XVAs: Funding, Credit, Debit & Capital in pricing

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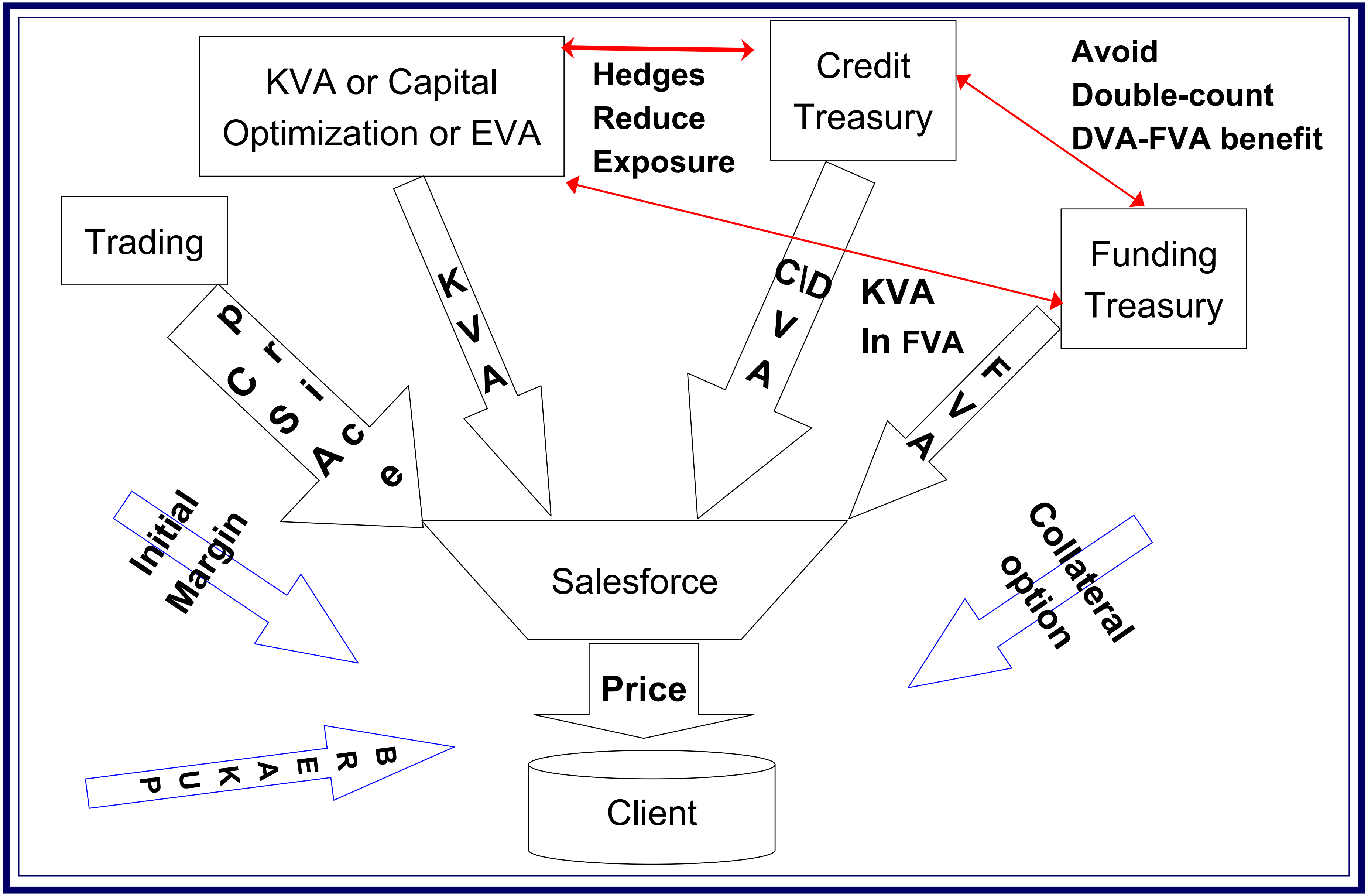
1.In the past, the price of derivatives was computed by just one trader, evaluating the expected return and risk of the underlying asset.

2.Years of Credit Crunch have changed this. There are other risks contributing to value, and they are no more negligible, both from a bank's internal risk management perspective and/or from a regulatory point of view:

1. Counterparty Credit risk (CVA)
2. Own Credit risk (DVA)
3. Funding Cost/Benefit (FVA)
4. Capital Costs (KVA)
5. Collateral conditions
6. Initial Margin on CCPs (and not only)

3.This revolution has required the creation of specialized desks, and an issue of correct aggregation without double counting.

XVAs: what makes the price



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1. Charging Capital Costs vs Charging CVA are two alternative strategies for counterparty risk protection. If **CVA and KVA** desks do not speak to each other, we have double counting.

2. Recognizing a Funding Benefit vs Recognizing DVA are two ways of realising the same benefit. If **CVA/DVA and FVA** desks do not speak to each other, we have double counting.

3. Charging an FVA based on bond funding costs can be in contradiction with charging Capital Costs based on equity costs. If **FVA and KVA** desks do not speak to each other, we have double counting.

The model for CVA/DVA/FVA is different from the one for Capital. They simulate under different measures, but they should speak to each other. Yet we must be sure we don't make they similar where they should be different and the other way around.

CVA vs KVA

One word for two worlds

- When speaking for example of Counterparty Credit Risk or CVA, we usually mean **two different things**, dealt with using **two models**

CVA and Counterparty Risk Management	**CVA and Counterparty Risk Pricing**
Regards risk management and capital.	Regards pricing and hedging
Requires model under real-world distributions.	Requires model under risk-adjusted measure
Now mostly driven by regulations	Mostly driven by business

- Usually the first one sits in Risk Management Unit, the second one sits in Front Office Unit (Capital Markets or Treasury).

- The models used are usually developed through indepent processes. This is partly correct and partly dangerous. It is important to understand where similarities and differences should go.

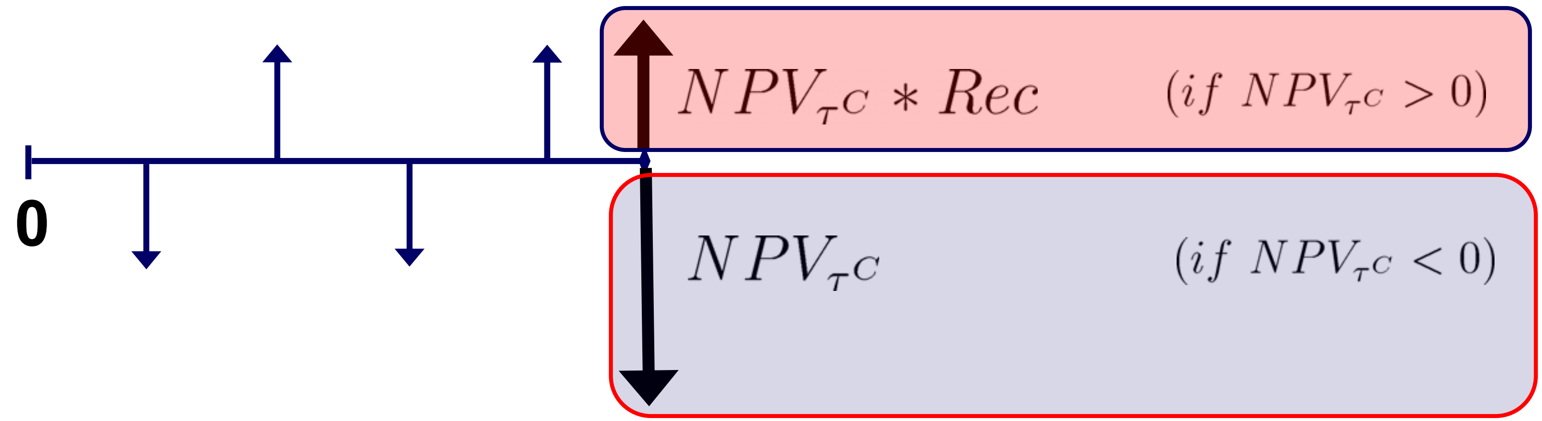
CVA

- CVA is pricing the default payout. All expectations are risk adjusted, incorporating market quotes. At default of counterparty C, compute the **mark-to-market** or **Net Present Value** of the residual deal:

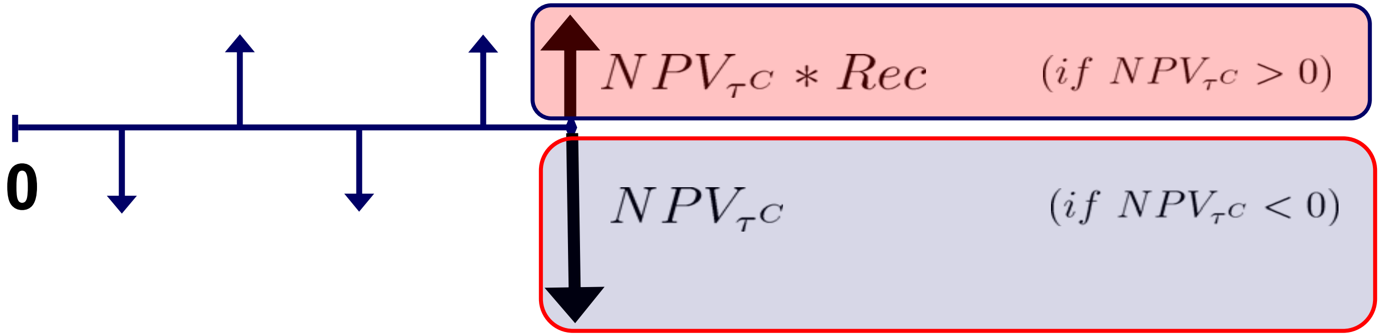
$$NPV_{\tau^C} = \mathbb{E}_{\tau^C}\left[Cash(\tau^C, T)\right]$$

Then:

$$\boxed{\text{DEFAULT PAYOUT}} = \begin{cases} NPV_{\tau^C} & (if\ NPV_{\tau^C} < 0) \\ NPV_{\tau^C} * Rec & (if\ NPV_{\tau^C} > 0) \end{cases}$$



Unilateral Counterparty Risk



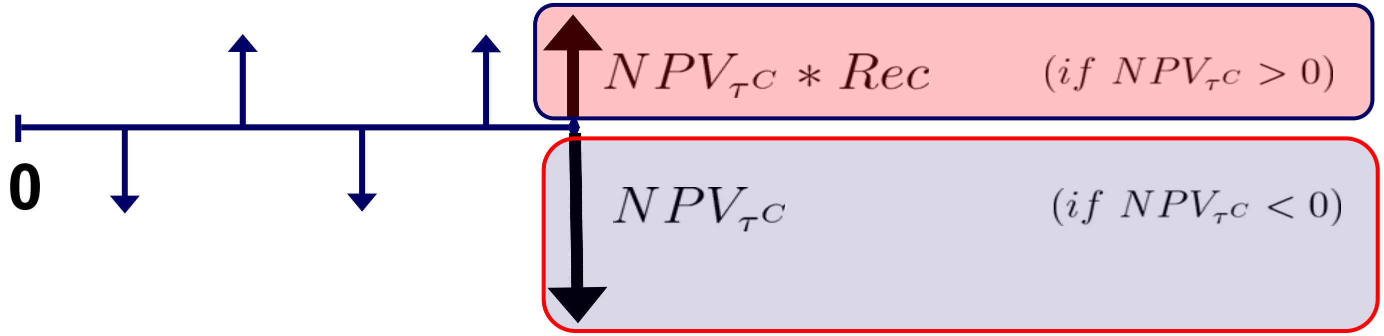
This can be written as

$$+Rec\,(NPV_{\tau})^{+} - (-NPV_{\tau})^{+}$$

leading to price

$$\begin{aligned} NPV^{C}(t) \;=\; & \mathbb{E}_t\left[1_{\{\tau^C > T\}} Cash\,(t,T)\right] + \\ & +\mathbb{E}_t\left[1_{\{\tau^C \le T\}} Cash\left(t,\tau^C\right)\right] \\ & +\mathbb{E}_t\left[1_{\{\tau^C \le T\}} D\left(t,\tau^C\right)\ \left\{Rec * (NPV_{\tau^C})^{+} - (NPV_{\tau^C})^{-}\right\}\right] \end{aligned}$$

Unilateral Counterparty Risk



Alternatively, we can perform the transformation

$$
\begin{aligned}
& +Rec\,(NPV_\tau)^+ - (-NPV_\tau)^+ \\
= \quad & NPV_\tau \underbrace{- (1 - Rec)\,(NPV_\tau)^+}
\end{aligned}
$$

This one is the loss due to counterparty risk, so

$$
\underbrace{NPV^{CR}}_{\text{Price with CVA}} = \underbrace{NPV}_{\text{Default-free Price}} - \underbrace{Lgd\,\mathbb{E}\left[1_{\{\tau \leq T\}} D(0,\tau)\,(NPV_\tau)^+\right]}_{\text{Counterparty Value Adjustment (CVA)}}
$$

CVA Pricing

$$\mathbb{E}^{\mathbb{Q}}\left[1_{\{\tau\leq T\}}D\left(0,\tau\right)\left(NPV_{\tau}\right)^{+}\right]$$

CVA is expectation under risk-adjusted probability measure Q, we know what it means…returns are lower than in real-world, default probabilities are higher.

We need this for pricing: if instead we took expectation under real-world P,

$$\mathbb{E}^{\mathbb{P}}\left[1_{\{\tau\leq T\}}D\left(0,\tau\right)\left(NPV_{\tau}\right)^{+}\right]$$

Standard (real-world) Expectation

Discount on funding

No external risk adjustment

pricing would be wrong: based only on expected returns/losses and forgetting the other crucial component of value, uncertainty/riskiness.

We take risk into account by reducing returns (or increasing loss probability) proportionally to riskiness/uncertainty, since in arbitrage-free complete market extra-returns just remunerate extra-risk. We can price with a simple expectation only if expectation is risk-adjusted: we trade returns with volatility.

Expected Return

Consider this example. We are back to the end of the 90's, ***just before the dot-com bubble***. An analyst tells you that if you invest now in an internet company, your ***expected annual rate of return over the next 3 years is 20%***.

With hindsight, knowing that most of those companies defaulted over the next 3 years, can we say now that the analyst was wrong?

No.

In fact, such an expected return can arise from taking into account that ***9 out of 10 internet companies were going to lose on average 1/3 of their value annually until default in three years, but 1 out of 10 was a Google or a Amazon, with returns that could reach 500% per year.***

The expected rate of return can be 20% even in a market where the most likely outcome is default over 3 years.

Risk Aversion

$$-33\% \times \frac{9}{10} + 500\% \times \frac{1}{10} = 20\%$$

The expected rate of return can be 20% even in a market where the most likely outcome is default over three years.

Now consider a completely risk-free investment, guaranteed say by the Bundesbank, giving your certainly 20% per year. Where do you prefer to put your money for the next three years, in an internet stock just before the worst crisis of the market, or in a guaranteed 20% investment?

Even if the expected rate of return is the same, 20% per year, most investors would prefer the second investment, particularly if they are professional investors.

There must be something beyond expected return that affects the value of a security…

Risk-Adjusted Probability Measure

Clearly we are speaking of ***risk***, the dispersion of the possible returns around the expected one. It is the other component of value beside expected return. An approach to pricing where we just do

$$\mathbb{E}\left[e^{-r(T-t)}\left(S\left(T\right)-K\right)^{+}\right]$$

Standard Expectation

Discount on risk-free funding

No external risk adjustment

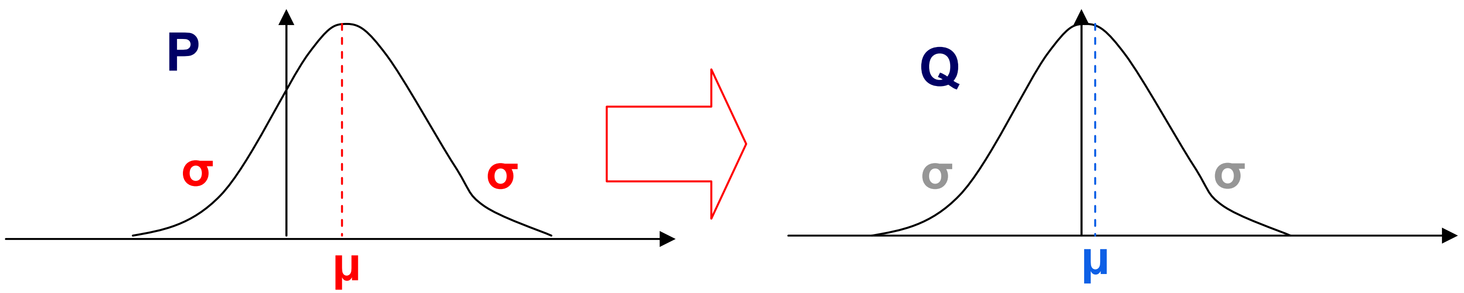
forgets the other crucial component of value, riskiness.

Quants took the approach of including risk by modifying the nature of the expectation. Prices remain pure expectations, but under modified probability distributions. They speak of moving from standard **"real-world probability measure"**, often indicated by ***P***, to **"risk-adjusted probability measure"**, often indicated by ***Q***.

$$\mathbb{E}^{\mathbb{Q}}\left[e^{-r(T-t)}\left(S\left(T\right)-K\right)^{+}\right]$$

Risk-Adjusted Probability Measure

The idea is modifying the distributions of the underlying assets to take riskiness into account in expectations. Mostly, this means reducing expected rate of returns proportionally to risk to get a correct valuation.



This is based on the assumption that most market operators are risk-averse, they want return above risk-free rate to compensate risk: for them return increases value while risk reduces it. So you reduce return proportionally to risk in order to include the reduction in value due to risk. In arbitrage free markets this lead to risk-free return.

Basel's Counterparty Risk

- Under Basel II the Counterparty Credit Risk (CCR) capital requirement is given by

K = 8% * RW * EAD

Minimum Capital Vs Risk Weighted assets

Depends on Counterparty Rating and Maturity

Exposure At DEfault=1.4*Effective EPE

Peculiar Time average of Exposures

$$RW = LGD \cdot \left[N\left(\frac{N^{-1}(PD) - \sqrt{\rho}\, N^{-1}(0.1\%)}{\sqrt{1-\rho}} \right) - PD \right] \cdot MF(M, PD)$$

Basel's Counterparty Risk

$$RW = LGD \cdot \left[N \left(\frac{N^{-1}(PD) - \sqrt{\rho}\, N^{-1}(0.1\%)}{\sqrt{1-\rho}} \right) - PD \right] \cdot MF(M, PD)$$

- What justification for this formula? With M, Y standard ⊥ gaussian:

$$X = \sqrt{\rho} M + \sqrt{1-\rho} Y$$

systemic factor ($\sqrt{\rho}M$) — idiosyncratic factor ($\sqrt{1-\rho}Y$)

- *PD* is the probability that *X<K*, $K = N^{-1}(PD)$
- Let's assume we know M, and M is low, say $M = N^{-1}(0.1\%)$

$$\Pr\left(X \le N^{-1}(PD) \,|\, M\right) = \Pr\left(\sqrt{\rho} M + \sqrt{1-\rho} Y \le N^{-1}(PD) \,|\, M\right)$$

$$= \Pr\left(Y \le \frac{N^{-1}(PD) - \sqrt{\rho} M}{\sqrt{1-\rho}}\right) = N\left(\frac{N^{-1}(PD) - \sqrt{\rho} N^{-1}(0.1\%)}{\sqrt{1-\rho}}\right)$$

Basel's Counterparty Risk

$$RW = LGD \cdot \left[N\left(\frac{N^{-1}(PD) - \sqrt{\rho}\, N^{-1}(0.1\%)}{\sqrt{1-\rho}} \right) - PD \right] \cdot MF(M, PD)$$

Loss Given Default

PD stressed: Systemic factor is At the level Of 99.9% Var

Unstressed PD (expected Loss)

Maturity Factor

- Basel III adds (not for corporates in EU) a charge for spread volatility, 99.9% spread Var of

$$CVA = LGD_{mkt} \sum_{i=1}^{T} \max \left[0, \exp\left(-\frac{s_{i-1} t_{i-1}}{LGD_{mkt}} \right) - \exp\left(-\frac{s_i t_i}{LGD_{mkt}} \right) \left(\frac{EE_{i-1} P_{i-1} + EE_i P_i}{2} \right) \right.$$

CVA Fair Value Adjustment and Capital Charge

- CVA computed by front office is a Fair Value Adjustment charged to clients
- But a new deal can also increase capital. Capital is expensive, so there is a cost that must be covered by the deals revenue.
- For this reason, banks have a desk (KVA desk or Capital optimization, at times EVA desk) with the task of computing a capital charge

  K*Cost Of Capital (perspective along the life of the deal) to be potentially added to the price (beside other tasks)

CVA and Capital: should we **sum** them?

■In all cases above, capital is based on some approximation of the worst possible lost, throught the concept of 99% Var and stressed PD, through historical stressing or through approximate multiplier…

$$Worst^P \left\{ Lgd \left[(NPV_\tau)^+ \right] \right\}$$

⇧

From historical information

■Economic capital means to cover unexpected losses, estimated under the real measure. One should charge expected loss and set aside capital for the unexpected one. Once all the extra-capital required to cover potential losses of a new deal is allocated and its cost charged to the client, we trust that even if a default happens the bank does not worsen its pre-deal situation.

CVA and Capital: should we **sum** them in client's charge?

- CVA as a price adjustment is the cost of replication (hedging) of any credit loss:

$$CVA = Lgd\mathbb{E}^{\mathbb{Q}}\left[1_{\{\tau\le T\}}D\left(0,\tau\right)\left(NPV_{\tau}\right)^{+}\right]$$

⇧

From market prices of hedges

- In fact it is an expectation under the **risk adjusted** measure $\mathbb{Q}$. It is different from just expected loss (and it is usually higher)

$$CVA > EL = Lgd\mathbb{E}^{\mathbb{P}}\left[1_{\{\tau\le T\}}D\left(0,\tau\right)\left(NPV_{\tau}\right)^{+}\right]$$

⇧

From historical estimation

- In fact in principle, remember the explanation we reviewed at the beginning, the risk-adjusted measure is such that even its expectation takes into account the risk (tails) of the historical distribution.

CVA and Capital: should we **sum** them?

- So, CVA price adjustment is meant to be the cost of an insurance to cover all credit losses, espected and unexpected. The Capital charge is meant to cover a capital allocation sufficient for the bank to be unaltered by credit losses (including the unexpected ones) with the maximum level of confidence.

- Somehow, protecting from risk by CVA is like **buying an insurance**, protecting by Capital is like **acting as an insurance company**.

- If one sets apart enough capital for expected and potential losses (capital charge) it does not need to buy insurance (CVA), if one buys insurance (CVA) it does not need to set capital apart (capital charge).

CVA and Capital: should we **sum** them?

- If the bank is free to choose the most convenient strategy, hedging or capital, the only charge should be

Min(CVA, Capital Charge)

- If the bank does not know if both strategies are available (capital shortage, illiquid CDS) the charge should be

Max(CVA, Capital Charge)

- In principle we should never sum CVA and Capital Charge.

CVA and Capital Charge: how different?

- **Moreover, the cost of CVA insurance and the cost of capital charge should, in a perfect world, be of comparable in size**.

- CVA seems to offer a better protection since it cover all losses, while KVA corresponds to a capital buffer that cannot cover all possible losses. KVA seems to live more systemic risk open.

- But this is misleading. If all credit losses had to happen at the same time, also CDS protection bough with CVA charge would fail, since many protection sellers would default. The CDS spreads in fact incorporate default risk of protection seller, particularly high in systemic crises.

- On the other hand the KVA capital buffer is usable for all losses and not only for losses from default of one specific counterparty. The only real difference is risk of failure of an external insurance scheme vs risk of failure of an internal insurance scheme.

CVA and Capital: should we **sum** them? Reality check

- It's important to understand how things are in principle, to understand what we aim at when we charge CVA or KVA. Then there's reality.

- CVA is probably an underestimation of the actual costs of hedging. It's one of the most hybrid and difficult hedging exercises, it involves high transaction costs since CDS notional must be readjusted often, CDS are affected by credit risk of protection seller, there is a strong model risk associated in particular to wrong way risk. This can justify a residual allocation of economic capital, essentially for model risk.

- Capital computations are also strongly affected by model risk (models under real measure are more difficult to design, quantiles or stressed values are more prone to errors) and additionally they don't adimttedly cover 100% of losses. This can partially justify a parallel hedging /insurance.

- But more importantly, here we are speaking of regulatory and not of economic capital.

CVA and Capital: should we **sum** them? Reality check

- Regulators have decided to impose capital requirements even if CVA is charged. And if this charge is used for buying a hedging strategy, not all hedging instruments are viable mitigators of regulatory requirements (differently from market risk).

- In Europe, only CDS hedging is recognized (with 50% haircut if index based) as a reduction of capital exposure. Hedging of sensitivites to the underlying is recognized only in the US.

- Additionally the reduction provided by CDS hedging is minimal, very conservative approach: it only allows to replace the counterparty's PD with the one of the protection seller. It basically assume perfect default correlation between counterparty and proteciton seller, overestimating systemic risk.

- Thus even if we are hedging counterparty risk with CVA charge there will be important capital requirements whose cost can be reasonably charged to counterparties. It is important to bear in mind that this is a market inefficiency leading, in economic terms, to double counting.

Q vs P

One word for two worlds

- When speaking for example of Counterparty Credit Risk or CVA, we usually mean **two different things**, dealt with using **two models**

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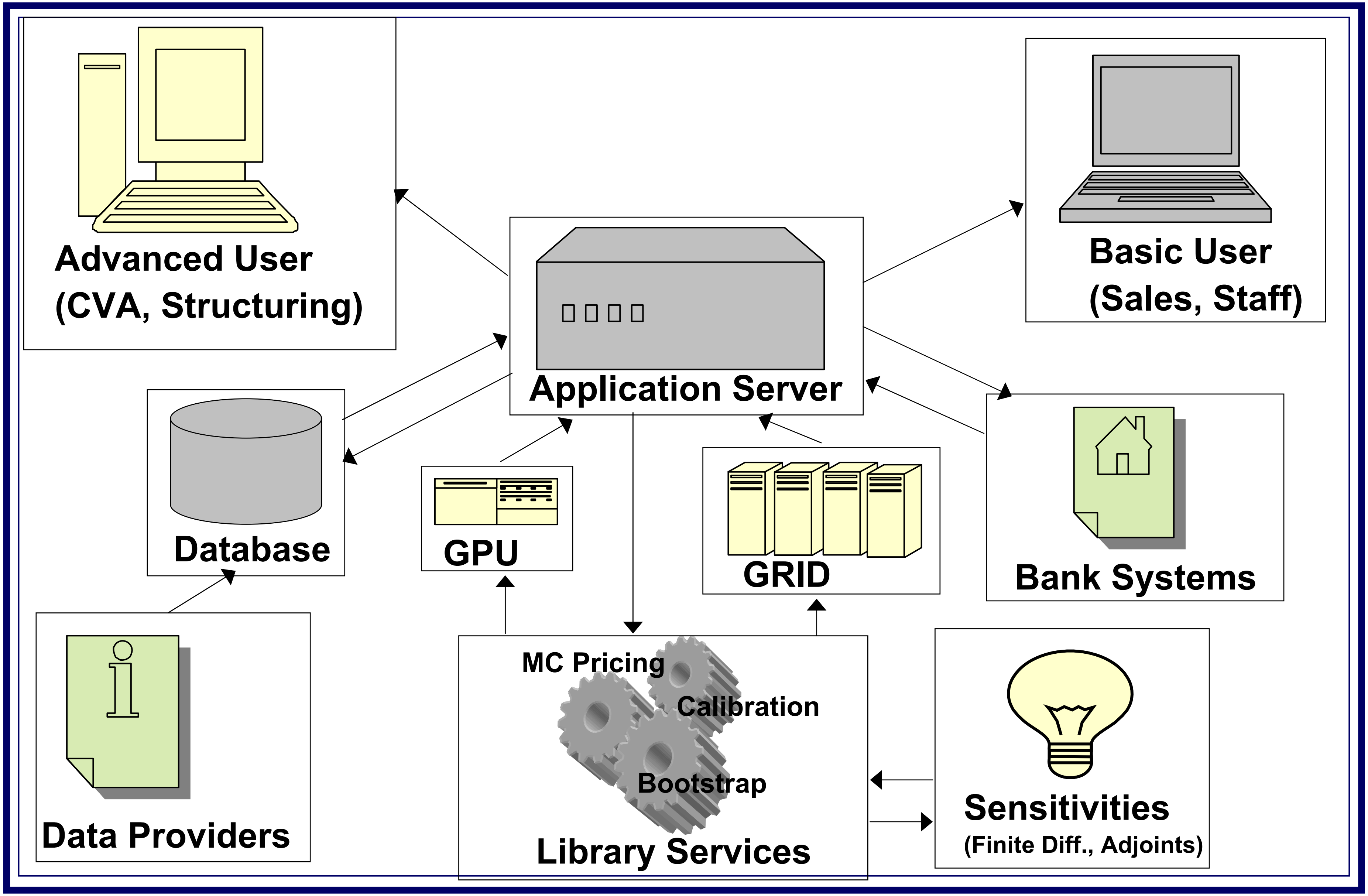
A CVA framework



Simulating in the real world

■Risk models should have real-world, non-adjused parameters. Yet, they often have features that resemble risk-adjusted models, for example with drifts

$$dL\left(t,t+T_i\right)=\mu_i\left(t,L,F\right)dt+\sigma_i L\left(t,t+T_i\right)dW_i\left(t\right)$$

such that

$$\mathbb{E}_0\left[L\left(t,t+T_i\right)\right]=F\left(0,t,t+T_i\right)$$

What is the justification for this? That historically estimated drifts are unstable and do not guarantee good forecasting capabilities. This is true…

One world for two worlds

Should the two models be the same?

No. They have different ***purposes***.

Risk:
- Credit Capital
- Credit Limits

Estimate a Loss:
- Unhedged
- Most Realistic (good backtest)
- Potential

Real-world Probability

Focus on tails

Pricing:
- Valuation
- Hedging

Value a Payoff:
- Hedged
- Arbitrage-Free
- Mkt Consistent

Risk-Adjusted Probability

Focus on arbitrage-free expectation

One world for two worlds

Let'see with a few examples what these differences mean in practice

1) Expectations consistent with mkt forwards?

Risk:
Irrelevant

- Not so relevant in tails
- Not realistic nor historical

Pricing:
Crucial

- Central to valuation
- Consistency with hedges and makes model arbitrage free

2) Avoid crazy tails?

Risk:
Crucial

- Fundamental to tails (worst case)
- Consistent with history and realism

Pricing:
Irrelevant

- Not crucial to expectation, Cancels out with hedges
- Probabilities are adjusted for risk..

Simulating in the real vs risk-adjusted world

- In practice, this should lead to two different approaches, for example with rates:
- PRICING:
  - Start from a model, say Vasicek
  - DRIFT (focus, need market consistency): calibrate expectations to forwards (maybe through long-term means as in HW model). It is a no-arbitrage constrain (it is only in drifts only in simple models).
  - TAILS (desideratum): you may desire to address tails, e.g. rates too negative, for realism. Often not done since it would modify forwards, and because risk-adjustment could justify higher probability for extreme scenarios than in real world expectation.

Simulating in the real vs risk-adjusted world

- In practice, this should lead to two different approaches, for example with rates:

- RISK
  - Start from a model, say Vasicek
  - DRIFT (desideratum). You could estimate it historically, but this is unstable. You can do as in HW as a starting point, difficult to find other starting points.
  - TAILS (focus, need realism). You modify tails to make them realistic, which is somehow easier than drifts. Then you happily accept modifications to drift: they make model more realistic and do not violate no-arbitrage or hedge constraints, since we have none.

Simulating in the real world

- So between IM for risk and pricing models there are often differences that could be made more consistent, but also some things that must be different (sad if we have consistency only where we shouldn't).

- Often risk-adjusted drifts and no-arbitrage conditions are used in IM, while they are not required to hold in the real-world measure. That's due to difficulty of drift estimation and lack of general constraints in real-world modelling. In IM no-arbitrage can be starting point but is not a constraint.

- In a real-world model, realism is the only constraint, so economic and not no-arbitrage hypotheses should be made. You can for example model central bank intervention to avoid extreme rate scenarios, that are averaged up in pricing but can strongly affect tails, like in computation of credit lines.

For what we know, the alteration to the drifts (borrowed from risk neutral) that comes for this intervention can only be beneficial for realism.

Rebonato et al (2005) adjustments to history for realism

- Rebonato et al. (2005) point out that the drift componente is dominated by the volatility component in the short term, but it becomes dominant in the long term.

- They use a semi-parametric approach for realistic modelling: start from random bootstrap of historical rate changes and notice differences from real world term structure movements: lack of the smoothness probably driven by “pseudo-arbitrage” trades, and lack of the autocorrelation visible in the history of the term-structure.

- Introducing an sketched “arbitrage” mechanism and a higher probability of random draws in the same order as they appear the history, they modify the drift of the term structure compared with the trivially estimated one. But in this way they obtain more realistic behaviour of the term structure and recover many more crucial statistical properties like transition distributions.

Rebonato et al (2005) adjustments to history for realism

- Hull, Sokol and White (2014) start from analogous considerations, but the aim at a model for joint simulation under the real and the risk-adjusted probability measures.

- In order to obtain this, they estimate historically a real-world long term expectation of the short rate, that in the example of the paper is a long term historical average, but the authors suggest that this could then be modified by macroeconomi views.

- A crucial contribution is that then they make the model consistent both with this long-term real world expectation and with market prices through the estimation of a time-dependent risk-premium affecting the dynamics of rates. See next presentation for more details.

- In this approach one starts from a risk-neutral model but modifies it for obtaining real world features. These remain subject to judgement, but we have the advantage of joint simulation very efficient nowadays.

DVA vs FVA

Debit Value Adjustment

With the increase of bank credit spreads and IFRS 13, CVA must be complemented with DVA, the adjustment to pricing due to our own default probability.

It is consistent with the principle of fair value and it is necessary to find market agreements when counterparties compute CVA. It can create moral hazard and misleading financial reporting. It is a natural hedge to balance sheet.

Let’s see how it affects pricing.

Bilateral Counterparty Risk

- When both I and C can default we speak of bilateral risk of default, precisely we have
- $$\begin{aligned} NPV^{C,I}(t) &= \mathbb{E}_t\left\{1_0 Cash(t,T)\right\} + \\ &+\mathbb{E}_t\left\{1_I\left[Cash(t,\tau^I) + D(t,\tau^I)\left(\left(NPV^0(\tau^I)\right)^+ - Rec\left(NPV^0(\tau^I)\right)^-\right)\right]\right\} \\ &+\mathbb{E}_t\left\{1_C\left[Cash(t,\tau^C) + D(t,\tau^C)\left(Rec\left(NPV^0(\tau^C)\right)^+ - \left(NPV^0(\tau^C)\right)^-\right)\right]\right\} \end{aligned}$$

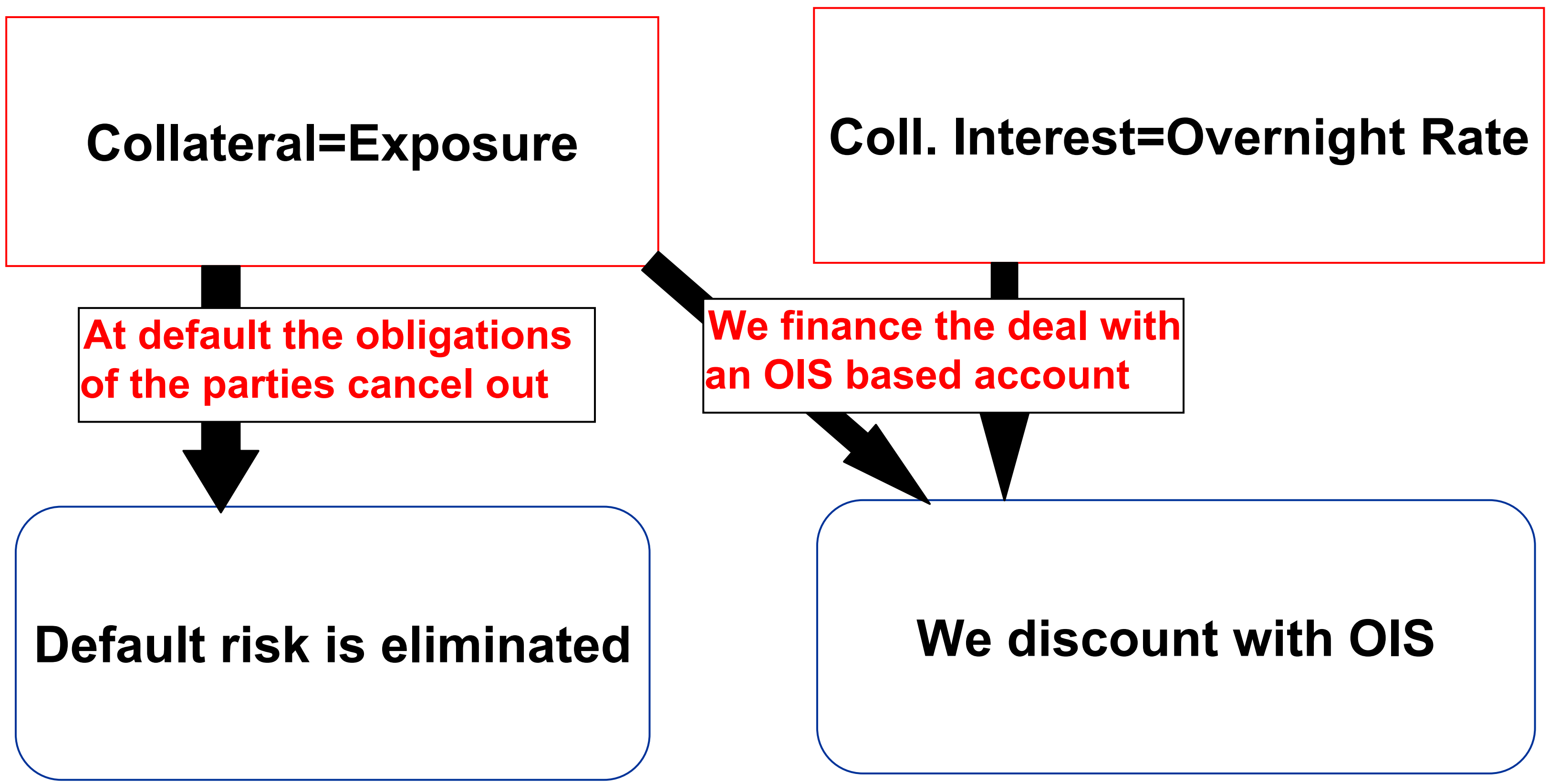
  where we use the following event indicators

$$\begin{aligned} 1_0 &= 1_{\{T<\min(\tau^I,\tau^C)\}}, \qquad 1_I = 1_{\{\tau^I\le\min(T,\tau^C)\}} \\ 1_C &= 1 - 1_I - 1_0 = 1_{\{\tau^C<\tau^I\}}1_{\{\tau^C\le T\}}. \end{aligned}$$

And this is not the end, because banks understood that with credit risk also funding costs were rising…

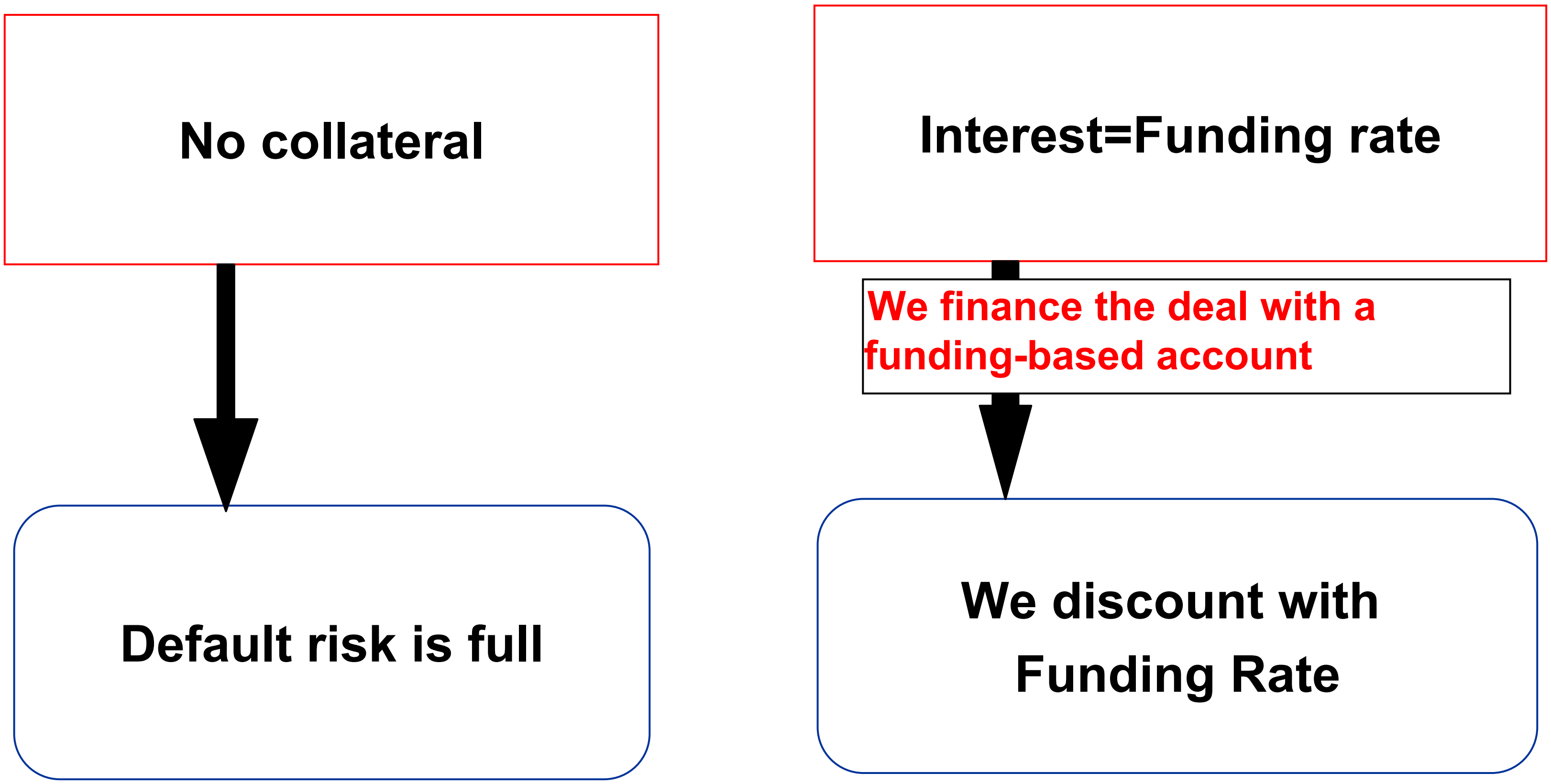
Collateral

What happens when a deal is collateralized, with no Minimum Transfer Amount, cash collateral, and continuous collateral regulation (approximation of standard collateral)? Market simplification is



Funding

The first approach, suggested also by Piterbarg 2010, was to extend this to non-collateralized deals...



However, as revealed by Morini and Prampolini 2011, things are not so simple...

Considering explicitly the funding strategy

- In order to solve the puzzle, we model explicitly the funding strategy. Here companies capitalize and discount money with the risk-free rate **r**, and then add or subtract credit and funding costs.

- The above deal has two legs. For the lender **L**, one is the deal leg, with net present value

$$\mathbb{E}\left[-P + e^{-rT}G\right]$$

where **G** is the payoff at **T**, including a potential default indicator; the other leg is the funding leg with net present value

$$\mathbb{E}\left[+P - e^{-rT}F\right]$$

where **F** is the funding payback at **T**, including a potential default indicator. In the general case the total net present value is

$$V_L = \mathbb{E}\left[-P + e^{-rT}G + P - e^{-rT}F\right] = \mathbb{E}\left[e^{-rT}G - e^{-rT}F\right]$$

The borrower. Default on the funding strategy

- The borrower **B** has a liquidity advantage from receiving **P**, as it allows to reduce its funding requirement by **P**. This amount of funding would have generated a negative cashflow at **T**, when funding must be paid back, equal to

$$-P\, e^{rT}\, e^{s_B T}\, 1_{\{\tau_B > T\}}$$

- The outflow equals **P** capitalized at the cost of funding, times a default indicator $1_{\{\tau_L > T\}}$. Why do we need a default indicator? Because in case of default the borrower does not pay back the borrowed funding. Thus reducing the funding by **P** corresponds to receiving at **T** a positive amount equal to

$$P\, e^{rT}\, e^{s_B T}\, 1_{\{\tau_B > T\}} = P\, e^{rT}\, e^{\pi_B T}\, e^{\gamma_B T}\, 1_{\{\tau_B > T\}}$$

to be added to what **B** has to pay in the deal. Thus the total payoff at **T** is

$$1_{\{\tau_B > T\}} P\, e^{rT}\, e^{\pi_B T}\, e^{\gamma_B T} - 1_{\{\tau_B > T\}} K$$

Default on the funding strategy

$$1_{\{\tau_B > T\}} P\, e^{rT}\, e^{\pi_B T}\, e^{\gamma_B T} - 1_{\{\tau_B > T\}} K$$

- **Taking discounted expectation,**

$$V_B = e^{-\pi_B T} P\, e^{\pi_B T} e^{\gamma_B T} - K\, e^{-\pi_B T} e^{-rT}$$

these cancel out

$$= P\, e^{\gamma_B T} - K\, e^{-\pi_B T}\, e^{-rT}$$

- **Notice that**

$$V_B = 0 \quad \Rightarrow \quad P_B = K\, e^{-(r+\gamma_B+\pi_B)T}$$

- Assume, as above, that $\gamma_B = 0$. In this case the breakeven premium is

$$P_B = K\, e^{-\pi_B T}\, e^{-rT}.$$

- Taking into account the probability of default in the valuation of the funding benefit shows that there is no pure liquidity charge, and no double counting of survival probability.

The accounting view

- DVA is disturbing since it evaluates as an asset our own default. But see what happens if the borrower pretends to be default-free. In this case the premium P paid by the lender gives B a reduction of the funding payback at T corresponding to a cashflow at T

$$P e^{rT} e^{s_B T},$$

where there is no default indicator because B is treating itself as default-free. This cashflow must be added to the payout of the deal at T, again without indicator. Thus the total payoff at T is

$$P e^{rT} e^{s_B T} - K$$

- This yields an accounting breakeven premium for the borrower equal to the previous breakeven, irrespectively of considering our default or not. If there is no basis:

$$P_B = K\, e^{-rT} e^{-\pi_B T}$$

- The borrower recognizes on its liability a funding benefit that takes into account its own market risk of default plus additional liquidity basis.

Avoiding double counting

- Putting credit and liquidity together since deal is not collateralized,

$$P = e^{-rT} e^{-\pi_B T} e^{-\pi_B T} K$$

Funding benefit

DVA term

- Is this correct? No. We have to take into account explictly our funding strategy, and the possibility of a default there (Morini and Prampolini (2011)), getting

$$P = e^{-rT} e^{-\pi_B T} K$$

Funding benefit from our internal perspective

DVA term for our counterparties

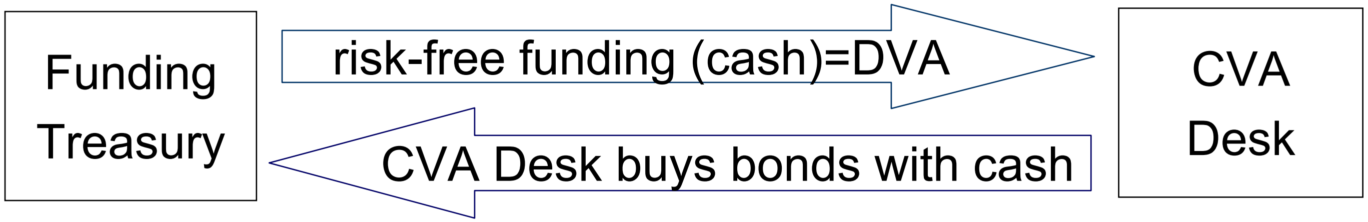
- And when we introduce the basis, there are surprising consequences also for the funding charge of the lender…

Managing DVA

- Who should manage DVA?

- In most banks, DVA is owned by the CVA desk. But this choice is arguable
  A. We have seen DVA is akin to funding benefit, so why not to leave it to the responsibility of the Funding Treasury?
  B. In any case, the Funding Treasury, through FVO, is the main producer of DVA effects in a Bank. Why to separate them?

- An alternative, not uncommon in the market, is to let the CVA desk compute and charge DVA, but then hedge it with the treasury that so manages the entire stock of bank's DVA



FVA debate: foundations

- The lender pays **P**. He needs to finance (borrow) **P** until **T**. At **T**, **L** will give back the borrowed money with interest, but only if he has not defaulted, so the outflow is

$$P\, e^{rT}\, e^{s_L T}\, 1_{\{\tau_L > T\}} = P\, e^{rT}\, e^{\pi_L T}\, 1_{\{\tau_L > T\}}.$$

The total payoff at T is

FVA

$$-P\, e^{rT}\, e^{\pi_L T}\, 1_{\{\tau_L > T\}} + K\, 1_{\{\tau_B > T\}}.$$

Taking discounted expectation

Funding Leg DVA

FVA

$$V_L = -P\, e^{\pi_L T}\, e^{-\pi_L T} + K\, e^{-rT}\, e^{-\pi_B T} = -P + K\, e^{-rT}\, e^{-\pi_B T}$$

these cancel out

The condition that makes the deal fair for the lender is

$$V_L = 0 \quad \Rightarrow \quad P_L = K\, e^{-(r+\pi_B)T}$$

The lender, when valuing all future cashflows as seen from the counterparties, does not include a charge for the credit component π_L of its own cost of funding, compensated by the fact that funding is not given back in case of default.

DVA or not DVA (of funding strategy)

- If the lender does not take into account its probability of default in the funding strategy, there is no simplification and he gets a different breakeven premium,

$$P_L = K\, e^{-rT}\, e^{-\pi_B T}\, e^{-\pi_L T}$$

Now the funding spread of the Lender is charged

- What is fair for an external observer, and for the borrower? What is fair is not charging the lender's funding costs: in fact they are compensated by the probability that the lender's defaults on funding, and the borrower has nothing to do with the credit risk of the lender that leads to funding costs.

- What is logic for the lender? Certainly charging the funding costs. If he charges only π_B (the credit risk of the borrower) and not π_L (its own credit risk, that leads to its funding costs), in case of no defaults his carry

$$\pi_B - \pi_L$$

can even be negative. This not possible when he charges funding costs since its carry becomes

$$\pi_B + \pi_L - \pi_L = \pi_B$$

The debate on FVA

- So, can we say with Hull & White that
  1. If a dealer takes into account the DVA of the funding strategy, then the FVA disappears, since FVA= DVA of the funding strategy ?

Yes

- So, can we say with Hull & White that

  2. The DVA of the funding strategy is a benefit to shareholders, so it should be taken into account ?

- This is really much more controversial…

Is DVA shareholder's value or company tragedy (or both)

2. The DVA of the funding strategy is a benefit to shareholders, so it should be taken into account

- This "benefit" emerges only in case of a default of a company. It is not clear why a company should consider benefits coming after its death. If there is no death, such an approach would lead to consider beneficial a deal with negative cashflows.

- Yet, even if it seems logic that a company reasons in terms of "going concern" not considering benefits after default, Hull & White actually talk of a benefit to shareholders, not to the company.

- Is the DVA of the funding strategy a benefit to shareholders? Shareholders of a company with Limited Liability, compared to those of a company with Unlimited Liability, hold a sort of call option, that allows them to take all the equity of a company when it is positive, but are not taken resposible when equity is negative (instead, shareholders with Unlimited Liability hold a forward contract). In this sense, the DVA of the funding strategy is a crucial component of the value of this option. A reasoning in line with the decisions of accountancy boards of including DVA in fair value accounting.

The debate on FVA

- So we have two approaches to FVA:
- From inside a company, FVA seems a real cost and must be charged to counterparties
- From outside a company, which includes certainly counterparties and possibly shareholders, FVA cancels out with the DVA of the funding strategy and there is no justification for charging to counterparties
- This misalignment of interest seems really disturbing. Hull & White, however, propose a point of view that justifies reconciles the two views, as we will see.

Market's Feeback according to Hull and White

- They say that even from an internal company's perspective there is no FVA cost. In fact, when for example a company that is worth 1bn and has a credit/funding spread of 100bps,

BANK (1bn)

100bps credit spread

invests 1 additional bn into a new project or derivative which is risk-free (0bps of credit spread), then the market recognizes that the bank is now

BANK (2bn)

100bps credit spread | 0bps credit spread

so in terms of funding costs the market will treat it as

BANK (2 bn)

50bps credit spread ← There is no FVA

The debate on FVA

- This reasoning leads to say that there is no FVA based on three crucial assumptions

1. The market has <u>instantaneous</u> efficiency
2. Funding of a deal happens <u>after</u> the market knows about the deal
3. The effect of a new deal on the funding costs of a bank is <u>linear</u>

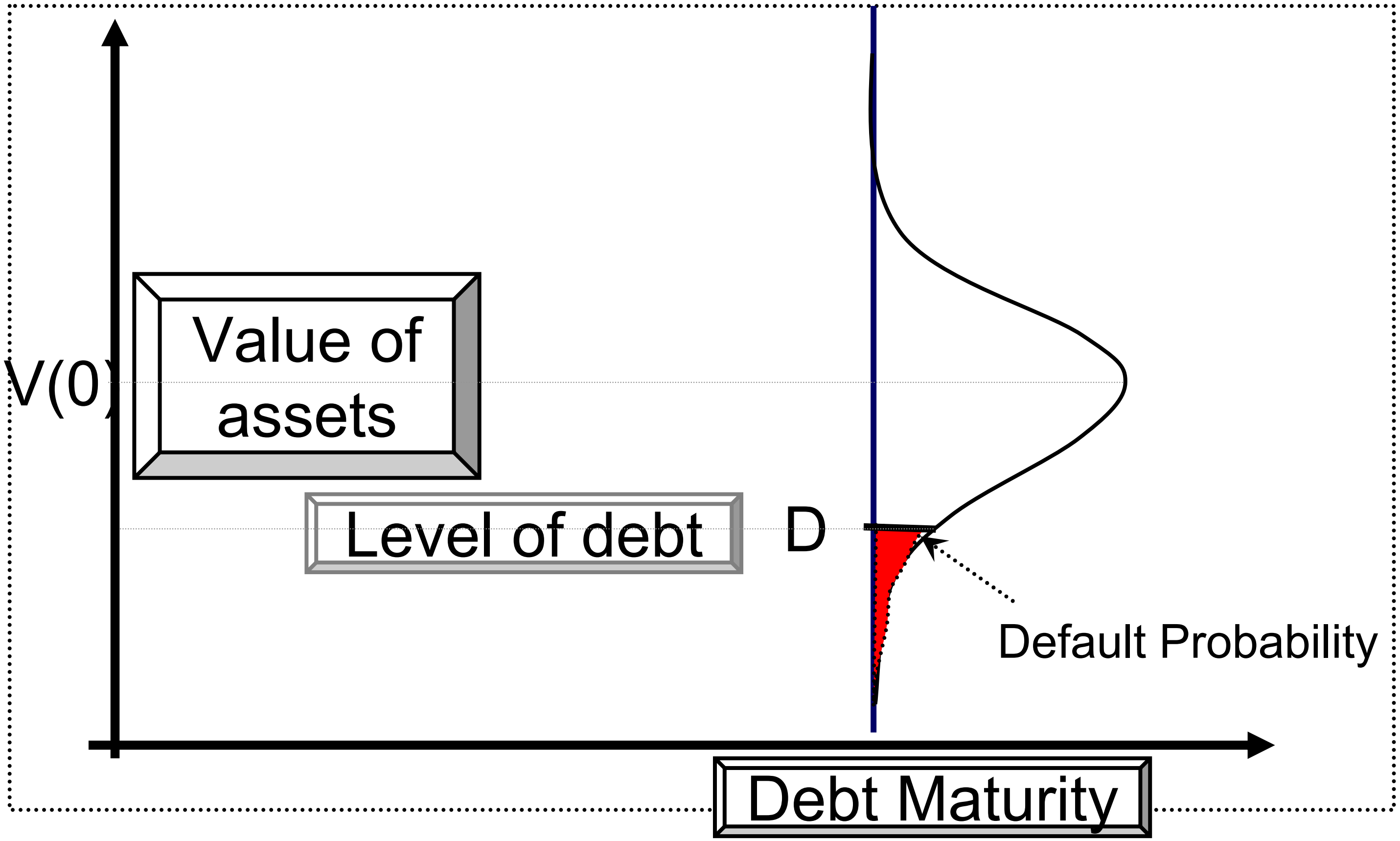
The debate on FVA

- This reasoning leads to say that there is no FVA based on three crucial assumptions

1. The market has <u>instantaneous</u> efficiency: this is not the case in the reality of funding markets, although we always use indirectly this assumption in pricing
2. Funding of a deal happens <u>after</u> the market knows about the deal: this can be true when a project is funded rolling short-term funding, but prudential management includes often part of funding at maturity
3. The effect of a new deal on the funding costs of a bank is <u>linear</u>: let's see if this must always be the case

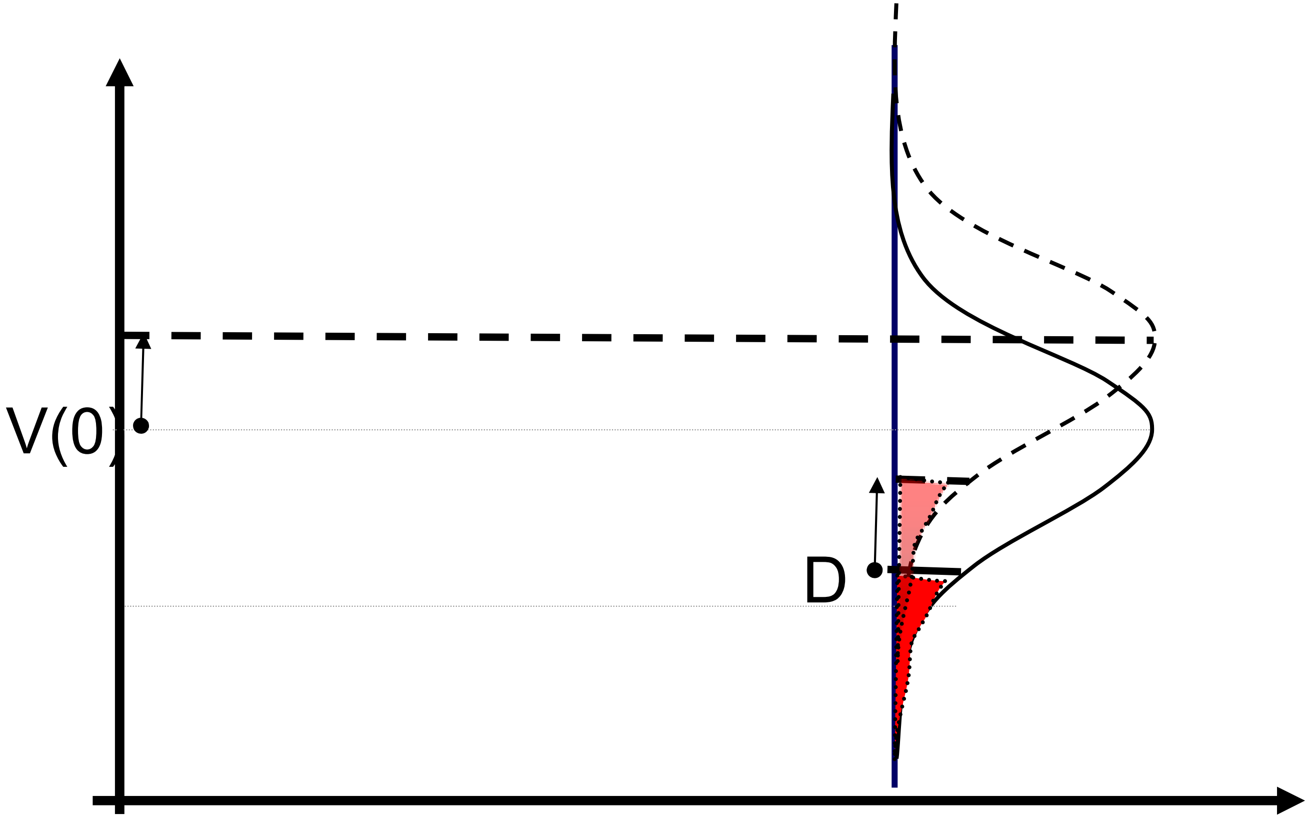
Linear Funding Feedback?

- Under some assumptions, the effect is actually approximately linear. Consider for example the simplest Merton Model



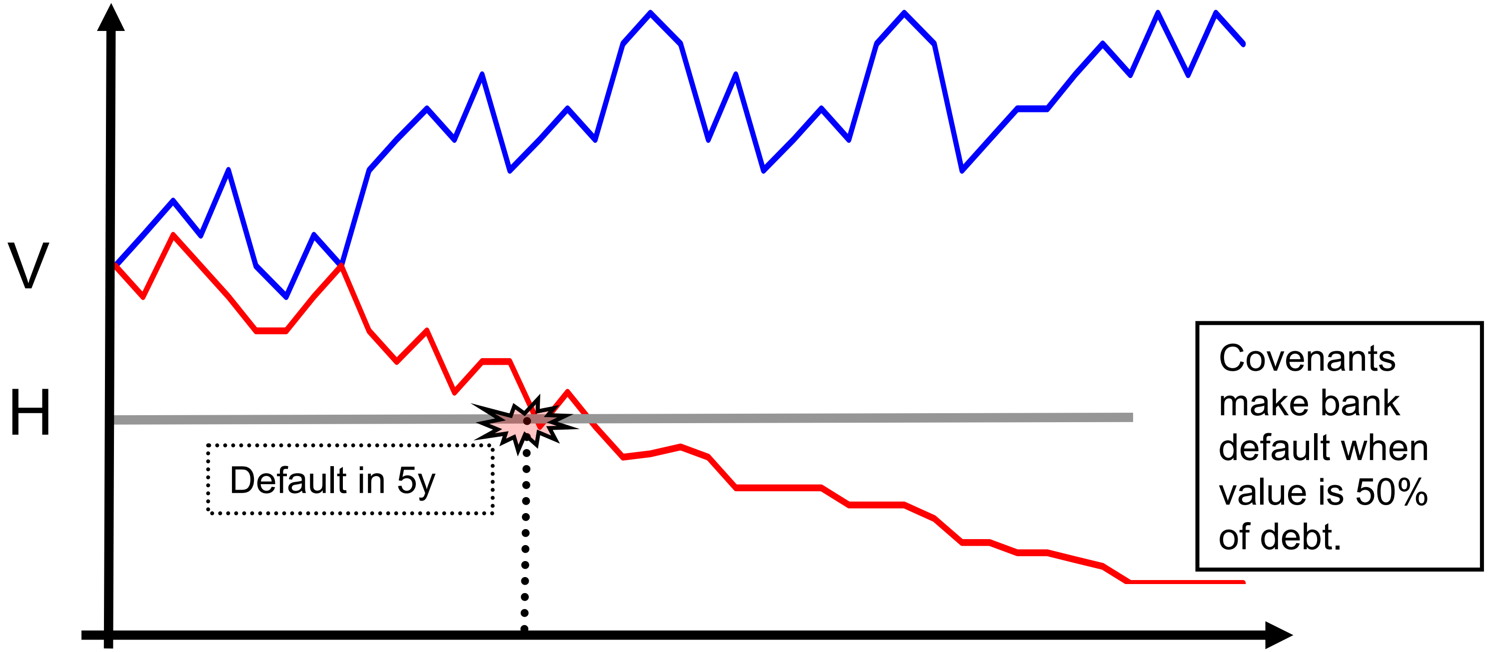
Linear Funding Feedback?

- What does it mean here to add a risk-fre project (worth in this case around 20% of the firm) ? It can be a project whose value never changes (no vol).
- In this case, under 0 rates, default probability is unchanged but recovery increases proportionally. Spreads are reduced linearly by around 20%.



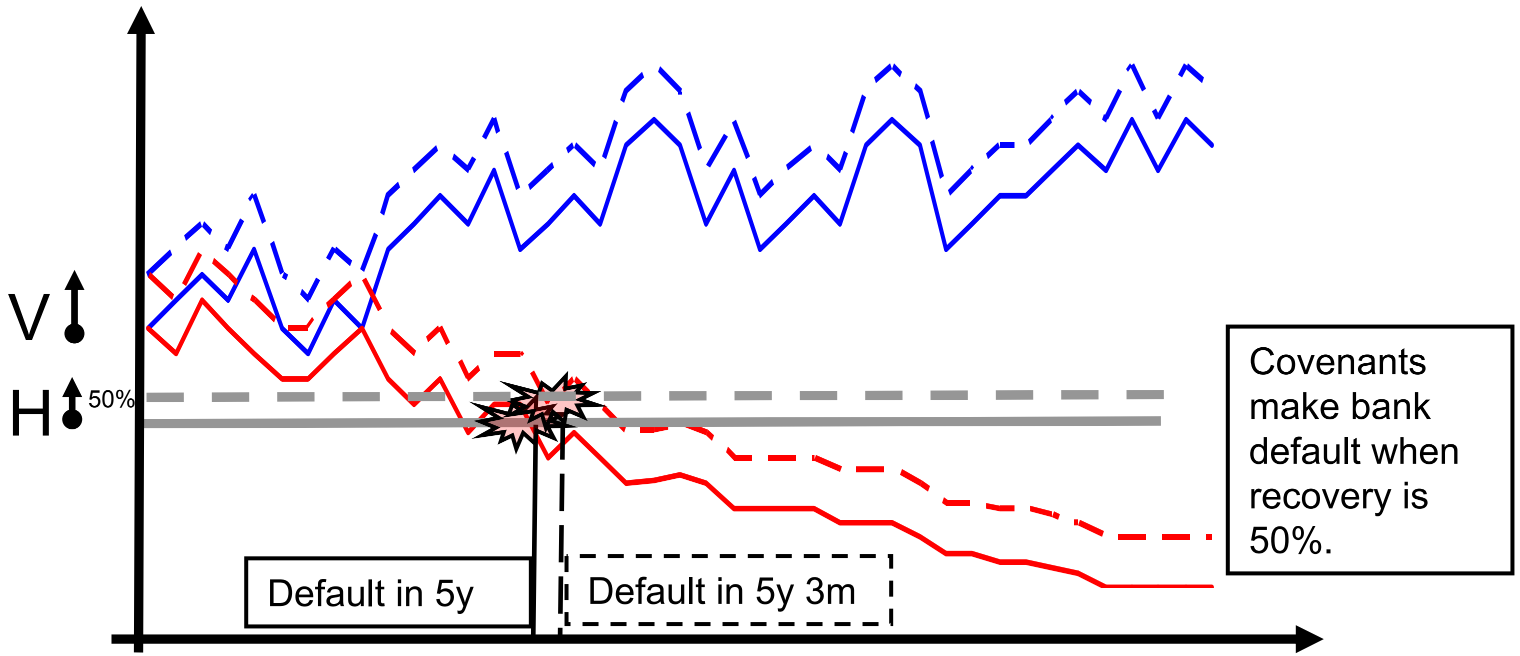
Linear Funding Feedback? First Passage Models

- Let's add some realism. First, we move to default barrier models were there is not one single default date but covenants can lead to earlier default
- Due to its current asset composition, the bank is very exposed towards its sovereign, which is represented by the two basic scenarios below: the blue one if the sovereign goes well (no default), the red one when sovereign enters a crisis (default when loss of value triggers covenants).



Excluding our own default. Internal symmetry

- Now the bank adds a project worth 20% of the company and risk-free, namely without volatilty, having maturity of 10y, so that the bank looks for 10y funding
- As we can see, the only effect of the project is to shift the default time in the bad scenario (sovereign crisis) by 3m. This has no effect on the 10y cost of funding. For decoupling the bank from the sovereign risk on such an horizon, probably the project should be worth more than 100% of the company itself.



The debate on FVA

- Thus, even if one believes in instantaneous market efficieny, only under some assumptions a new project has a linear effect on credit spread. Under rather realistic assumptions the effect is highly non-linear.

- Hull and White have the merit of pointing out that FVA is a distortion compared to an efficient market. As pointed out in Morini 2011, FVA makes deals fair for lenders but can make them unfair for borrowers in a negative spiral of growing funding costs.

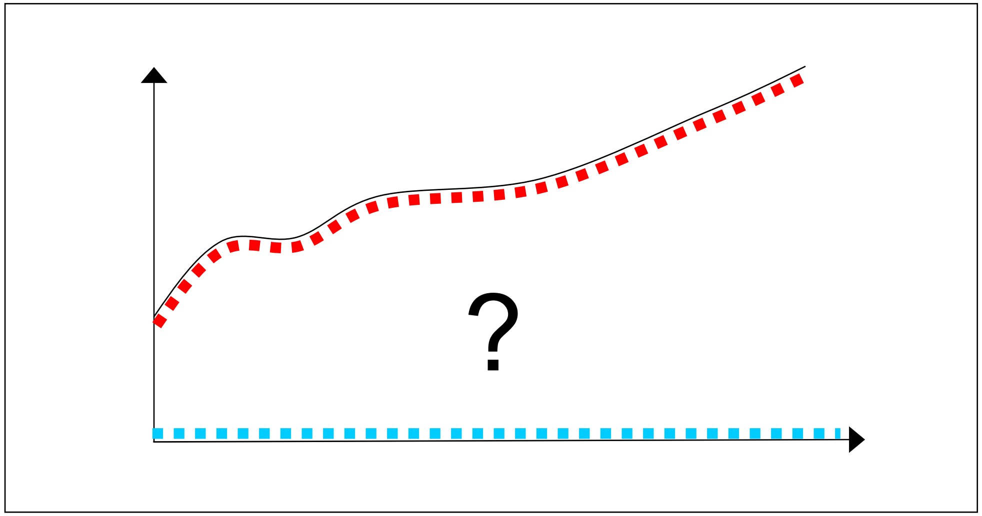
- Yet, in the current market situation a dealer following a going concern must take some FVA into account

A way out

- A market where the main leanders are the most risky payer is unavoidably distorted. FVA cannot be neglected by banks and yet is an unjustified burden on the economy.

- Banks con recognize the other side of the distorsion, that is funding through central bank facilities and guaranteed deposits…which moves the debate from funding, yes or no, to funding, how much?

Which funding spread?

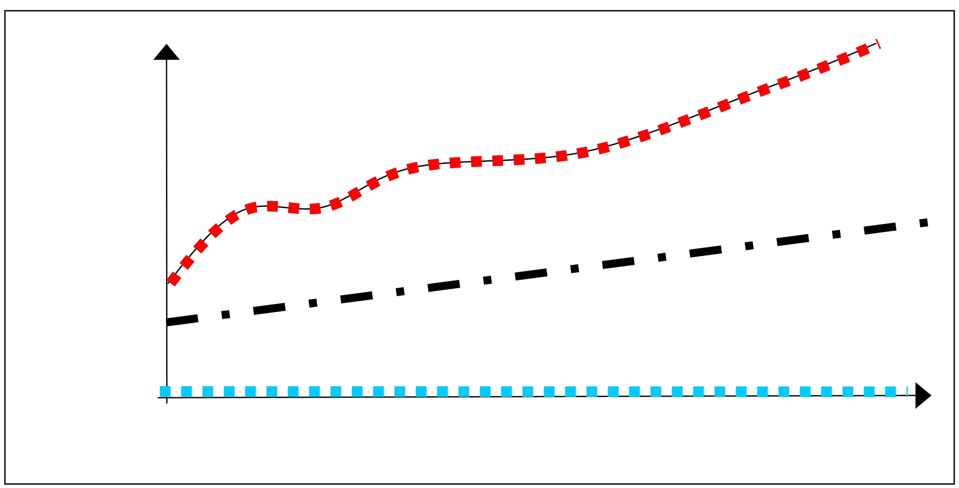


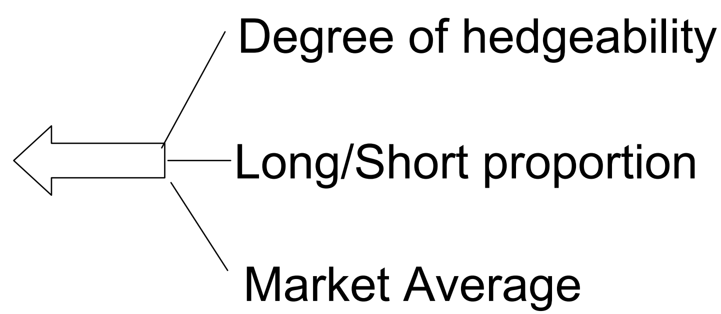
Bond term spread (1° Piterbarg):

- DVA2 unhedgeable
- Sticky Market
- Real cost
- Margin for service

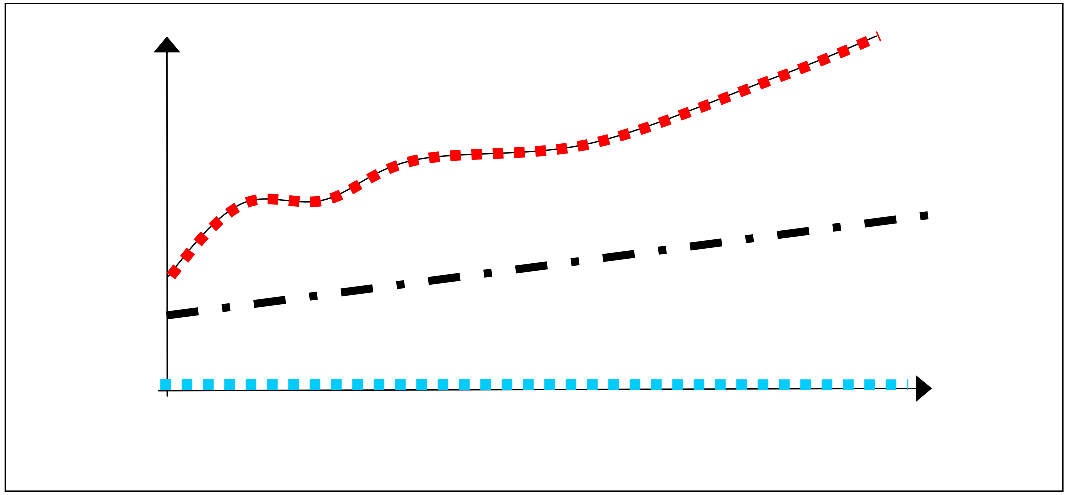
Null spread (1° Hull&White) :

- Compensated by DVA2
- Adjusted by mkt feedback
- Unjustified for cpty
- Different for same service





Which funding spread?



<u>Bond term spread</u>:

- DVA2 unhedgeable
- Sticky Market
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- Margin for service

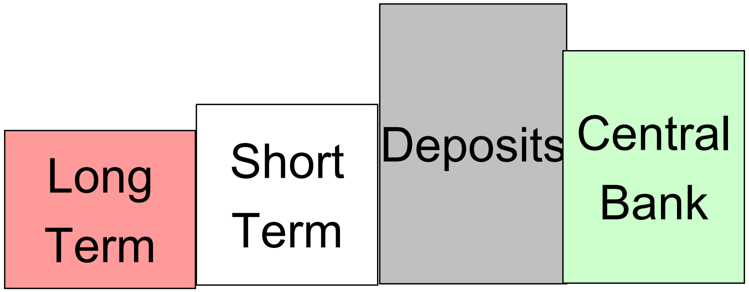
<u>Null spread</u>:

- Compensated by DVA2
- Adjusted by mkt feedback
- Unjustified for cpty
- Different for same service

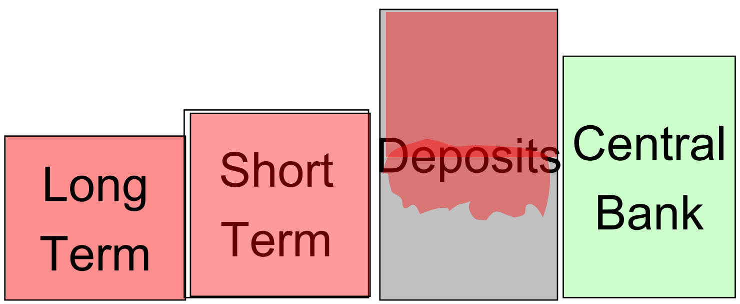
<u>There are three main justifications for an intermediate spread:</u>

- Degree of hedgeability (Goldman): DVA2 can be partially hedged, that part can be subtracted from the spread – critique: hedging, i.e. protection selling on correlated/index counterparties, is illusory.
- Market Average Spread (FSA): to be justified, funding cost should be a market spread, average of the funding spread of main banks (Libor?) – critique: it's unrelated to actual bank's costs/benefits.

Which funding spread?



- Long/Short Term proportion: funding should not be based on marginal funding cost (bond spread), but on average funding cost. Short-term funding is less costly – critique: when you take into account the risk of liquidity shortage, the cost of short term rolling is the same as long term funding.



- That's true. But there is short term funding which is externally guaranteed so bank-run risk is low and here banks are not charged their risk of default. This is other side of coin with respect to problems that lead to high funding costs. It can be used as a mitigant to such costs. Not far from market average cost.

Is FVA a part of Fair Value?

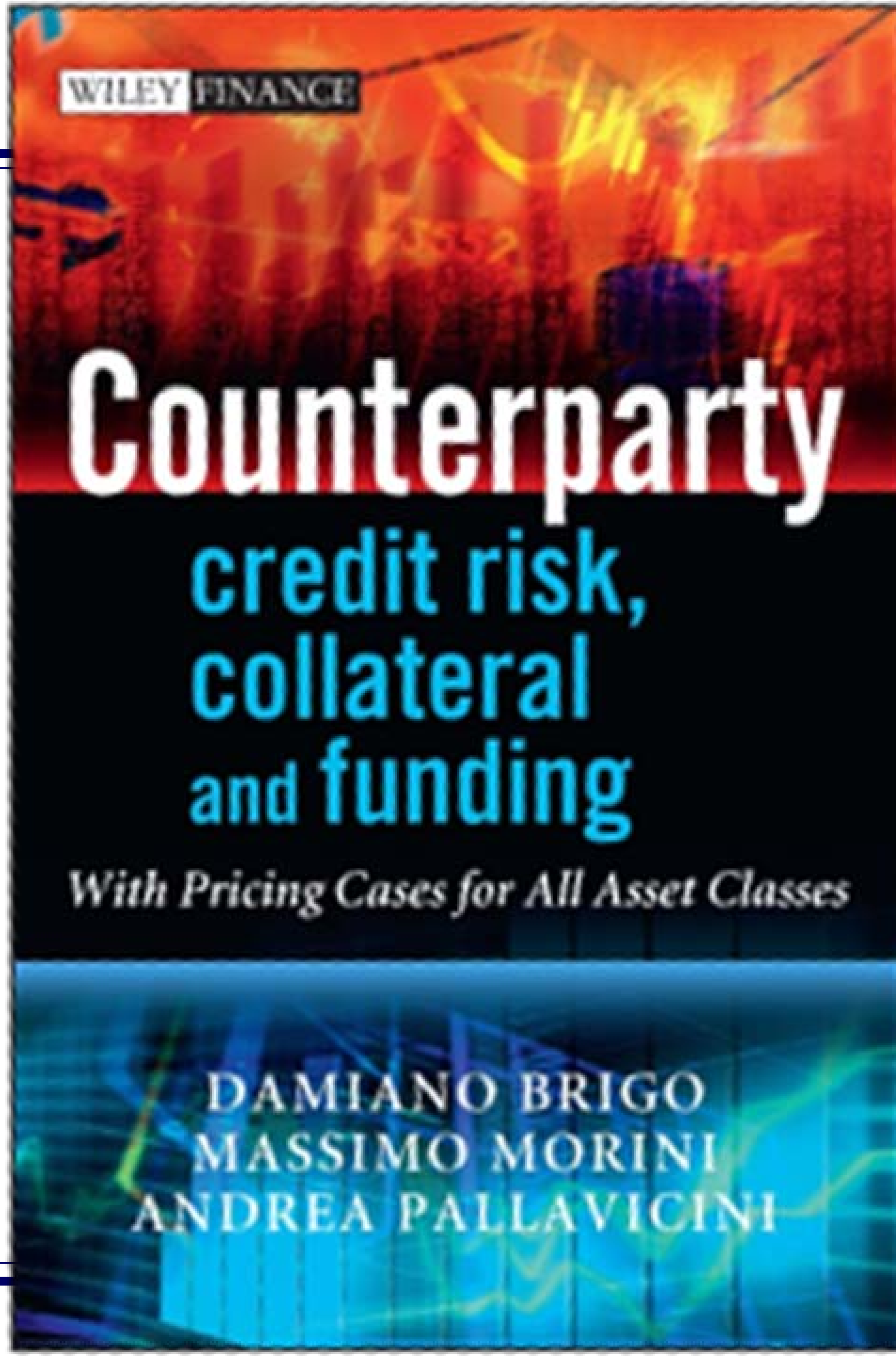
- In the last years, at least in Europe, we have seen a shift in the accounting approach, with full recognition of DVA as a component of fair value. Now the issue is FVA. Should it be considered part of fair value?
- Since fair value is an “exit price”, it is arguable that a quantity that depends on entity-specific figures (funding spread) is accepted by external parties when one wants to exit a position. The usual wisdom is that, leaving aside modelling differences, fair value should not depend on whom is making the valuation.
- With FVA, even the two current parties of a deal cannot agree of fair value since each one is using its own funding curve.
- Some propose to break FVA in two parts: a “market FVA” based on some average or minimum funding cost (Index Spread? Markit FVA consensus? Libor??), to be included in fair value, and an extra-balance-sheet adjustment for the entity specific part.
- This introduces a discrepancy between balance-sheet and actual prices, with further problem if fair value is higher than price. Shouldn’t an intermediate spread be already ok?
- **TO BE DISCUSSED IN PANEL**

Disclaimer

Thank you!

The main references are the books:

* This presentation expresses the views of its authors and does not represent the opinion of Banca IMI, which is not responsible for any use which may be made of its contents.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Counterparty
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