XVA Metrics for CCP Optimisation

Presentation based on the eponymous working paper on
math.maths.univ-evry.fr/crepey

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Outline

- Central clearing is becoming mandatory for vanilla products on the markets
- The alternative being bilateral transactions under SIMM

In a centrally cleared setup, the clearinghouse (or CCP, for "central counterparty") interposes itself in all transactions, becoming "the buyer to every seller and the seller to every buyer"

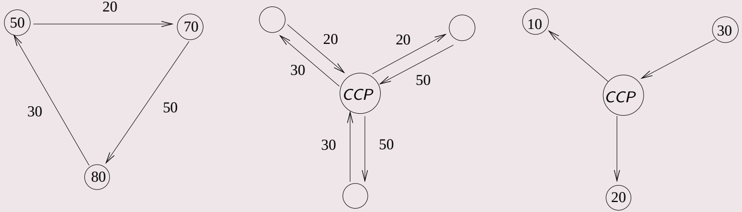
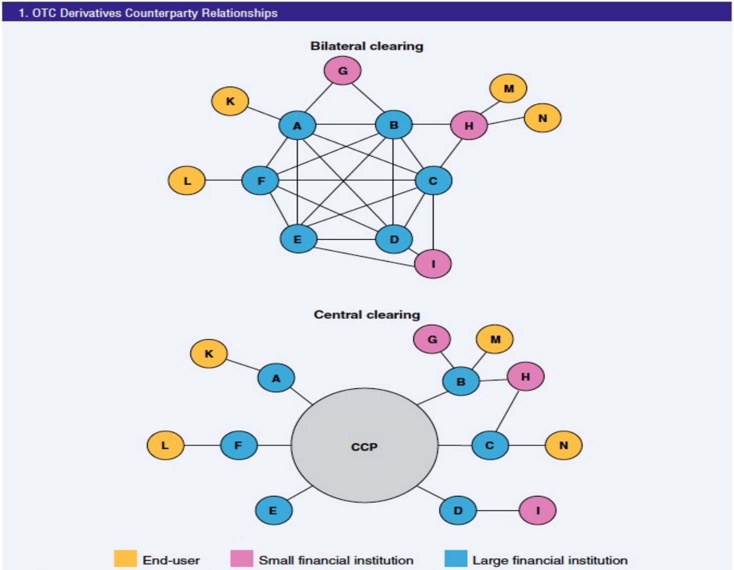


Figure : From bilateral to centrally cleared trading.



Source: Reserve Bank of Australia, Central Clearing of OTC Derivatives in Australia (June 2011), available at: http://www.rba.gov.au/publications/consultations/201106-otc-derivatives/central-clearing-otc-derivatives.html

Collateral

- Variation margin (VM) tracking the mark-to-market of the members' portfolios on a $\sim$ daily basis
- Initial margin (IM) set as a barrier against gap risk, i.e. the slippage between the portfolio and the variation margin of a member during its portfolio liquidation of length δ
  - $\delta \sim$ one week (resp. two weeks) in the case of centrally cleared (resp. bilateral) transactions
  - Initial margin itself updated at a frequency analogous to the one used for variation margin
  - Conditional VaR of the P&L of each member over a period of length δ
  - "Initial safety cushion" at the time of default of a member, possibly eroded by gap risk during the liquidation period
- Mutualized default fund contributions (DFC) in the CCP setup, meant to protect the members against extreme and systemic risk
  - EMIR "cover two" default fund allocated proportional to the IMs
  - Allows requiring less initial margins than in bilateral SIMM transactions

Pros and Cons of CCPs?

- Less counterparty credit risk: Reduced CCR of the CCP itself and reduced "domino effects" between members...
    - But concentration risk if a major CCP were to default (e.g. via a great imbalanced non-dealer position that have developed in US markets since the crisis), with about 30 major CCPs today and only a few prominent ones
    - joint membership and feedback liquidity issues
- Multilateral netting benefit...
    - But loss of bilateral netting across asset classes
- Better information of the CCP and the regulator...
    - But opacity of the default fund for clearing members

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- Default resolution cheaper: Bilateral trading means a completely arbitrary transaction network. An orderly default procedure cannot be done manually. It requires an IT network, whether it is CCP, blockchain (bitcoin), SIMM reconciliation appliance or whatever.
- However the way CCPs are designed today entails two major inefficiencies for the clearing members:
  - Default fund contributions are capital at risk not remunerated at a hurdle rate
  - Cost of borrowing unsecured the IM

This work

- In the direction of the last bullet point, our vision is a clearinghouse effectively eliminating counterparty risk
  - We don't incorporate the default of the clearinghouse in our setup...
- ...But at a certain cost for clearing members, that we analyze.

FTP=CVA+FVA+MVA(−DVA−FDA−MDA) +KVA

- We consider the problem from a shareholder optimization point of view
  - → Contra-liabilities (the terms in parenthesis above) are ignored
- Moreover, in the case of centrally cleared trading (as also in the case of bilateral trading under SIMM):
  - CVA very small due to the high level of IM that is used
  - FVA negligible due to the daily (or more) variation margin calls

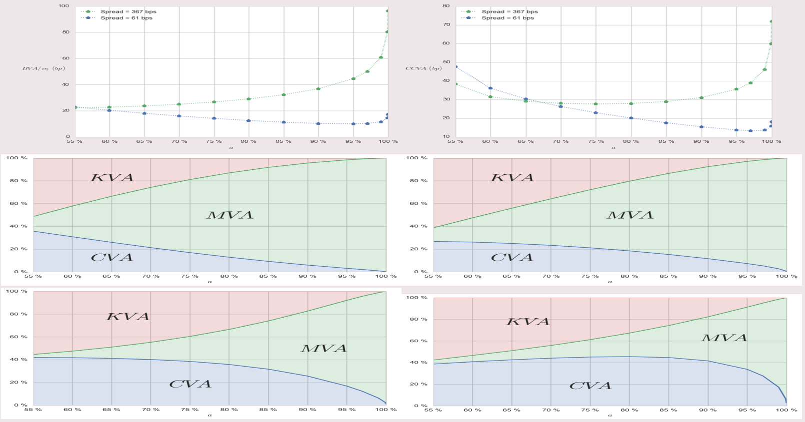
→ The prominent XVA metrics are the MVA and (especially if model risk is accounted for) the KVA.

- Two related CCP inefficiencies are the facts that, regarding

  Capital: Default fund contributions are capital at risk for which clearing members shareholders are not remunerated

  Funding: It seems that the IM must be borrowed entirely.

Varying the quantile level used for IM. *Left*: SIMM setup. *Right*: CCP setup. *Top*: FTP (scaled for netting and in bps for a swap with fixed leg equal to one). *Middle*: XVA relative contributions (high credit name). *Bottom*: XVA relative contributions (low credit name).
Source: “Central Clearing Valuation Adjustment”, SC and Y. Armenti, forthcoming in *SIAM Journal on Financial Mathematics*.



- In what follows we argue that these two major inefficiencies related to CCPs could be significantly compressed by resorting to suitable IM funding scheme and DF sizing, allocation and remuneration policies.

Albanese, C. (2015). The cost of clearing. ssrn.2247493.

Outline

- In this section we challenge the EMIR "cover two" rule for the sizing of the default fund and the IM proportional rule for its allocation, based on the economic capital principles of

Claudio Albanese, S. Caenazzo, and S. C. (2016). Capital and funding. *Risk Magazine*.

Albanese, C. and S. Crépey (2016). XVA analysis from the balance sheet. Working paper available on math.maths.univ-evry.fr/crepey.

- We assume the CCP default free in our setup. Accordingly, we assume that the CCP can obtain unsecured funding at the OIS rate.
- When no default fund is assumed (i.e. if only variation and initial margins are in place), a CVA of the CCP can be stated as

$$\mathrm{CVA}_t^{ccp} = \mathbb{E}_t \sum_{t<\tau_i^\delta<T^\delta} \beta_t^{-1}\Big(\beta_{\tau_i^\delta}(P^i_{\tau_i^\delta} + \Delta^i_{\tau_i^\delta}) - \beta_{\tau_i}(\mathrm{VM}^i_{\tau_i} + \mathrm{IM}^i_{\tau_i})\Big)^+$$

and the loss-and-profit process of the CCP is given, for $t \in [0, T]$, by

$$\int_0^t \beta_t dL_t^{ccp} = \sum_{\tau_i^\delta \le t} \big(\beta_{\tau_i^\delta}(P^i_{\tau_i^\delta} + \Delta^i_{\tau_i^\delta}) - \beta_{\tau_i}(P^i_{\tau_i} + \mathrm{IM}^i_{\tau_i})\big)^+$$
$$+ \beta_t \mathrm{CVA}_t^{ccp} - \mathrm{CVA}_0^{ccp}.$$

- Hence it could make sense to consider a default fund set at any time t, at least in the context of XVA computations, as the economic capital of the CCP in the sense of some conditional risk measure (e.g. expected shortfall at some quantile level a_{df}) of its one-year ahead loss and profit, i.e.

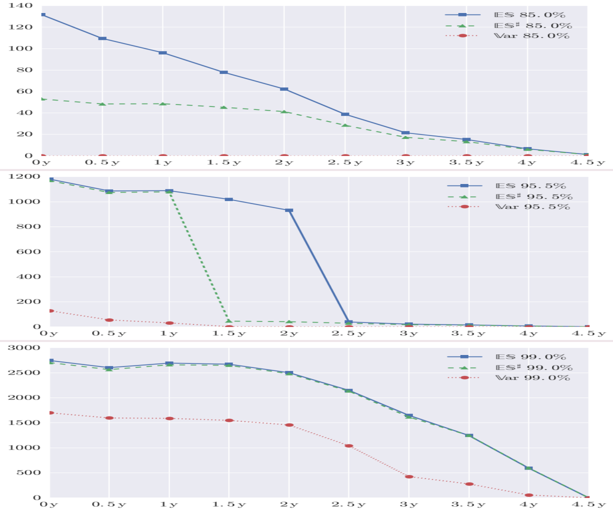
$$\mathrm{DF}_t = \mathrm{EC}_t(L^{ccp}) = \beta_t^{-1}\mathbb{ES}_t^{a_{df}}\Big(\int_t^{t+1} \beta_s dL_s^{ccp}\Big).$$

Ghamami, S. (2015). Static models of central counterparty risk. *International Journal of Financial Engineering*.

- In practice, for numerical tractability, we work with $\mathbb{ES}_0$ instead of $\mathbb{ES}_t$ in the above equation, i.e. we simulate the process L^{ccp} and compute at regular grid times t the a_{df} confidence level expected shortfall of the simulated one-year-ahead increments of the process L^{ccp}
  - E.g. in the context of our case study, for every $t = 0., 0.5, \ldots 4.5$, i.e. every 6 months between time 0 and the maturity of a swap that drives all our CCP portfolios.
- Hence we obtain a DF term structure as opposed to a whole process.
- Computing a full-flesh conditional expected shortfall process would require doubly nested Monte Carlo simulation.

- We use $m = 10^5$ simulated paths of an underlying swap rate S and default scenarios, in a toy model CCP consisting of nine clearing members.
- All the reported numbers are in basis points. We recall that the nominal of the swap was fixed so that each leg equals $1 = 10^4$ bps at time 0.
- Unless stated otherwise we use $a_{im} = 85\%$ and $a_{df} = 99\%$.

Solid blue: DF based on EC of the CCP as a function of time for $a_{df} = 85\%, 95.5\%$ and 99%. *Green*: Ignoring the CVA terms in L. *Red*: Using VaR instead of ES.



KVA from the CCP perspective

- The KVA from a CCP perspective estimates how much it would cost the CCP to remunerate the shareholders of the clearing members at some hurdle rate h for their capital at risk in the default fund, namely

$$\mathrm{KVA}_t^{ccp} = h\mathbb{E}_t[\int_t^T e^{-(r+h)s}\mathrm{DF}_s ds].$$

  - h taken for simplicity in our numerics as a common and exogenous constant $h = 10\%$.

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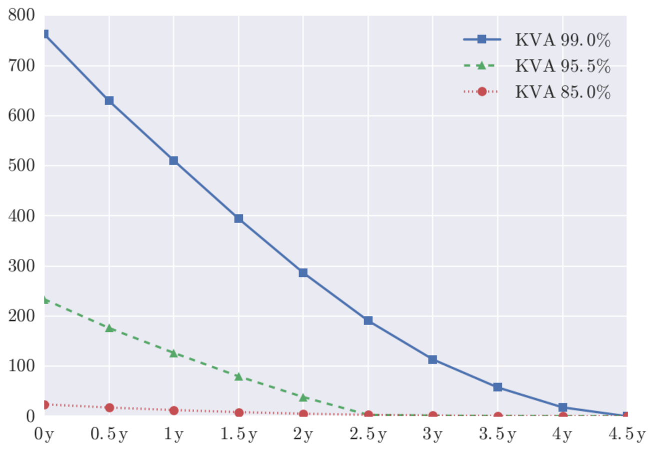
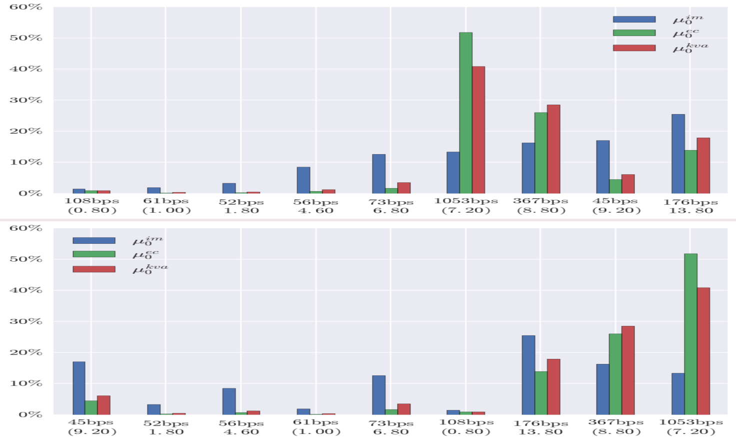
KVA term structures corresponding to the EC (blue) curves of Figure 3.



Default Fund Allocation

DF allocation based on IM, member incremental EC and member incremental KVA. *Top*: Members ordered by increasing position $|\nu_i|$. *Bottom*: Members ordered by increasing credit spread Σ_i.



Outline

- Let $\lambda = \gamma(1 - R)$ denote the credit spread of the bank, where γ is its risk-neutral default intensity and R its recovery rate as implicit in CDS spread quotation (typically $R = 40\%$).
- The time-0 MVA of the bank when the IM is funded through unsecured borrowing is

$$\mathrm{MVA}_0^{ub} = \mathbb{E}[\int_0^{\bar{\tau}} \beta_s \lambda_s \mathrm{IM}_s ds]. \quad (1)$$

- However, instead of assuming its initial margin borrowed by the bank on an unsecured basis, one can consider a more efficient scheme whereby IM is funded through a liquidity supplier, dubbed "specialist lender", which lends IM and, in case of default, receives back the portion of IM unused to cover losses.
- Assume as standard that IM is subordinated to own DFC, i.e. that the first levels of losses are absorbed by IM
  - Subordinating own DFC to the IM would result in even more efficient specialist lender IM funding schemes.
- In terms of the gap

$$G_t = P_t + \Delta_t - \beta_t^{-1}\beta_{t-\delta}\mathrm{VM}_{t-\delta}, \tag{2}$$

the exposure of the specialist lender to the default of the bank is

$$(1-R)(G^+_{\tau^\delta} \wedge \beta^{-1}_{\tau^\delta}\beta_\tau \mathrm{IM}_\tau),$$

which is "typically much less" than $(1-R)\mathrm{IM}_\tau$.

- More precisely the time-0 MVA of the bank under a third party arrangement follows as

$$\mathrm{MVA}_0^{sl} = \mathbb{E}\Big[\beta_{\tau^\delta} 1_{\tau<T}(1-R)\big(G^+_{\tau^\delta} \wedge \beta^{-1}_{\tau^\delta}\beta_\tau \mathrm{IM}_\tau\big)\Big] = \mathbb{E}\Big[\int_0^{\bar{\tau}} \beta_s \lambda_s \xi_s ds\Big],$$

  where ξ is a predictable process such that $\mathbb{E}_{\tau-}\big[(\beta_{\tau^\delta} G^+_{\tau^\delta} \wedge \beta_\tau \mathrm{IM}_\tau)\big] = \beta_\tau \xi_\tau$.
- By identification with a generic instantaneous cost specification $\bar{\lambda}_s \mathrm{IM}_s$, the formula (3) corresponds to a blending factor $\bar{\lambda}/\lambda = \xi/\mathrm{IM}$, which is typically much smaller than one, under a common specification of $\beta_s \mathrm{IM}_s$ as a high quantile (value-at-risk) of $\beta_{s^\delta} G_{s^\delta}$.

MVAs of the nine clearing members for unsecurely borrowed (top) vs. specialist lender (bottom) initial margin funding policies, for $a_{im} = 70\%$ (blue), 80% (green), 90% (red) and 97.5% (purple).

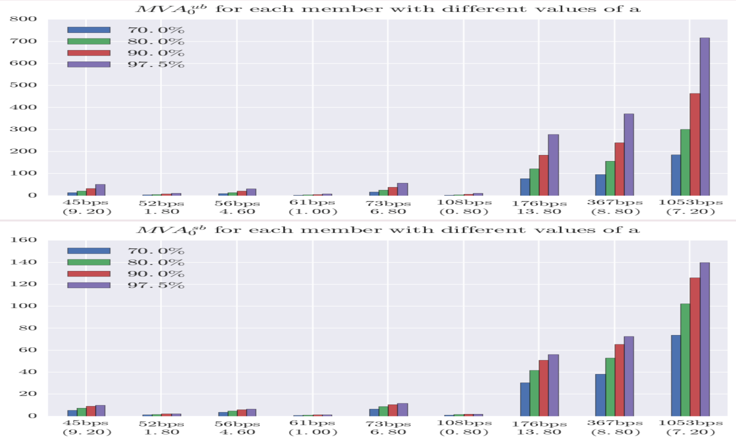
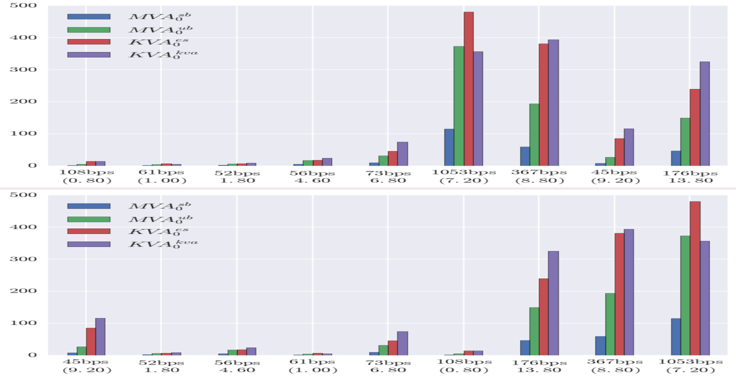


Figure :

MVA and KVA for each of the clearing members ordered along the x axis by increasing position $|\nu_i|$ (top) or credit spread Σ_i (bottom).



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Outline

- In this work we consider two important capital and funding issues related to CCPs.

From the CCP perspective

- We challenge the Cover 2 EMIR rule, for the sizing of the default fund, by an economic capital (EC) specification.
- We compare the usual IM based allocation of the default fund with an allocation proportional to the incremental impact of each clearing member on the economic capital of the CCP (or on the ensuing KVA).
- The EC based size and allocation of the default fund incorporate a mix of market and credit risk of the clearing members, by contrast with the purely market risk sensitive Cover 2 sizing rule and IM based allocation.
- The EC perspective also opens the door to an organization of the clearance framework, whereby a CCP could remunerate the clearing members at some hurdle rate for their default fund contributions.

From a clearing member perspective

- We compare the MVAs resulting from two different strategies regarding the raising of their initial margin:
  - the classical approach where the initial margin is unsecurely borrowed by the clearing member
  - and a strategy where the clearing member delegates the posting of its initial margin to a specialist lender in exchange of a service fee.
- The alternative strategy yields a very significant MVA reduction.

Merci pour votre attention