CVA and CCR:

Approaches, Similarities, Contrasts, Implementation

Part 1. Economic and Legal Background of
Counterparty Risk

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Workshop introduction and plan

Economics, regulation and theory

- ▶ *Part 1. Economics and Regulation*
    - ▶ Economics of market and counterparty risk
    - ▶ Basel III Regulation
    - ▶ Counterparty Credit Risk (CCR)
    - ▶ CVA VAR: the feedback loop
    - ▶ Regulatory DVA
    - ▶ Central counterparties
- ▶ *Part 2. CVA, DVA and FVA theory*
    - ▶ Review of credit pricing
    - ▶ CVA/DVA derivation
    - ▶ Critique
    - ▶ Wrong way risk

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Workshop introduction and plan

Modelling and implementation

- ▶ *Part 3. Modelling and Valuation*
  - ▶ Modelling for CVA
  - ▶ Modelling for CCR
- ▶ *Part 4. Implementation and daily operations. Comparisons and contrasts*
  - ▶ CVA as exotic portfolio derivative
  - ▶ CVA pricing steps and infrastructure design
  - ▶ CCR infrastructure design
  - ▶ Comparisons and contrasts
  - ▶ Operational issues

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Outline

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Equivalence of capital and risk

Risk and return

- ► The fundamental problem in finance is optimizing the risk/return tradeoff.
  - ► This is actually a special case of a more general case of utility maximization
- ► It is the subject of Modern Portfolio Theory (MPT) and its derivatives.
- ► In investment/capital allocation theory, capital (and its cost) are given.
- ► Risk is measured as standard deviation of return.

Capital market line (CML)

Risk, %

Return, %

— Efficient frontier — CML → Cost of capital
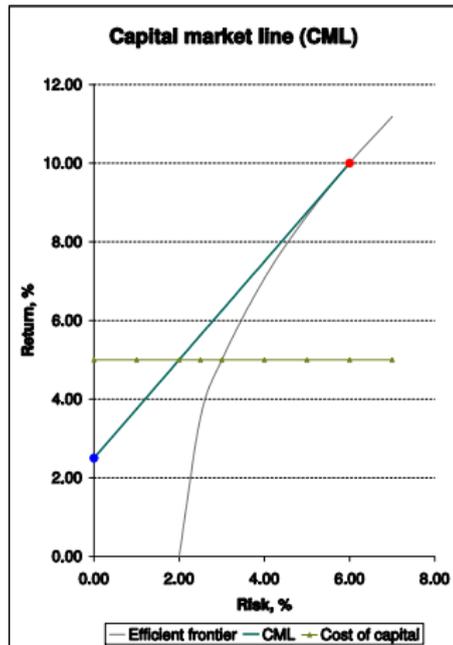
Equivalence of capital and risk

Risk neutral limit

- When risk cannot be fully diversified, the goal is to maximize the excess return given the level of risk

$$\frac{\mathbb{E}(r) - r_f}{\sigma}$$

- Risk neutral valuation is the limit when both nominator and denominator are zero

- Note that in this case typical regulatory capital requirements are also asymptotically zero

  - Market risk is zero by the virtue of continuous time delta hedging
  - Credit risk is not present
  - Operational risk is out of scope (even the market is frictionless)

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Equivalence of capital and risk

Derivatives pricing = optimization of return on regulatory capital (RORC)

- ► Presence of the regulatory capital requirement turns derivatives pricing into a leveraged pricing problem.
  - ► You must invest your own capital, hence you are expected to earn excess returns on it.
- ► For a client driven derivatives business, capital requirement is not entirely exogenous.
  - ► It is a function of both the product flow/type and the hedging strategy.
  - ► The function itself is vaguely prescribed by the regulator.
- ► Effectively, regulator prescribes the maximum amount of leverage the trading desk is allowed to take by optimizing its hedging of the client business.

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Regulation: bodies and process

Move towards more centralized EU power

- ▶ *Basel Committee on Baking supervision*
  Consultative body within Bank of International Settlements (BIS), formulates accords, but not legislation.

- ▶ *European Commission*
  Legislative body, issuing Regulations and Directives that implement Basel accords as legislation.

- ▶ *Local Regulators*
  Historically they had to transpose the European legislation into the local regulation and oversee application of the legislation.

- ▶ *Single Rule Book*
  Work in progress. Intended to streamline implementation of European law in the member states. UK singed up in 2009.

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Regulation: framework

The three pillars of capital adequacy framework

Since Basel II, the capital adequacy framework has been formulated in terms of the three pillars.

- ▶ *Pillar 1: Minimum capital requirements*
  How much leverage is allowed; how this leverage can be computed. Governs the economical and mathematical aspects of the framework.

- ▶ *Pillar 2: Supervisory review*
  The review process, risk management guidance, especially with regards to items not well covered in Pillar 1.

- ▶ *Pillar 3: Market discipline*
  Disclosure of capital and risk.

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Regulation: UK legislation

CRD4 is expected to become binding since 1 January 2013

- ► FSA Handbook BIPRU and GENPRU are the current capital adequacy legislation in UK.
- ► Basel III accord (2010), as mostly an add-on to Basel II (2006) and 2.5 (2009) introduces new requirements. Focused on the counterparty credit risk (CCR) area.
- ► Capital Requirements Directive 4 (CRD4) is legislative package adopted by European Commission in July 2011. This package implements Basel III accord via Capital Requirements Regulation (CRR), addressing Pillars 1 and 3, and Capital Requirements Directive (CRD), addressing Pillar 2.
- ► CRR is to be applied directly (so the quantitative stuff is known).
- ► CRD is to be transposed by FSA.

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Regulation: documents

- ► International Convergence of Capital Measurement and Capital Standards (compressive version, June 2006).
  This is the cumulative Basel II document. Other documents are add-ons to this one.

- ► Revisions to the Basel II market risk framework (July 2009).

- ► Enhancements to the Basel II framework (July 2009).

- ► Guidelines for computing capital for incremental risk in the trading book (July 2009).

- ► Basel III: A global regulatory framework for more resilient banks and banking system (June 2011).

- ► Application of own credit risk adjustments to derivatives - consultative document (Dec 2011).

- ► Capitalization of bank exposures to central counterparties (July 2012), consultative paper.

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Regulation: minimal capital requirements

Risk weighted assets (RWA) vs capital, capital buffers

- ► Capital requirement is defined as 8% of RWA (Basel III).
- ► RWA as a concept seems to be kept in the regulations mostly to allow for the "standardized" approach to credit risk. In this approach, the meaning of RWA is literal: all exposures have regulatory weights assigned to them. Standardized approaches also exist for market and counterparty risk, but as they do not involve any modelling; we do not discuss them further.
- ► Additional buffers have been introduced by Basel III: capital conservation buffer (2.5% of RWA, global and compulsory) and countercyclical buffer (up 2.5% of RWA, the regional regulator's discretion).

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Regulation: risk types covered

Credit, counterparty

- ▶ Credit risk (CR): default risk both in banking and trading books.

  - ▶ Standardized approach (already mentioned).
  - ▶ Internal Rating Based (IRB) approach. In the "advanced" form deals with modelling probability of default (PD) and loss given default (LGD) for a homogenous group of exposures, as well as exposure at default (EAD) and effective maturity (M) of the exposure. A simpler "foundation" approach exists, where the firm only has to estimate PD.
  - ▶ Securitization Framework. Out of our scope.

- ▶ Counterparty credit risk (CCR). Strictly speaking not a risk category on its own, but a method to compute EAD for netting sets of OTC derivatives to be plugged into the credit risk model. Covered mostly by Annex 4 to Basel II, as augmented by Basel III.

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Regulation: risk types covered

Operational, market

- Operational risk (OR): loss due to failures in an internal process. Out of our scope of our discussion.
- Market risk (MR): market value loss due to fluctuations in the values of the market observables. We only need it to understand CVA VAR, i.e. market risk on the newly introduced regulatory CVA charge. CVA VAR is a standalone charge, but it is *essentially* another type of VAR.
- The total RWA is given by

$$RWA_{Total} = \left(K_{MR} + K_{OR} \right) / 8\% + RWA_{CR}^{Std}$$
$$= \left(K_{MR} + K_{OR} + K_{CR}^{IRB} \right) / 8\%.$$

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Market risk

- ▶ Traditional measure of risk, defined as the 99% quantile of the short term (10 day) portfolio mark to market distribution with the given level of significance.
- ▶ Both standardized and Internal Model methods allowed.
- ▶ Internal Model Method allows for both historical and parametric approaches for factor specification; variance/covariance vs full reval.
- ▶ The capital requirement is the sum of the baseline VAR and stressed VAR (Basel II.5):

$$K = \max\{VAR_{t-1}, m_c\, VAR_{avg}\} + \max\{sVAR_{t-1}, m_s\, sVAR_{avg}\}$$

with the averages taken over the past 60 days.

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Credit risk: ingredients

Probability of Default, Maturity, Exposure at default, Loss given default

- ▶ We consider Internal Rating Based approach, where the bank can estimate all four inputs into the model: EAD, PD, LGD and M.

Under this approach

$$RWA_{CR}^{IRB} = EAD \cdot K(PD, LGD, M)/8\%$$

- ▶ All exposure types are categorized into "homogenous" pools of exposures (across counterparties), e.g. banking, sovereign, retail, etc.
- ▶ Rules are given how to estimate all four parameters for each pool type.
- ▶ *EAD* for each exposure can then be computed separately.

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Credit risk: capital requirement

Expected loss vs unexpected loss

- ▶ The key point about $K(PD, LGD, M)$ is that it defines capital requirement as the difference between 99.9% conditional loss and expected loss over 1 year horizon.

- ▶ Regulators chose Asymptotic Single Risk Factor (ASRF) model, which is essentially Gaussian copula based.

- ▶ If the one year conditional on the common economic factor G default probability $F^{cond}(G)$, then

$$K(PD, LGD, M) = LGD \cdot \left(F^{cond}(99.9\%) - PD \right) \cdot g(M),$$

where $g(M)$ is maturity adjustment, which is a slowly growing function, defined by regulator after some statistical analysis such that $g(1) = 1$.

Credit risk: ASRF model

The key valuation step

- Conditional loss is given by the familiar Gaussian copula form:

$$F^{cond}(G) = N\left(\frac{N^{-1}(p) - \sqrt{\rho}G}{\sqrt{1-\rho}}\right)$$

  and conditional joint loss distribution is binomial with "success" probability $F^{cond}(G)$, where $G \sim N(0,1)$. Here the highest conditional probability is when G is large negative.

- Perhaps to introduce the analogy with VAR, regulators slightly modify the above formula using the symmetry of Normal distribution:

$$F^{cond}(G) = N\left(\frac{N^{-1}(p) + \sqrt{\rho}(-G)}{\sqrt{1-\rho}}\right).$$

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Credit risk: capital requirement

Main formula

Now for the extreme scenario, $-G$ can be set to a large number, which probability can be interpreted as a VAR-like confidence level.
Regulator set $-G = N^{-1}(99.9\%)$, yielding

$$K = LGD \cdot \left(N \left(\frac{N^{-1}(p) + \sqrt{\rho} N^{-1}(99.9\%)}{\sqrt{1-\rho}} \right) - p \right) \cdot g(M).$$

- ▶ The rules are specified how to compute ρ for different types of exposures. The common feature is that $\rho = \rho(p)$.
- ▶ Together with *EAD* the above formula is the basis for computing *RWA* for the exposure. In particular, a special set of rules ("CCR methodology") are provided to compute *EAD* on netting sets of OTC transactions that expose the bank to counterparty risk.

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Counterparty credit risk: scope

EAD for SFT and OTC transactions in trading book

- ► Regulation provides for a special method of computing EAD under IRB approach for OTC and SFT transactions.
- ► Designed to fit into "expected" vs "unexpected" loss framework of credit risk.
- ► Unit of calculation is netting set. There must be a legally binding agreement between the counterparties for the netting set to be considered as such to realize netting benefits for regulatory purposes.
- ► $RWA_{CCR}^{IRB} = EAD \cdot K \ / \ 8\%$, where K is *capital requirement*, computed using general CR methodology, discussed above, only using specially computed M.

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Counterparty risk: exposure types

Expected, Effective Expected, Positive Expected, Effective Positive Expected

- Denote MtM_t the netted set mark-to-market at time t.
- Then the regulation defines

Expected Exposure:	$EE_t = \mathbb{E}\left(MtM_t^+\right)$
Expected Positive Exposure:	$EPE_t = \frac{1}{t}\int_0^{t\wedge 1} EE_u \mathrm{d}u$
Effective EE	$EEE_t = \max\left(EE_t, EEE_{t^-}\right)$
Effective EPE	$EEPE_t = \frac{1}{t}\int_0^{t\wedge 1} EEE_u \mathrm{d}u$

- "Effective" exposures are defined for the shortest of the longest maturity in the netting set and one year.
- $EEPE_t$ serves as a proxy for EAD of the netting set in a trading book.

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Counterparty risk: exposure type examples
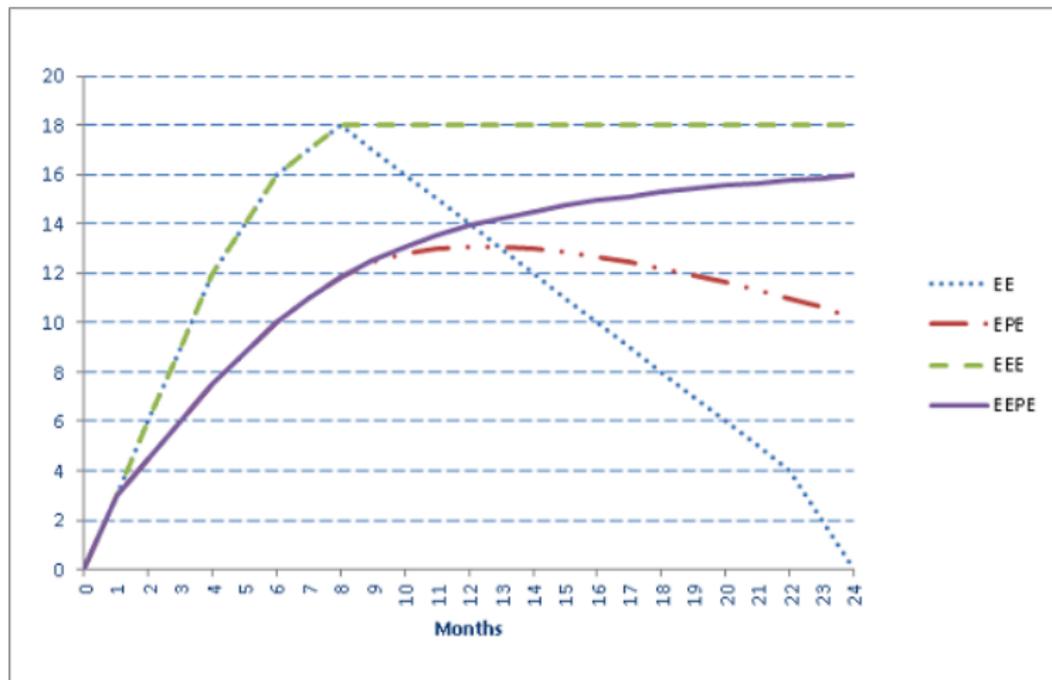
Counterparty risk: EAD and M

Main formulas

- Basel III requires that for a netting set

$$EAD = \alpha \cdot \max \left(EEPE_{1\ year}, EEPE_{1\ year}^{stressed} \right)$$

- Default $\alpha = 1.4$.

- It can be estimated by the bank itself, upon the regulator's approval, with the floor of 1.2.

- Effective maturity:

$$M = \min \left[5, \frac{\sum_{t \leq 1 year} EEE_k \Delta t_k df_k + \sum_{t > 1 year} EE_k \Delta t_k df_k}{\sum_{t \leq 1 year} EEE_k \Delta t_k df_k} \right],$$

hence accurate calculation of EE_t beyond one year is also important.

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Counterparty risk: Stressed EEPE

New Basel III requirement

- Using $EEPE^{stressed}_{1\ year}$ is supposed to make the estimate more conservative.
- For non-stressed EEPE the model may be estimated either from current market data or from a 3 year history of data.
- Stressed EEPE is to be computed by the EPE infrastructure with the models estimated from 3 years of data, containing the stressed counterparty credit spreads.
- The whole CCR model has to be reestimated for Stressed EEPE calculation. Counterparty spread's stress period is only used to identify the correct calibration period.
- Also, EE_k computed with similarly stressed model will go into stressed CVA VAR (see below).

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Counterparty risk: netting and collateral

Just another lagged asset

- ▶ *Shortcut* and *advanced* methods available.
- ▶ Shortcut method is effectively current exposure plus add-on, to be estimated as $\mathbb{E}\left(\triangle MtM^{+}\right)$ over "margin period of risk" (MPR). This is very conservative as it does not account for the path dependent nature of collateral at all.
- ▶ Full option implies modelling collateral together with other instruments in the netting set with MPR. Apart from being shifted by this time, collateral is essentially just another asset in the netting set.
- ▶ In practical implementation, trades may or may not be aged during MPR.

Counterparty risk: adjustments

Large institutions and wrong way risk

- Specific and general wrong way risks.
- Deals that are subject to specific wrong way risk must be taken out of the netting set.
- Wrong way risk CDSs receive $LGD = 1$.
- Capital requirements on exposures to large institutions must be computed with 1.25x multiple to correlation.

Counterparty risk: 3E + 2A

Estimate, evolve, evaluate, aggregate, apply collateral

EE is to be estimated by a Monte Carlo simulation. The key steps are as follows.

- ▶ Estimate evolution models.
- ▶ Evolve risk factors (will be covered later).
- ▶ For each future moment of time build Future MtM (FMTM) distribution for each trade on each path. This is really the key ingredient.
- ▶ Apply collateral logic together with aggregation.
- ▶ Compute whatever output is necessary for the use case.

Counterparty risk: IRB model requirements

Validation, use test, backtesting.

- ▶ Follow general guidelines on how to estimate the model parameters.

- ▶ The model must go through internal validation, performed by an independent function.

- ▶ The model must be backtested and stress tested regularly. This is most relevant for CCR model, where the underlying factor evolution model has to be re-estimated at least on the quarterly basis.

- ▶ Also, if the bank uses an internal model for CCR, this model must be integrated into the general counterparty risk management and control workflows. E.g. same factor Monte Carlo must be used both to evaluate *EE* and *PFE* (peak exposure), which then may be used for limits setting and monitoring.

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CVA VAR: Motivation

"Spread widening risk" vs "event risk"

- ▶ Recognizes that values of positions with credit risky must be adjusted to account for the credit worthiness of the counterparty.
- ▶ Defines regulatory CVA to capture such adjustment.
- ▶ Pure credit (event) risk already handled by CCR capital charge, CVA VAR quantifies the market risk of the regulatory CVA due to changes in the counterparty credit spreads.
- ▶ To be computed using existing VAR model, including stressed VAR, excluding incremental risk charge.
- ▶ Introduces the up-front and standalone charge for this CVA VAR.
- ▶ Motivates banks to actively hedge CVA by allowing to include hedges into calculation of the regulatory CVA.

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CVA VAR: Regulatory CVA

Definition

- Since ultimately CVA VAR is computed by applying VAR model to regulatory CVA, its own definition depends on the type of the VAR model used by the bank.

- For banks with full IMM approval for bonds and advance method for collateral, pretty much the intuitive definition of CVA:

$$CVA = LGD \sum_i \left(\frac{EE_{i-1}D_{i-1} + EE_i D_i}{2} \right) \left(e^{-s_{i-1}t_{i-1}/LGD} - e^{-s_i t_i/LGD} \right)^+$$

- Banks with different scale of IMM model are provided with other formulas, e.g. CS01 CVA approximation.

- Banks using standardized VAR model have to use standardized CVA VAR charge.

CVA VAR: Regulatory CVA

Implementation details

- EE_t are *regulatory* (not risk neutral!) expected exposures, hence here is the link to the traditional EPE model used by the bank.
- Maturity equals to the longest maturity in the netting set.
- When computing EE_t, MtM_t is allowed to include the values of the credit hedges taken to mitigate CVA *specifically* (not to just some CDSs on cpty in the book).
- Hedges that can be single name CDS, or index CDS.
- VAR methodology applied to CVA produce CVA VAR.
- Both baseline and stressed CVA VAR to be computed, in line with the bank's policies for regular VAR.

CVA VAR: to hedge or not?

Capital vs delta hedge by the CVA desk

- ▶ Relying or regulatory *EE*, CVA VAR can never be perfectly hedged by the front office CVA team, because its *EE* will be produced by a risk neutral model.

- ▶ The question is therefore open, whether CVA desk's goal is CVA PNL management or bank capital optimization.

- ▶ This is similar to the situation with structured credit 10 years ago: there were capital relief driven securitizations and arbitrage synthetic CDOs.

- ▶ The intuitive answer is that the approach to add more capital should be used: CVA VAR hedging releases capital, while CVA trading, if profitable, increases capital (via PNL).

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Delta hedging vs capital optimization

Old story of capital securitization

- ▶ Introduction of CVA VAR has two implications.
  - ▶ One is motivated to hedge market risk of (at least) credit component of CVA.
  - ▶ However given the amount of proxying and reserving, the question is whether one should focus on optimizing the capital charge or onto tracking PNL?
  - ▶ Note that this is a "constrained" version of the J. Gregory's argument against hedging CVA at all. The issue is that given CVA VAR you *do* want to hedge at least to optimize capital.

- ▶ Such tradeoff is not new. It is a new incarnation of the usage of credit derivatives for capital relief.
  - ▶ In late 90's, early 00's the purpose of most securitizations, including synthetic ones, was release of the regulatory capital.
  - ▶ Then agency arbitrage took over (till 2008).

Delta hedging vs capital optimization

Payoff replication

- ► The biggest difference of derivatives pricing from portfolio hedging is not minimizing risk, but reproducing payoff
- ► Continuous time delta hedging does exactly that
- ► In hedging CVA the payoff need not (and cannot) be hedged exactly, therefore the portfolio (RORC) view is possible

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Regulatory DVA

Initial proposal

- ► Published in Dec 2011
- ► Introduced a regulatory DVA charge; this was directly a capital charge not a regulatory CVA number that would be used to compute CVA VAR charge
- ► Essentially suggested to fully charge DVA against equity
- ► Received generally negative feedback from the industry.
- ► No final decision yet

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Central counterparties

New regulation

- *2009 G20 Pittsburgh Summit.* By end of 2012 we should have had:
    - Standard OTC derivative contracts to be traded on exchanges or electronic trading platforms.
    - To be cleared on CCP, where possible.
    - Non-cleared contracts to attract higher capital requirements.

- *Dodd-Frank Act, Title VII*
    - Requirement to clear eligible trades via a CCP.
    - Focus on swaps.
    - Implementation delayed, as rules have not been finalized.
    - Opens up client clearing business, which requires infrastructure upgrade.

Central counterparties

New regulation: Europe

- *Basel* Imposes 2% capital charge, was 0% in the past.

- *European Market Infrastructure Regulation (EMIR)*
  - Pretty much adaptation of Dodd-Frank to Europe.
  - Report OTC derivative contracts to trade repositories.
  - Disclose aggregate positions in OTC derivatives.

- *MIFID 2*
  OTC derivatives to utilize equity dealing environments

Central counterparties

Pros and cons

- *Pros*
    - Multilateral netting
    - Loss mutualization
    - Standardization
    - Higher liquidity and operational efficiency (once running)

- *Cons*
    - Transitional operational challenges and cost
    - Cost of entry
    - Risk concentration (how default fund is computed?)

Central counterparts

Effect on CVA: benefit or challenge?

- ► Largest effects on swaps, typically accounting for 30-40% of the trading book.
- ► Most of the swap portfolio is already collateralized via CSAs.
- ► Moving to CCP will ultimately simplify trading, but introduces technical hurdles to overcome in the near term.
- ► One side exposure may actually increase with regards to the counterparts that are allowed not clear via CCP.
- ► CVA is really about (light) exotics, therefore the subject will remain relevant, perhaps removing the necessity to deal with volume products (for CVA).
- ► For EPE, given the 2% capital requirement, EPEs are still to be computed.

Conclusion

Workshop introduction and plan

Equivalence of capital and risk

Regulation: framework and risk coverage
Regulation
Market risk
Credit risk

Basel III Capital Charges
Counterparty Credit Risk (CCR)
CVA VAR
Delta hedging vs capital optimization
Regulatory DVA

Central counterparties

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