reporting for the enterprise – when used, most firms report DVA on a separate line and identify it as an accounting charge rather than a real P&L

Regulatory status of DVA

- **Embraced by many regulators for capital calculations, but viewed warily by the Basel Committee**
 - Consultative Document BCBS214 discusses several options of recognizing DVA for capital purposes, which in some jurisdictions may cost banks significant amounts of capital relative to the current treatment
 - DVA is expressly excluded from the CVA capital charge



Funding Value Adjustment (FVA)

Part IIIb

Pre-crisis view of funding

- **During the pre-crisis period of practically unlimited liquidity, banks could expect to borrow money for posting collateral via a variety of low cost funding options**
 - The cost of this borrowing was largely offset by the interest paid on collateral by the receiving party
- **This allowed banks to disregard collateral and funding costs in assessing trading desk P&L**

Post-crisis view of funding

- **Post-crisis, a fundamental shift occurred in the role of funding in derivatives business**
 - Funding became costly, making it essential to consider the cost of funding in assessing OTC derivatives P&L
 - **The risk of credit lines being pulled if the firm is perceived to be at risk of default makes evaluating and controlling OTC derivatives funding needs an critical part of risk management strategy for the firm**

Perils of ignoring funding needs

- **The perils of ignoring funding in assessing the impact of new trades**
 - A trade has positive P&L but also high potential future exposure
 - If the market moves against the trade and CSA is in place, massive additional funding will be required immediately to post collateral
 - In the absence of CSA, expected future losses may cause immediate crisis of confidence causing creditors to pull funding from the firm
- **“MF Global scenario”**

The dual role of FVA

- **Internally, the primary role of FVA is to provide monetary incentive for trading desk to use less funding**
 - This is accomplished by charging a high rate for borrowing from the funding desk (FCA) and paying for posting money back to the funding desk (FBA)
- **In the future, FVA may also be used to replace DVA as the way to reflect own credit risk in fair value accounting**
 - Not supported by accounting rules now

Components of FVA calculation

- **FVA is measured relative to perfect CSA**
 - For each time interval calculate the expected amount of difference C'_{post} , C'_{rec} between collateral actually posted to or received from the counterparty and the amount which would have been posted/received under perfect CSA
 - Borrowing spread r_{fca} and lending spread r_{fba}

$$FCA = - \int C'_{post}(t) r_{fca}(t) SP(t) SP_{self}(t) dt < 0$$

$$FBA = \int C'_{rec}(t) r_{fba}(t) SP(t) SP_{self}(t) dt > 0$$

How are the two spreads determined?

- **Because the bank is a net borrower, both FCA and FBA spreads are priced around the bank's own funding costs, which incorporate credit spread**
 - FCA is borrowing by the trading desk to the funding desk causing a net increase in borrowing for the bank
 - FBA is lending by the trading desk to the funding desk causing a net reduction in borrowing for the bank – but the bank remains a net borrower. *It is not a rate for lending to the market.*

Using FVA internally

- **FVA can be used internally to properly allocated trading desk P&L and reduce funding risk**
 - By setting both FCA and FBA spreads to be high during the time periods of anticipated high borrowing (e.g. when major cashflows are expected), the bank can trades which help meet the funding needs more profitable
 - By setting FCA-FBA spread to fair values, the funding desk will recoup collateral funding costs

FVA and DVA

- **The argument for using FVA as a better alternative to DVA**
 - Both FCA and FVA spreads are based on net borrowing by the bank and include banks' own credit spread – this double counts the DVA
 - Replacing DVA by FVA will allow the bank to recognize today the P&L of their future funding costs, which can replace DVA as an offset to CVA and also reflect the future liquidity costs
- ***Not yet supported by accounting rules***

What we covered

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- **Understanding CVA**

- Methodology fundamentals
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- Wrong way risk in CVA
- CVA hedging
- Regulatory CVA (Basel III CVA Capital Charge)

- **Understanding DVA and FVA**

- FVA vs. DVA?