# Counterparty Credit Risk Measurement Under Basel II

**A presentation by ISDA**

**Asia 2007**

# Outline

1- Definition of counterparty credit risk (CCR)

2- Basel I treatment

3- Basel II treatment : Regulatory approved methods for measuring counterparty exposures

4- Simple approaches

5- Internal Model Method

a- EPE

b- Corrections brought to the pure EPE concept

c- Short term maturity transactions

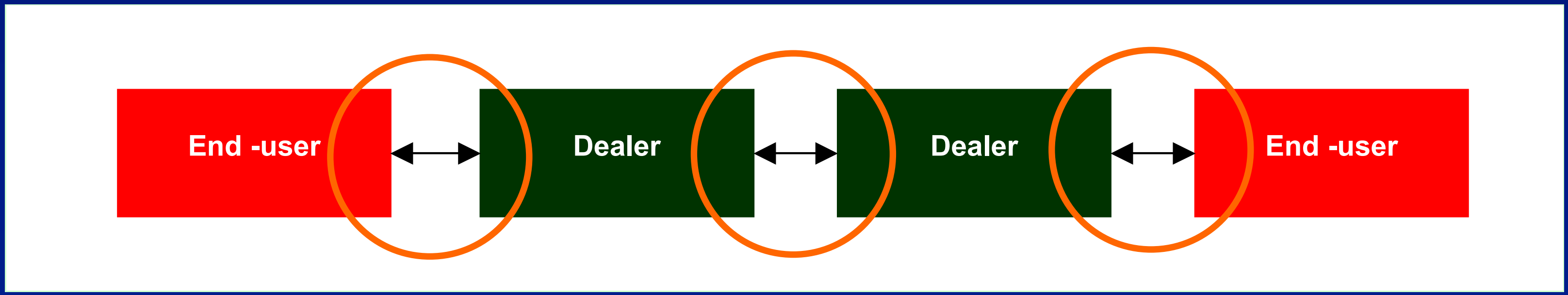
# Definition of counterparty credit risk

- “the risk that the counterparty to a transaction could default before the final settlement of the transaction’s cash flows. An economic loss would occur if the transactions or portfolio of transactions with the counterparty has a positive economic value at the time of default”

  *[Excerpt from The Application of Basel II to Trading Activities and the Treatment of Double Default Effects, July 2005, BIS*]

# The nature of counterparty credit risk

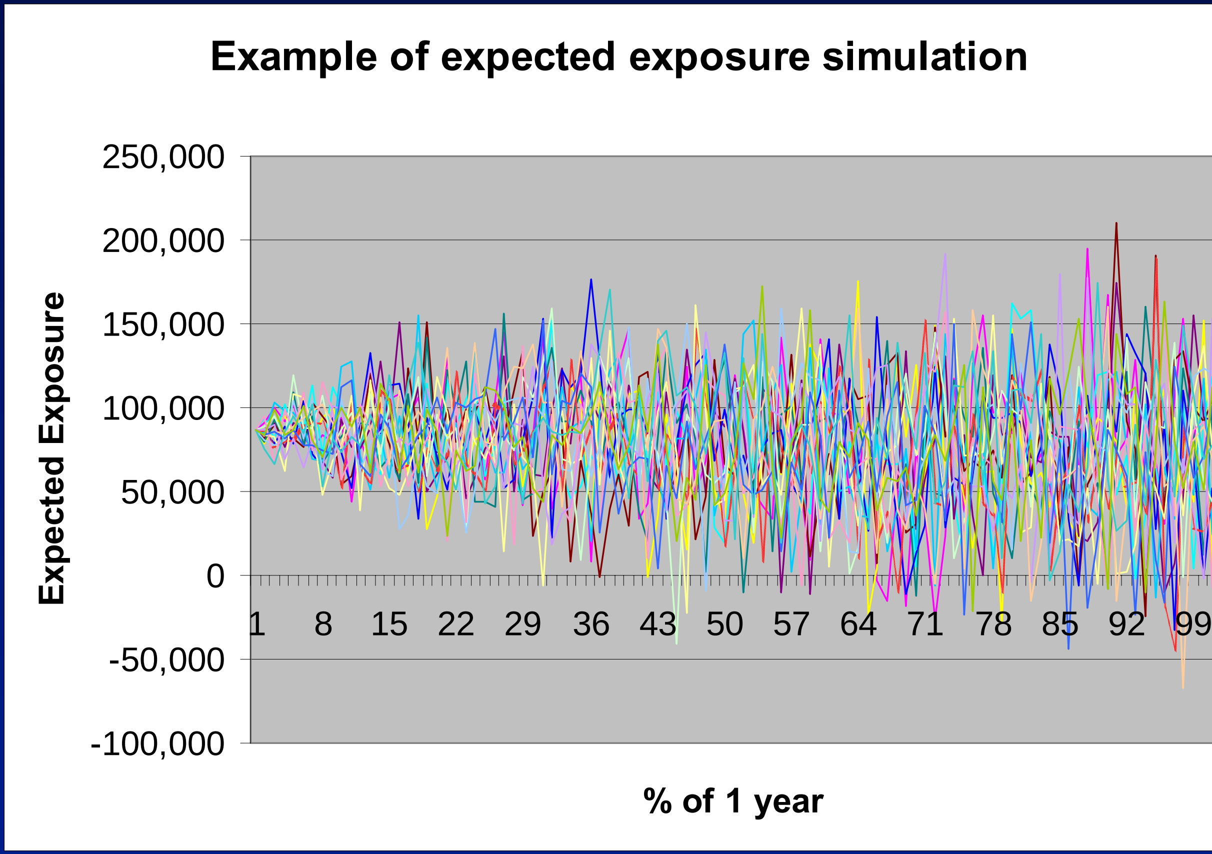
- Counterparty risks are an inevitable by-product of privately-negotiated derivatives transactions
- Counterparty risks create a chain of dependencies among derivatives counterparties
- Counterparty risks lead to exposures that must be measured and managed



# The nature of counterparty credit risk

- CCR exposure is the potential exposure at the time of default.
- Because it is a future exposure it is not known with certainty, but depends on the value, at the time of default, of the market factors driving the valuation of the instrument or portfolio under consideration.
- Instruments concerned include Securities Financing Transactions (SFTs) and OTC derivatives
- A horizon for calculating this value is necessary; in the regulatory framework, this is set at ONE YEAR.

# Example of CCR exposure



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# Counterparty risk milestones

- 1988 – Basel Capital Accord – first set of derivative add-ons
- 1994 – Basel Committee recognises netting
- 1995 – Market Risk Amendment to the Accord, expanded add-ons matrix
- 2001 – Basel Models Task Force defers reform of counterparty risk treatment
- 2003 – SEC Capital Proposals for SIBC and CSE
- 2004 – Basel Committee and IOSCO announce plans to consider counterparty risk and other trading book issues
- July 2005 – Basel Committee and IOSCO publish *The Application of Basel II to Trading Activities and the Treatment of Double Default Effects, otherwise known as the Trading Book review document*
- September 2005 – EU Commission incorporates the Trading Book review in the Capital Requirements Directive
- October 2006 – FSA publishes its rulebook
- Sept 06-June07 – US agencies consult on a Notice of Policy Rulemaking implementing Basel II



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# Basel I treatment

# Basel I treatment of CCR risk

| OTC derivatives | SFTs in the trading book |
|---|---|
| Capital= EAD x Counterparty RW x 8%<br><br>EAD= Current exposure + Add-on x Notional principal<br>Potential future exposure (PFE)<br><br>Add-on : fixed percentage, function of underlying and maturity. Low for interest rate, high for commodities.<br><br>Netting of add-ons is permitted:<br>Potential future exposure is reduced to :<br>0.4 x PFEgross+ 0.6 x net to gross ratio x PFE gross<br>PFEgross= sum of all add-on terms for contracts included in a netting set.<br>net to gross ratio: net CE/gross CE<br><br>Counterparty risk weight function of nature of counterparty | If documented properly, no charge applies |



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# Criticism of Basel I treatment

- Not risk sensitive:
  - PFE is in reality not proportional to notional;
  - Should be adjusted to reflect changing volatilities of underlying;
  - Netting of add-ons is a rule of thumb;
  - RW is reflective of the nature of the counterparty, not its risk quality
- Not consistent: SFTs and OTC derivatives should be treated consistently, as they pose similar risks [an SFT is a combination of a spot position and a forward]

# Basel II treatment

# In a nutshell:

- Basel II treatment broadly consistent between SFTs and OTC derivatives. Cross product netting is recognised between product types, provided that "*the bank obtains a legal opinion that concludes that relevant courts would find the firm's exposure to be the cross product net amount under the laws of the relevant jurisdictions*".
- Greater risk sensitivity is included in measurement of EAD [exposure] and counterparty RW
- Capital charge= EAD x Counterparty RW x 8%

# Counterparty RW

- 2 approaches:
  - Standardised approach simply links the RW with the external rating of the counterparty. Non-rated counterparty attracts a 100% risk weight
  - Internal Ratings Based approach:

    RW=f(PD,LGD, maturity);

    PD is determined by the firm;

    LGD, maturity can be determined by the regulators or by the firm.



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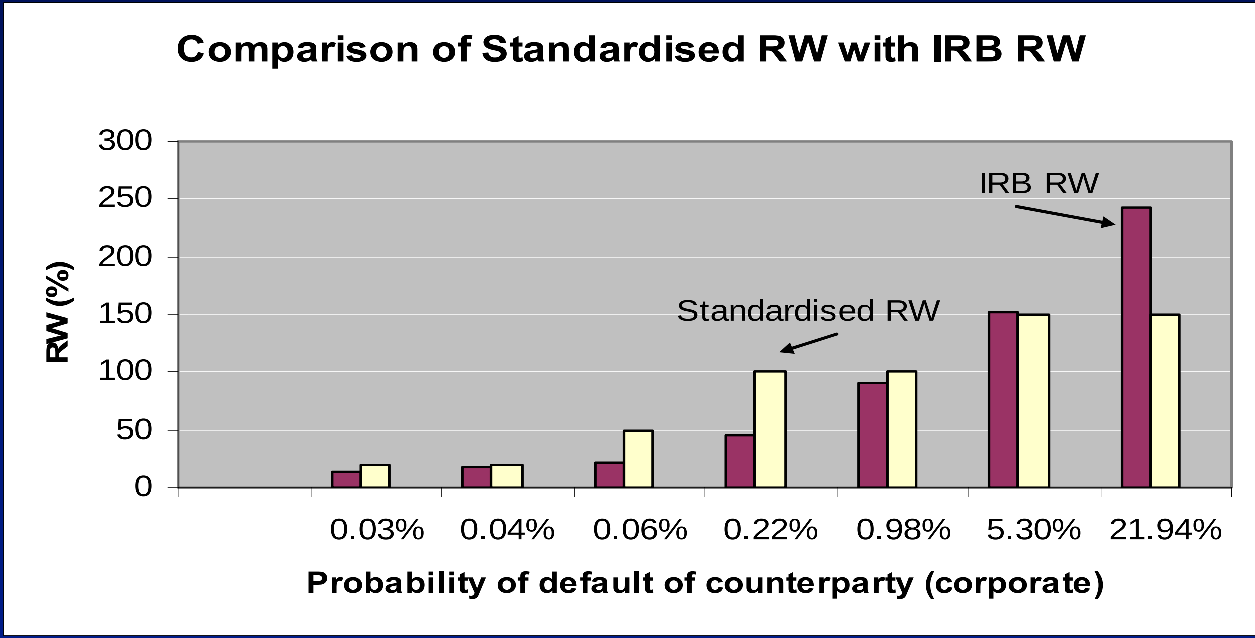
# IRB versus Standardised capital charges



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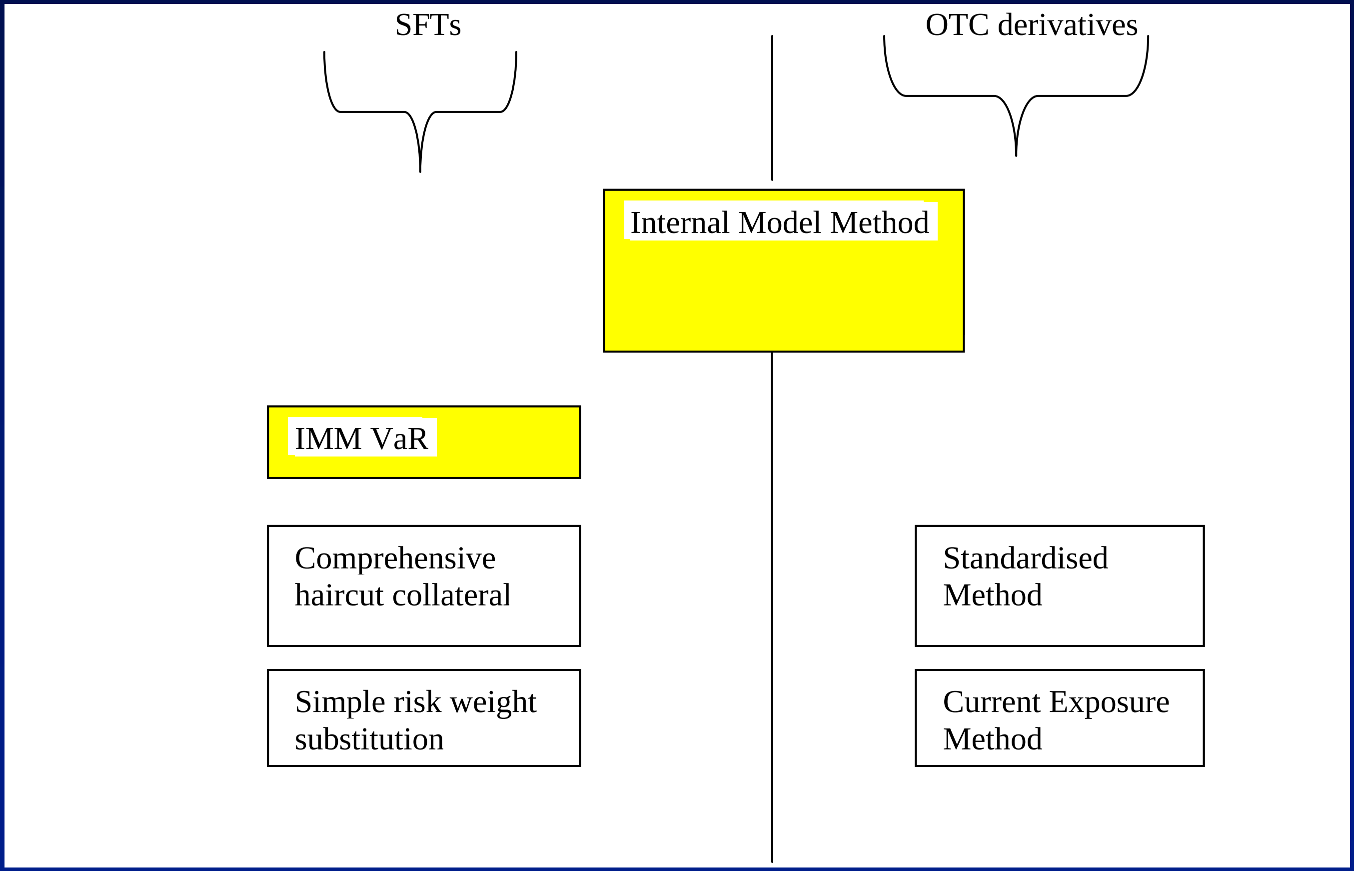
# Our primary focus today: measurement of CCR EAD under Basel II



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# Product specific approaches to measuring CCR EAD

# SFTs- simple approaches

- Simple method : RW substitution [only available in the banking book]

  Claims collateralised receive the risk weight of the collateral issuer, subject to a floor of 20%;

  Broader definition of collateral than under Basel I [IG debt, government debt rated above BB-, listed equity]



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# SFTs- simple approaches

- Comprehensive approach:

  EAD= max (0, E(1-He)-C(1-Hc-Hfx)),

  Where: E is the exposure being collateralised;

  He is the haircut applicable to E;

  C is the collateral available

  Hc is the haircut applicable to C

  Hfx is the haircut for currency mismatch between E and C

  Haircuts can be supervisory or calculated by firms to a ($99^{th}$, 5 or 10 day) standard



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# SFTs - IMM VaR approach

- EAD on a portfolio of repos with a counterparty calculated using VaR ($99^{th}$, 5 days)
  - Correlation /diversification effects taken into account
- Same qualitative requirements as for market risk VaR models
- Backtesting on sample of 20 counterparties
- Backtesting multipliers apply

# OTC derivatives: simple approaches

- CEM approach:

  -EAD defined as per Basel I;

  -Collateral captured under the simple or the comprehensive approach outlined before. Under simple approach, floor is brought down to 0% for daily cash margined positions where no FX mismatch occurs

  -New add-ons for credit derivatives: 5% for IG underlyings; 10% otherwise.



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# OTC derivatives: Standardised Method

- Standardised Method:

  - Intermediate approach between IMM and CEM, useful for firms which are not equipped to use the IMM.

  - The standardized formula for the credit equivalent exposure (EAD) under discussion is:

$$EAD = \beta \cdot \max( E - C; \sum_j | RPE - RPC | xCCF_j )$$

where the conversion factors *CCF* are intended to "convert" a "net risk position" RPE-RPC into a potential exposure "add-on" which is compared to the net current value MtM. The result is multiplied by a corrective factor $\beta$.

RPE is the risk position attributable to a transaction assigned to a particular hedging set; RPC is the risk position attributable to collateral assigned against this transaction.

RP= dV/dp [delta of the position]

The CCF are conversion factors imposed by the regulators, corresponding to the EPE attributable to a position of 0 current value in the hedging set.



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# Example of use of the standardised method

Commodity forward

| | |
|---|---|
| delta | 2 |
| CCF | 10% |
| beta | 1.4 |

| MTM | EAD |
|---|---|
| 0 | 0.28 |
| 1 | 1.4 |
| 2 | 2.8 |
| 3 | 4.2 |
| 4 | 5.6 |
| 5 | 7 |



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# The Internal Model Method:

**EPE**

**Corrections to pure EPE concept**

**Short term maturity adjustment**

# Expected Positive Exposure (EPE)

# EPE

- **Capital = EAD. RW. 8%**
  - RW is the Risk Weight, a function of the credit quality of the counterparty, expected recovery rate and tenor of the credit risk (Effective Maturity M)
  - EAD is the Exposure At Default

- What is EAD for the market-driven OTC derivatives counterparty exposures?
  - PFE(99%,1-year)
  - Expected Positive Exposure
  - Something else ?



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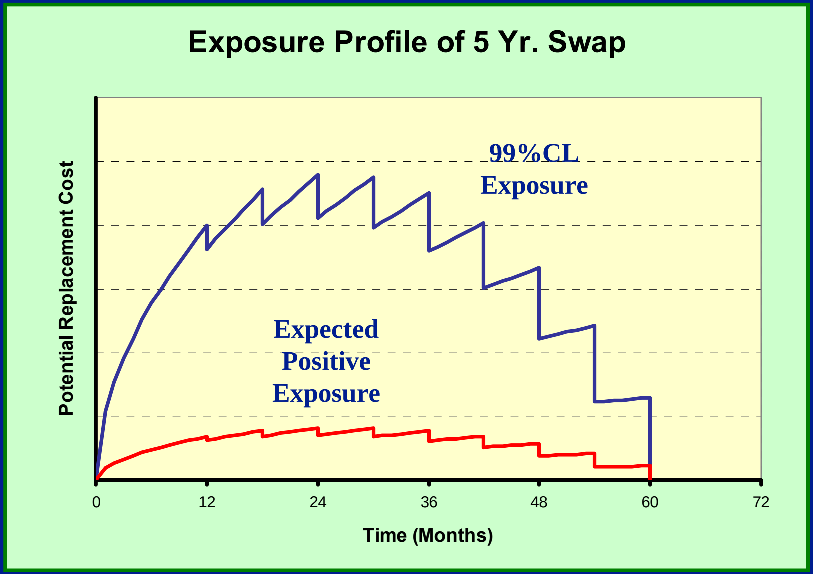
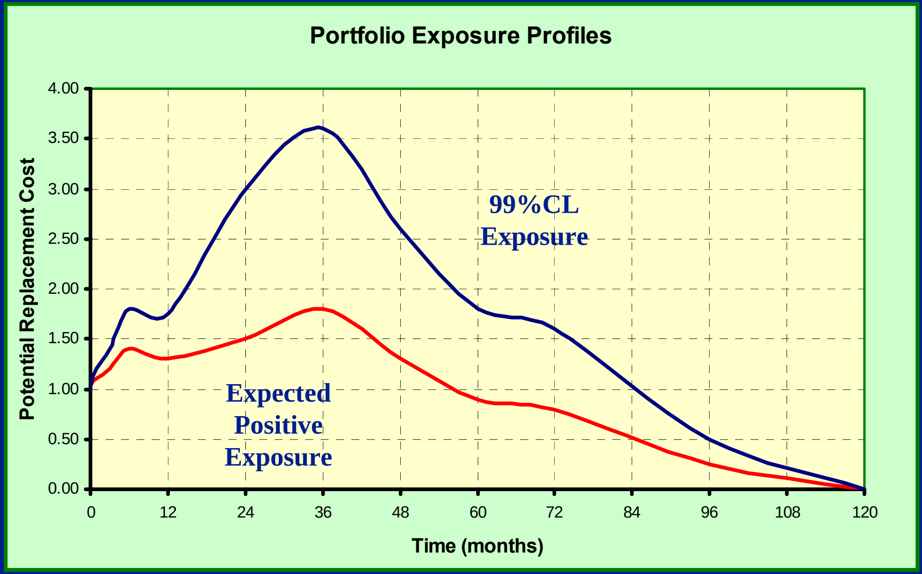
# EPE

**Exposure Profile**
**Single Transaction**
**Initial CMTM = 0.**




**Exposure Profile**
**Portfolio of Many Transactions**
**Initial Portfolio Net CMTM > 0.**

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## EXPOSURE PROFILE

Potential replacement cost of portfolio of contracts, over time, calculated at some confidence level, assuming:

- No Additional Transactions
- Netting And Margin Taken Into Account

Exposure Profile for <u>credit line limits</u> is typically calculated at a <u>very high CL</u> (e.g. 97.7%).

Exposure profile can be calculated at other CL, including <u>expected positive profile</u> or even a <u>negative profile</u> – how much one's firm may owe counterparty in the future.



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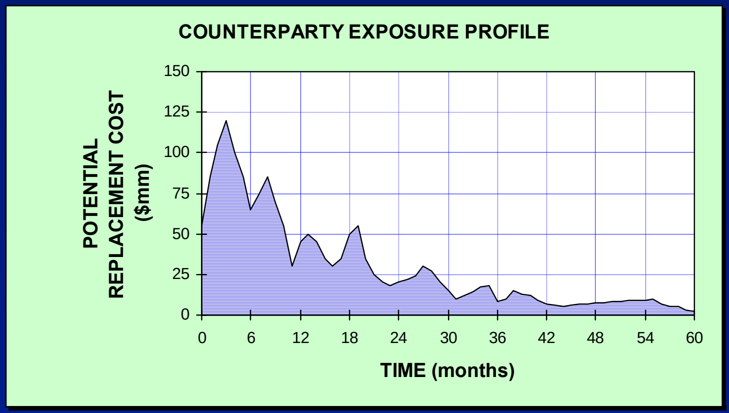
# EPE

- **Initial Industry Proposal: Loan equivalent = EPE for SFTs and OTC Derivatives.**
  - **EPE = Average of expected positive profile over one year horizon.**




- Calculate the expected positive value of the counterparty's exposure profile over the life of the portfolio
- EPE = Average of expected profile over one year horizon.



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# Calculation of EPE- Process steps

- Forecast future values of market factors; distribution of values at future points in time.
- Value each position under each market scenario at each point in time;
- Aggregate positions to netting set level, taking collateral into account

→ An exposure profile is obtained enabling the calculation of the expected positive exposure



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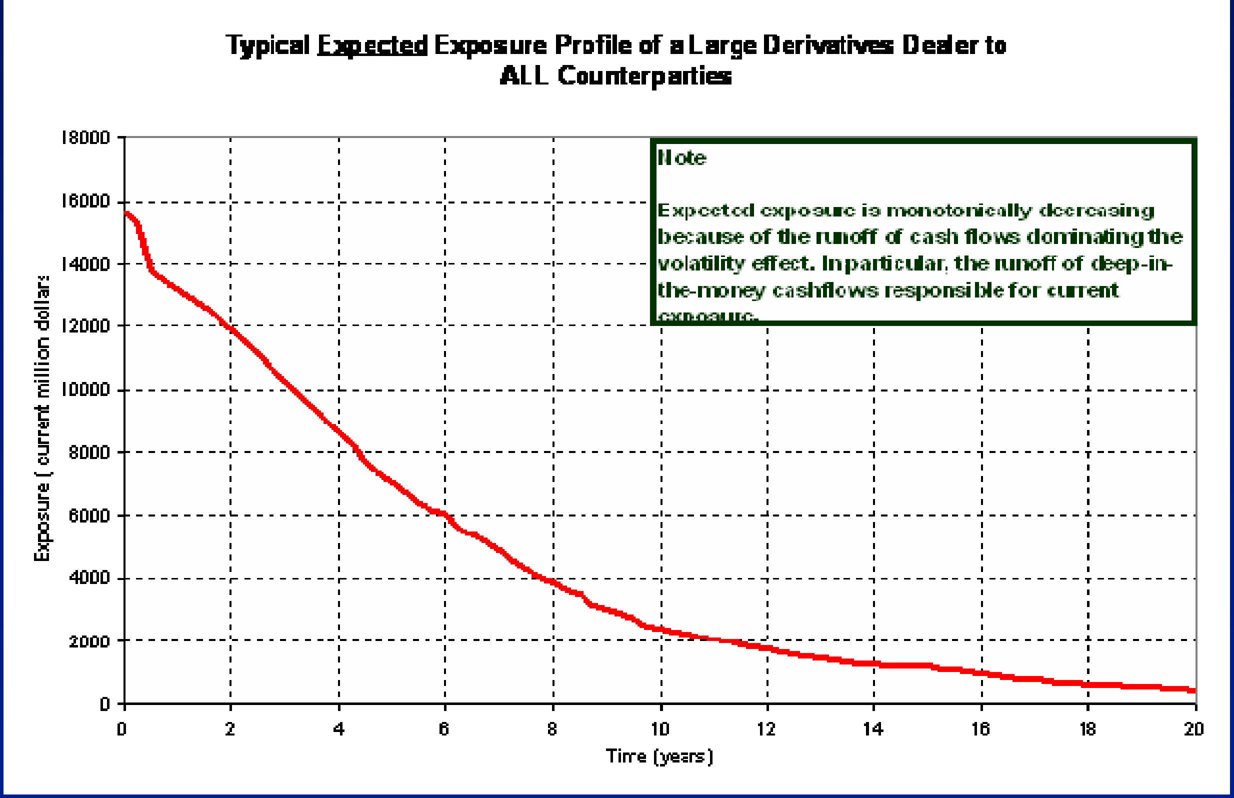
# Corrections to pure EPE concept

# Corrections to EPE : Rollover risk

- Most short term exposures are rolled over
- If this effect is ignored, EPE <CE for many counterparties:



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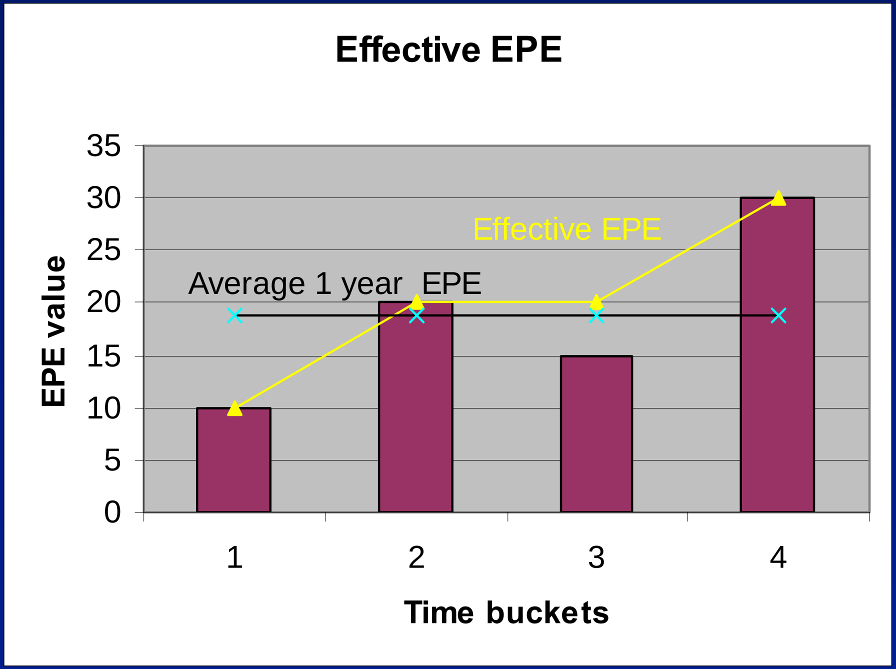
# Rollover risk

- Solution : regulators propose to use Effective EPE, defined as:
- Eff EPEt =Max(Eff EPEt-1, EPE)



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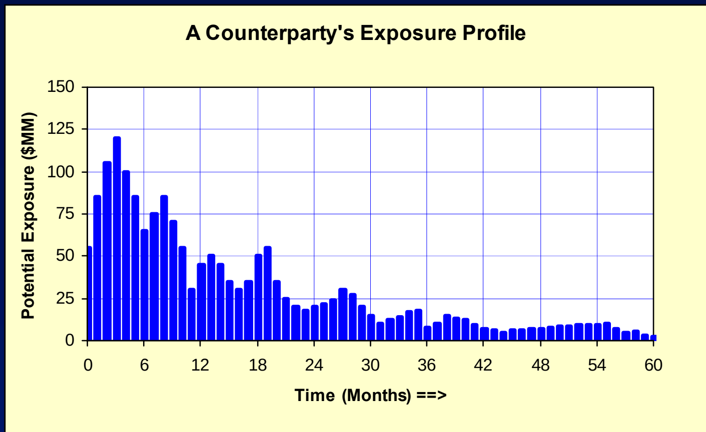
# Rollover risk

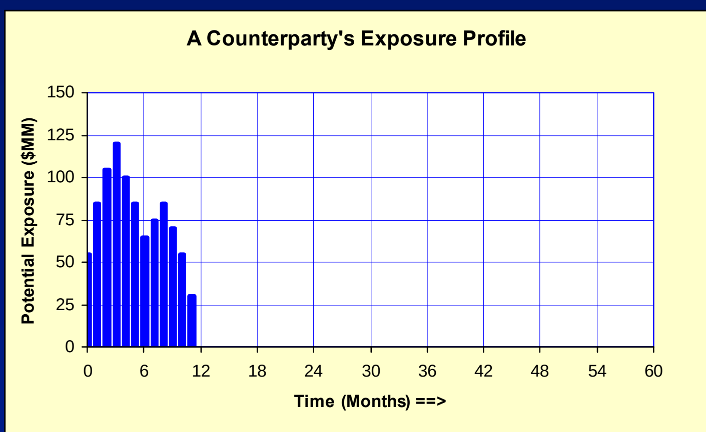
- Remaining issues:
  - Industry would like to be able to calculate Effective EPE at the level of the counterparty, rather than the netting set;
  - Some would also like to ignore roll-over risk where portfolios are rapidly changing [either very short term, or entered into with counterparties who will assign or novate trades quickly]

# Correction: Effective maturity




**Lifetime area under discounted curve**

$$\sum_{k=1y}^{\text{Full Life of Portfolio}} EPE_k \; \Delta t_k \; df_k + \sum_{k=1}^{1\text{ year}} EEPE_k \; \Delta t_k \; df_k = 140.7$$




**One year area under discounted curve**

$$\sum_{k=1}^{1\text{ Year}} EEPE_k \; \Delta t_k \; df_k = 75.9$$

**Therefore** M = (140.7/75.9) yrs
= 1.85 yrs
= 22.2 months

**M is simply the ratio of:**

**The area under the full-lifetime EPE curve, corrected for EEPE divided by the area EEPE 1-year.**

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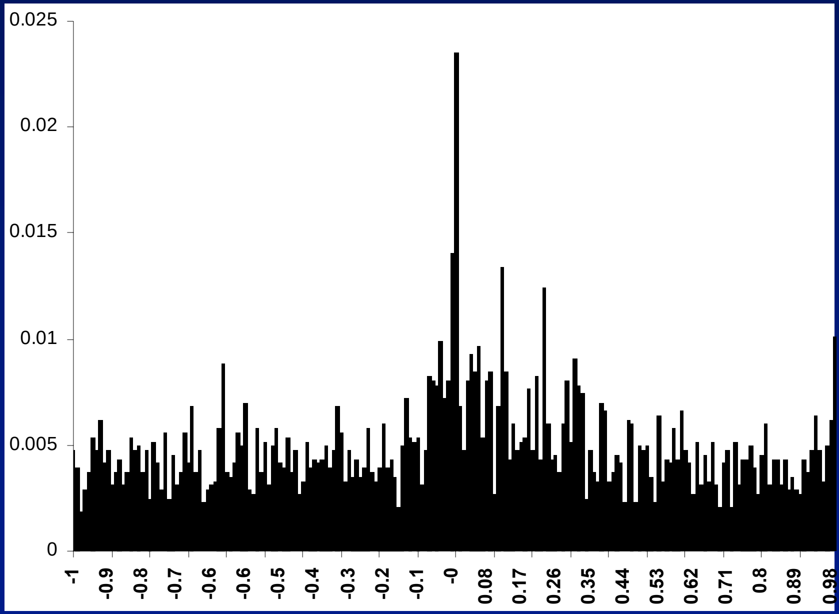
# Correction : imperfect diversification (alpha factor)

- Tom Wilde (2001) showed that if the portfolio of counterparty exposures is "perfectly diversified", EPE is the correct measure of EAD under the Basel II model
- But … real portfolios are not perfectly diversified …they have market and credit risk granularities. The graph below shows the distribution of correlation between pairs of counterparties in a typical derivatives portfolio.




- Evan Picoult (2002) defined and proposed α as the gross-up factor for EPE necessary to account



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# Alpha factor

- Evan Picoult (2002) defined and proposed $\alpha$ as the gross-up factor for EPE necessary to account for the risk granularities in the portfolio:

$$\alpha = \frac{\text{Economic capital under market and credit uncertainty}}{\text{Economic capital under credit uncertainty only}}$$

- But … What is the value of $\alpha$ ? How does $\alpha$ vary with the characteristics of the portfolio of exposures ?
- Eduardo Canabarro (2002) developed a quantitative model to represent a portfolio of market-driven counterparty exposures with parameters defining various characteristics of the portfolio. With that model, Eduardo calculated $\alpha$'s via Monte Carlo simulations. Tom Wilde (2002) derived the analytical expressions for $\alpha$ for the model.



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# Example Portfolio Specification

- Intended to be a realistic model of a large derivatives portfolio.
- Portfolio parameters were as shown for "base" portfolio.

| PORTFOLIO PARAMETERS | | |
|---|---|---|
| Percentile | $q$ | 99.90% |
| *Credit information* | | |
| Number of counterparties | $N$ | 200 |
| Default probability | $p$ | 0.30% |
| Asset correlation | $l$ | 22.00% |
| *Exposure information* | | |
| Number of market factors | $K$ | 3 |
| Spot values | $\pm u$ | $\pm 1.36$ |
| Market volatilities | $s$ | 1 unit |

← Within IRB range (12% to 24%) [pointing to Asset correlation]

← $K$ = 3 chosen based on the empirical correlation structure discussed above [pointing to Number of market factors]



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# The value of alpha

| Asset corr'n | Spot value+/- | No factors | No. of cpties | PD | Conf level | Systematic risk | Actual Portfolio A | | Reference Portfolio B | | α = A/B | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| λ | *u* | *K* | *N* | *p* | *q* | *Analytic* | MCarlo | Analytic | MCarlo | Analytic | MCarlo | Analytic |
| **Base case** | | | | | | *Percentile* | *Percentile* | | *Percentile* | | | |
| 22% | 1.36 | 3 | 200 | 0.3% | 99.9% | *10.19* | **13.14** | **12.96** | **12.06** | **12.02** | **1.09** | **1.08** |
| **Sensitivity to asset correlation** | | | | | | | | | | | | |
| **0%** | 1.36 | 3 | 200 | 0.3% | 99.9% | *0.51* | 6.09 | NA | 4.26 | NA | 1.43 | 1.46 |
| **12%** | 1.36 | 3 | 200 | 0.3% | 99.9% | *5.31* | 8.99 | 8.91 | 7.43 | 7.73 | 1.21 | 1.15 |
| **24%** | 1.36 | 3 | 200 | 0.3% | 99.9% | *11.30* | 14.08 | 13.96 | 13.04 | 13.05 | 1.08 | 1.07 |
| **50%** | 1.36 | 3 | 200 | 0.3% | 99.9% | *30.69* | 32.70 | 32.50 | 32.06 | 31.82 | 1.02 | 1.02 |
| **Sensitivity to current market values** | | | | | | | | | | | | |
| 22% | **0** | 3 | 200 | 0.3% | 99.9% | *5.65* | 8.42 | 8.23 | 6.24 | 6.18 | 1.35 | 1.33 |
| 22% | **1** | 3 | 200 | 0.3% | 99.9% | *8.26* | 10.96 | 10.81 | 9.61 | 9.61 | 1.14 | 1.12 |
| 22% | **2** | 3 | 200 | 0.3% | 99.9% | *14.28* | 17.80 | 17.64 | 16.95 | 16.96 | 1.05 | 1.04 |
| 22% | **3** | 3 | 200 | 0.3% | 99.9% | *21.24* | 25.95 | 25.73 | 25.19 | 25.26 | 1.03 | 1.02 |
| **Sensitivity to the number of market risk factors** | | | | | | | | | | | | |
| 22% | 1.36 | **1** | 200 | 0.3% | 99.9% | *10.19* | 13.22 | 13.11 | 12.02 | 12.02 | 1.10 | 1.09 |
| 22% | 1.36 | **5** | 200 | 0.3% | 99.9% | *10.19* | 13.07 | 12.93 | 12.10 | 12.02 | 1.08 | 1.08 |
| 22% | 1.36 | **10** | 200 | 0.3% | 99.9% | *10.19* | 12.97 | 12.91 | 12.01 | 12.02 | 1.08 | 1.07 |
| 22% | 1.36 | **50** | 200 | 0.3% | 99.9% | *10.19* | 12.96 | 12.89 | 12.00 | 12.02 | 1.08 | 1.07 |
| **Sensitivity to number of counterparties** | | | | | | | | | | | | |
| 22% | 1.36 | 3 | **20** | 0.3% | 99.9% | *1.02* | 3.54 | 3.72 | 2.81 | 2.85 | 1.26 | 1.31 |
| 22% | 1.36 | 3 | **50** | 0.3% | 99.9% | *2.55* | 5.21 | 5.26 | 4.27 | 4.37 | 1.22 | 1.20 |
| 22% | 1.36 | 3 | **100** | 0.3% | 99.9% | *5.10* | 7.79 | 7.83 | 7.08 | 6.92 | 1.10 | 1.13 |
| 22% | 1.36 | 3 | **500** | 0.3% | 99.9% | *25.48* | 28.92 | 28.36 | 27.81 | 27.31 | 1.04 | 1.04 |
| **Sensitivity to probability of default** | | | | | | | | | | | | |
| 22% | 1.36 | 3 | 200 | **0.1%** | 99.9% | *4.55* | 7.03 | 6.93 | 6.01 | 6.16 | 1.17 | 1.12 |
| 22% | 1.36 | 3 | 200 | **0.5%** | 99.9% | *14.56* | 17.59 | 17.56 | 16.44 | 16.50 | 1.07 | 1.06 |
| 22% | 1.36 | 3 | 200 | **1.0%** | 99.9% | *23.10* | 26.60 | 26.50 | 25.09 | 25.20 | 1.06 | 1.05 |
| 22% | 1.36 | 3 | 200 | **5.0%** | 99.9% | *59.40* | 65.00 | 64.55 | 61.90 | 61.84 | 1.05 | 1.04 |
| **Sensitivity to confidence level** | | | | | | | | | | | | |
| 22% | 1.36 | 3 | 200 | 0.3% | **99.0%** | *4.37* | 6.08 | 6.11 | 5.68 | 5.56 | 1.07 | 1.10 |
| 22% | 1.36 | 3 | 200 | 0.3% | **99.5%** | *5.85* | 7.90 | 7.90 | 7.18 | 7.23 | 1.10 | 1.09 |

**ISDA worked with example portfolios to quantify α:**

**Actual portfolio A**

- This is the portfolio with full stochastic exposures and correlations as per the settings described above.

**Reference portfolio B**

- This portfolio is as A but with each exposure fixed = EPE of the corresponding portfolio A counterparty.

**$\alpha = A_q / B_q$**

- alpha measures the extra risk arising from the fact that exposures are variable and correlated.

**Comments**

- Analytic and Monte-Carlo results agree on α = 1.09 for the base portfolio
- Importantly, α is not very sensitive to most parameters; don’t need “tailored” values of α

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# Regulatory value of alpha

- Firms can, subject to operational risk requirements, calculate own alphas, subject to a floor of 1.2
- Basel Committee will re-examine the floor in the light of further advances made by firms in modelling economic capital.

# Other risks not captured

**There are further possible risks with a counterparty portfolio**

- Wrong way risk and systematic LGD risk
- These risks are not part of the simulations that produced $\alpha$. They are not accounted for by simply using the $\alpha$ multiplier, and must be considered separately.

**Wrong way risk**

- This is risk where the exposure is adversely correlated with counterparty credit quality
- A classic example is the “own shares financing”, where the transaction is essentially a loan collateralised by equity related to the borrower.
- ISDA advocates prudent treatment (e.g. treat as unsecured). Not appropriate to incorporate into $\alpha$, as requires tailored transaction by transaction treatment.

**Systematic LGD risk**

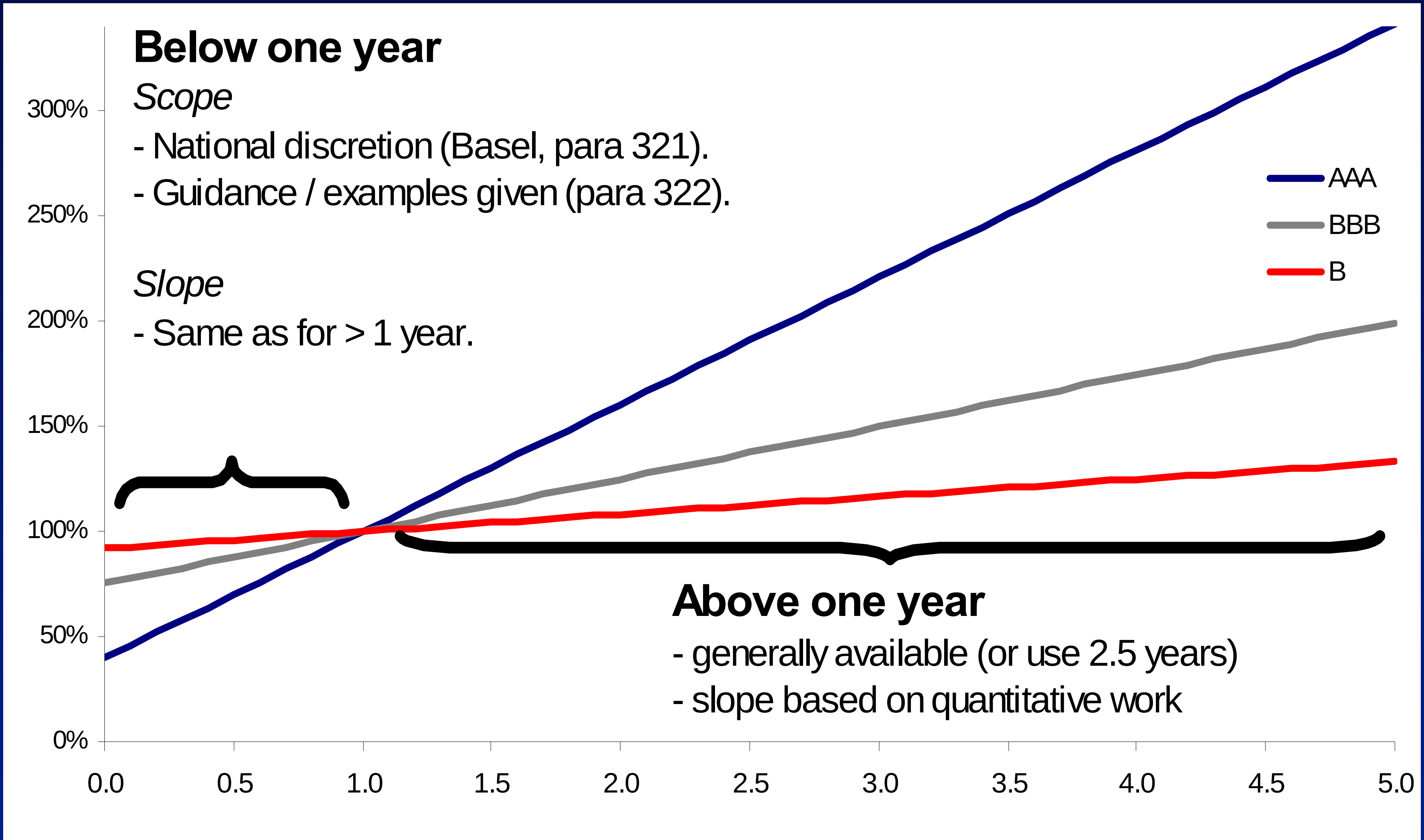
- Accepted that capital requirements should reflect LGD appropriate to bad years.
- Principally an issue for loans. However, is there an effect on counterparty LGD’s as well? Evidence likely to be sparse, but prudence needed.
- It can be shown that effect on $\alpha$ is a slight *decrease*, which can therefore be ignored.

# Short term maturity

# Short term maturity issues

- Some portfolios are principally comprised of short term transactions [repos are often overnight, FX derivatives tend to be short term].
- For those portfolios, industry has argued that it should be feasible to adjust maturity below one year [a one year floor otherwise applies in the IRB framework]
- Regulators have accepted the argument and applied the maturity adjustment below one year.

# Maturity effect on the IRB capital charge



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# Problems with Basel's treatment

**Slope: Same as > 1 year**

- The treatment of short dated products "borrows" the > 1 year formula.
- This formula was not developed for short dated products.
- Industry and regulators agree the technicalities are different for < 1 and >1 year.

**-> Can we develop a tailored approach to short dated products?**

**-> Principles for inclusion within scope :**

**-availability of information concerning credit quality of counterparty**

**-ability to hedge or terminate the exposure**

# - ANNEX -

# Extract from Citigroup Presentation

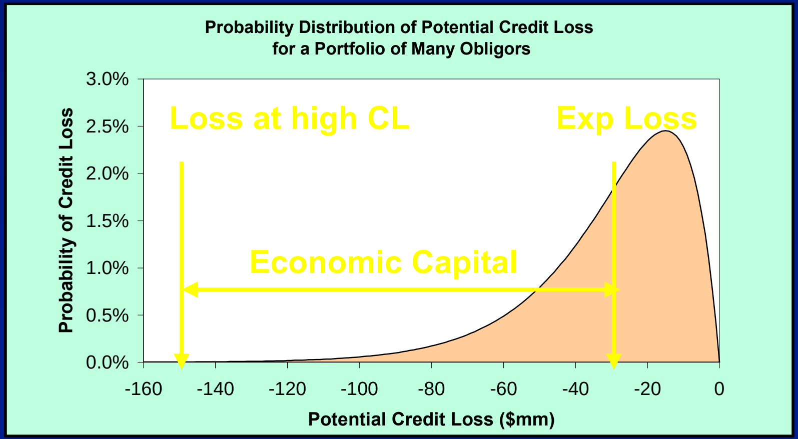
## ECONOMIC CAPITAL

# DEFINITION OF ECONOMIC CAPITAL

**THE TERM "CAPITAL" HAS SEVERAL MEANINGS:**

- **SOME MEASURE OF AVAILABLE FINANCIAL RESOURCES:**
  - ❑ **BOOK CAPITAL = ASSETS – LIABILITIES**
  - ❑ **MARKET CAPITALIZATION = NUMBER OF SHARES * PRICE PER SHARE**
    **= IMPL. MKT. VALUE OF ASSETS – LIABILITIES (Implied Market Value of Assets)**

- **A MEASURE OF ECONOMIC RISK (solvency, i.e. debt holders, perspective):**
  - ❑ **ECONOMIC CAPITAL = MEASURE OF UNEXPECTED LOSS AT HIGH C.L.**



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# ECONOMIC CAPITAL BASICS

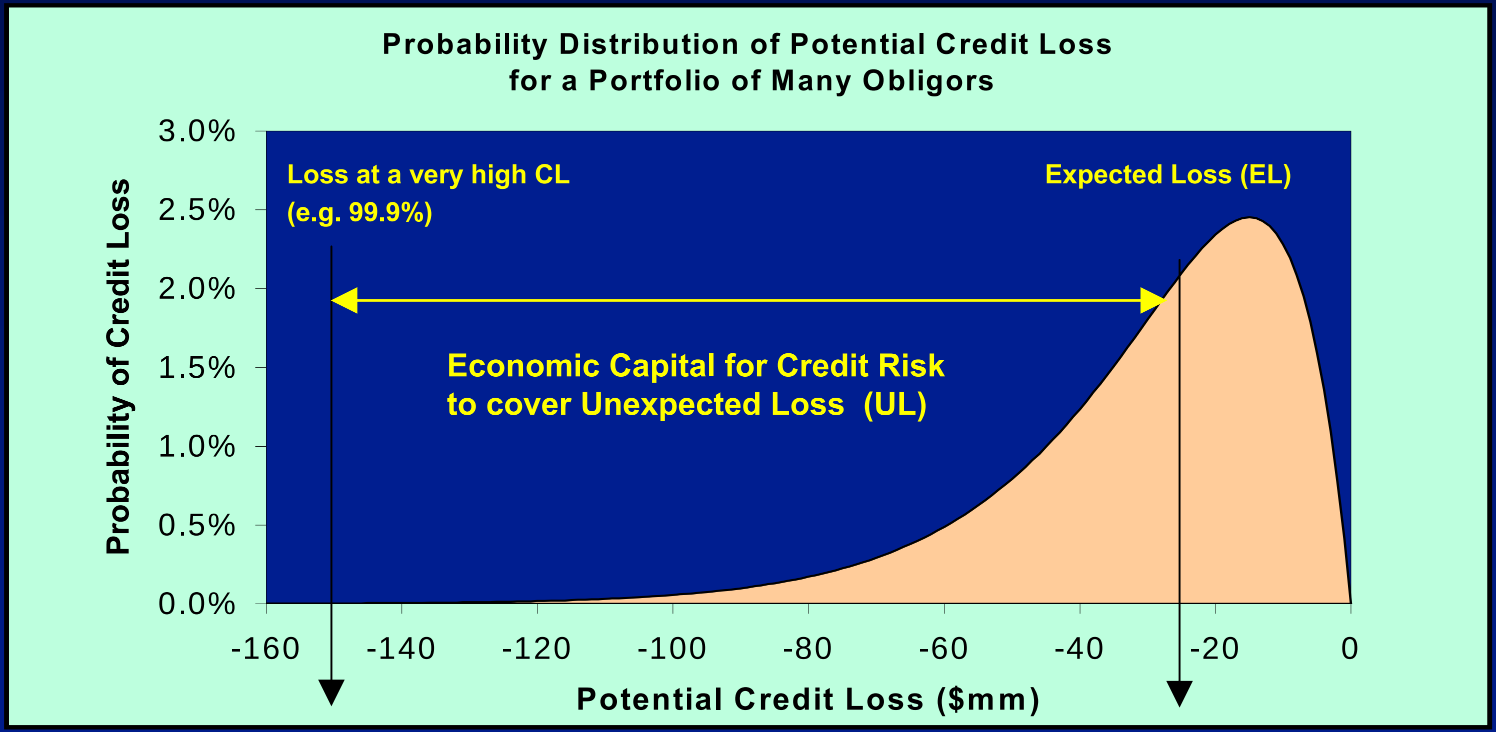
- **EC should always be defined on a <u>portfolio basis for all obligors in the portfolio</u>.**
  - **EC is defined by width of potential loss distribution. The width depends on the characteristics of the <u>entire portfolio</u> of obligor exposure.**

- **There are <u>two levels of portfolio diversification</u> that needs to be taken into account when measuring <u>ec for counterparty credit risk</u>:**
  - **Diversification / portfolio effects with regard to the <u>potential exposure</u> across all transactions with <u>a particular counterparty</u>.**
  - **Diversification/portfolio effects across <u>all counterparties</u>.**

# DEFINITION OF ECONOMIC CAPITAL

## EXAMPLE: EC FOR CREDIT RISK

**Economic Capital For Credit Risk = A measure of risk: The <u>unexpected loss</u>, at a high confidence level, in excess of the <u>expected loss</u>.**




**The probability distribution of potential credit loss, and the ratio UL/EL, depends on the <u>composition of the portfolio</u> and the <u>definition of credit loss</u>.**



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# ECONOMIC LOSS - LOAN PORTFOLIO - DEFAULT ONLY ANALYSIS

SIMULATING LOSS DISTRIBUTION OF LOAN PORTFOLIO: Default only Perspective

**ASSUME SOURCE OF CREDIT RISK IS DEFAULT AND RECOVERY ONLY.**

**FACTORS NEEDED TO SIMULATE LOSS DISTRIBUTION:**

- **Credit exposure per obligor**
- **Probability distribution of exposure at default, for contingent credit.**
- **Probability of default (i.e. by obligor risk rating) and correlations of probability of default**
- **Probability distribution of loss given default (LGD) (i.e. 1 – recovery%).**

**THERE ARE SEVERAL VERY DIFFERENT WAYS OF MODELING THE POTENTIAL LOSS DISTRIBUTION DUE TO DEFAULT AND RECOVERY.**

## FACTORS EFFECTING ECONOMIC CAPITAL FOR LOANS: DEFAULT ONLY

- **Even if had certainty about PD and LGD:**
  - **Uncertainty in how many obligors default.**
  - **Uncertainty in which obligors default (particularly important for inhomogeneous portfolio)**
  - **Uncertainty in recovery after default**

- **In addition have uncertainty about future state of economy and therefore uncertainty in PD.**

## ECONOMIC CAPITAL FOR COUNTERPARTY RISK

## DEFAULT ONLY PERSPECTIVE

# ECONOMIC LOSS - COUNTERPARTY RISK - DEFAULT ONLY ANALYSIS

SIMULATING POTENTIAL LOSS DISTRIBUTION OF DERIVATIVE PORTFOLIO: DEFAULT ONLY ANALYSIS

## FACTORS NEEDED TO SIMULATE LOSS DISTRIBUTION:

- Probability distribution of Credit Exposure per obligor
- Probability of Default (by risk rating, industry, etc.) and correlations of probability of default.
- Probability distribution of Loss Given Default (LGD)
- Correlation of Potential Exposure and Default

## MATERIAL DIFFERENCES WITH SIMULATION OF LOAN PORTFOLIO LOSS DISTRIBUTION.

- Variability of Exposure per obligor
  - All else held constant, increases risk relative to a fixed exposure.
- Not all obligors have exposure at same time
  - All else held constant, decrease risk relative to a fixed exposure.

Need a method of measurement of economic capital for counterparty credit risk, taking into account the potential volatility of counterparty exposure over time.



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# TWO METHODS FOR SIMULATING POTENTIAL LOSS DISTRIBUTION DUE TO COUNTERPARTY RISK

- **FULL SIMULATION:**
  - **Simulate a <u>path the market could take over time</u>. For each path the cash flows of each counterparty are fixed and the exposure of each counterparty is determined. Hence, for each potential path of the market, one can simulate thousands of potential default and recovery scenarios over time just as for a loan portfolio.**
  - **Repeat by simulating thousands of potential paths market rates could take over time.**
  - **Derive EC from the distribution of potential loss.**
  - **This has virtual of coherent simulation. The consequence of default and recovery take into account the particularly exposure given the particular simulated state of the market.**
- **SIMULATION WITH FIXED EXPOSURE PROFILE**
  - **Assume the potential exposure of each counterpart can be represented by a fixed exposure profile over time equal to the expected exposure profile.**
  - **Simulate thousands of defaults and recoveries over time, just as if this were a loan portfolio.**
  - **Derive EC from the distribution of potential loss.**

# ECONOMIC LOSS - COUNTERPARTY RISK - DEFAULT ONLY ANALYSIS

## EC BY FULL SIMULATION: GENERAL METHOD, FIVE STEPS

1) SIMULATE A PATH, P, OF MARKET RATES OVER TIME $M(t)_P$

*Same as for Exposure Profile.*

2) **FOR SIMULATED PATH P, MEASURE THE POTENTIAL MARKET VALUE OVER TIME OF EACH TRANSACTION WITH FOR COUNTERPARTY K.** *Same as for Exposure Profile.*

3) **FOR SIMLUATED PATH P, DERIVE COUNTERPARTY K'S POTENTIAL EXPOSURE OVER TIME.**
**i.e. For each counterparty K, for path $M(t)_P$ derive $Exposure(t)_{K,P}$** *Same as for Exposure Profile.*

4) **USING THE SET OF EXPOSURE PROFILES $\{Exposure(t)_{K,P}\}$ FOR ALL COUNTERPARTIES K, GENERATED BY MARKET PATH P:**

**CALCULATE THE POTENTIAL LOSS DISTRIBUTION BY SIMULATING THOUSANDS OF SCENARIOS OF DEFAULT AND RECOVERY FOR THE SET OF COUNTERPARTIES K.**

5) **AFTER SIMULATING THOUSANDS OF POTENTIAL PATHS OF MARKET RATES, $M(t)_P$ CALCULATE FULL LOSS DISTRIBUTION AND DERIVE THE FULL SIMULATION ECONOMIC CAPITAL FOR COUNTERPARTY RISK.**

Loop over thousands of paths P.

Loop over thousands of scenarios of default and recovery.



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## IS IT POSSIBLE TO DEFINE A "LOAN EQUIVALENT" FOR COUNTERPARTY EXPOSURE?

A "Loan Equivalent" is the fixed exposure profile, per counterparty, that would generate the same economic capital as calculated with full simulation.

**Note:**

The use of a fixed exposure profile per counterparty to calculate total EC for the credit risk of all counterparties entails the incoherent summation of each counterparty's potential exposure and has the same potential error as the simple, incoherent summation of the potential exposure of each transaction with a counterparty to get the counterparty's total potential exposure. In other words, for any state of the market, some counterparties will have positive exposure, some negative. There will be no state of the market in which every counterparty has its "average positive expected exposure".

## HOW GOOD AN APPROXIMATION OF A LOAN EQUIVALENT IS THE EXPECTED EXPOSURE PROFILE?

## IN WHAT CONTEXT, IF ANY, IS IT A GOOD APPROXIMATION?

## EC USING EXPECTED EXPOSURE EXPOSURE PROFILE AS A LOAN EQUIVALENT:

1) CALCULATE THE EXPECTED POSITIVE EXPOSURE PROFILE, $EPE(t)_K$ , OF EACH COUNTERPARTY K

Loop over thousands of paths P.

a) Simulate a path, P, of market rates over time $M(t)_P$

b) For simulated path, P, measure the simulated market value over time of each transaction with counterparty K.

c) For simulated path, P, derive counterparty exposure over time. i.e. For the counterparty K, for path $M(t)_P$ , derive $Exposure(t)_{K,P}$

LOOP OVER THOUSANDS OF SIMULATED PATHS M

d) Derive each counterparty's expected positive exposure profile $EPE(t)_K$

2) USING THE SET OF EXPECTED POSITIVE EXPOSURE PROFILES $\{EPE(t)_K\}$ FOR EVERY COUNTERPARTY K

Loop over thousands of default scenarios.t

Calculate the potential loss distribution by simulating thousands of scenarios of default and recovery for the set of counterparties K.

3) CALCULATE THE ECONOMIC CAPITAL FROM THE LOSS DISTRIBUTION DERIVED FROM EACH COUNTERPARTY'S EXPECTED EXPOSURE PROFILE.



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# DEFINING THE "LOAN EQUIVALENT" FOR ECONOMIC CAPITAL

## a.k.a. The Credit Equivalent Amount (CEA) - From a default only perspective

Define a as the ratio of a) EC calculated by full simulation to b) EC calculated by simulation where each counterparty's exposure is represented as a fixed expected positive exposure profile:

$$\alpha(P; CL, T) = \frac{\text{Econ Cap }(P; CL, T)_{\text{FULL\_SIM; DEFAULT ONLY}}}{\text{Econ Cap }(P; CL, T)_{\text{FIXED\_EPE\_SIM; DEFAULT ONLY}}}$$

Where:

| | | |
|---|---|---|
| P | = | Particular portfolio of counterparties with transactions and assumptions about portfolio, e.g. PDs, Correlations, etc. |
| CL | = | Confidence Level that EC is measured at. |
| T | = | Time Horizon over which EC measured. |

Therefore: $CEA(t)_K = \alpha(P;CL,T) * EPE(t)_K$ for counterparty K

**Questions:**

- How will $\alpha$ vary with the characteristics of the entire portfolio of counterparty risk?
- What characteristics of the portfolio does $\alpha$ depend on ?



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# ISDA TESTS

**CREATE TEST PORTFOLIOS AND CALCULATE a AS A FUNCTION OF THE CHARACTERISTICS OF THE PORTFOLIO:**

- **NUMBER OF EFFECTIVE COUNTERPARTIES**
- **NUMBER OF EFFECTIVE MARKET FACTORS**
- **PROBABILITY OF DEFAULT OF COUNTERPARTIES**
- **CORRELATION OF DEFAULT.**
- **INITIAL MTM OF COUNTERPARTIE'S PORTFOLIO**
- **OTHER FACTORS.**

**INITIAL PROPOSAL:** **Evan Picoult, Citigroup**
**SIMULATIONS OF STYLIZED PORTFOLIOS:** **Eduardo Canabarro, Lehman**
**ANALYTICAL CALCULATIONS:** **Tom Wilde, CSFB**
**MEASUREMENT OF a FOR REAL PORTFOLIOS:** **Several Firms**

**SUMMARY CONCLUSION:** **For Large Market Makers a ≈ 1.10**

***See: - ISDA web site. Papers on Counterparty Risk to Basel Committee, June 2003***
***- Risk Magazine, September, 2003***



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# ISDA Contact Details

**Emmanuelle Sebton – Co-Head European Office & Policy**

One New Change
London EC4M 9QQ
England
Phone: 44(0)20 7330-3571
Fax: 44 (0)20 7330-3555
esebton@isda-eur.org

**ISDA Website**

www.isda.org

Go To: Committees/Risk Management for more detail on ISDA's activities in the field of prudential regulation.



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