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Some Remarks on CVA and COUNTERPARTY CREDIT RISK Measurement

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Preface… CVA and Basel III

"Mark-to-market losses due to credit valuation adjustments (CVA) were not directly capitalised. Roughly two–thirds of CCR losses were due to CVA losses and only one-third were due to actual defaults."

Basel Committee on Banking Supervision (2009)

Key Points

1. Introduction: the evolution of CCR measurement – towards pricing of counterparty credit risk (CVA)
2. Practical issues with CVA
3. Wrong-way risk – a reality to deal with
4. Allocation of counterparty credit risk (CVA and capital)
5. CCR measurement – from OTC trading to central clearing

Counterparty Credit Risk Evolution

- Market and credit risk are intertwined in a trading book and cannot be easily decomposed
  - Pricing includes credit risk (and has become more important in pricing)
  - Credit risk measurement depends also on market prices (exposures, LGDs)

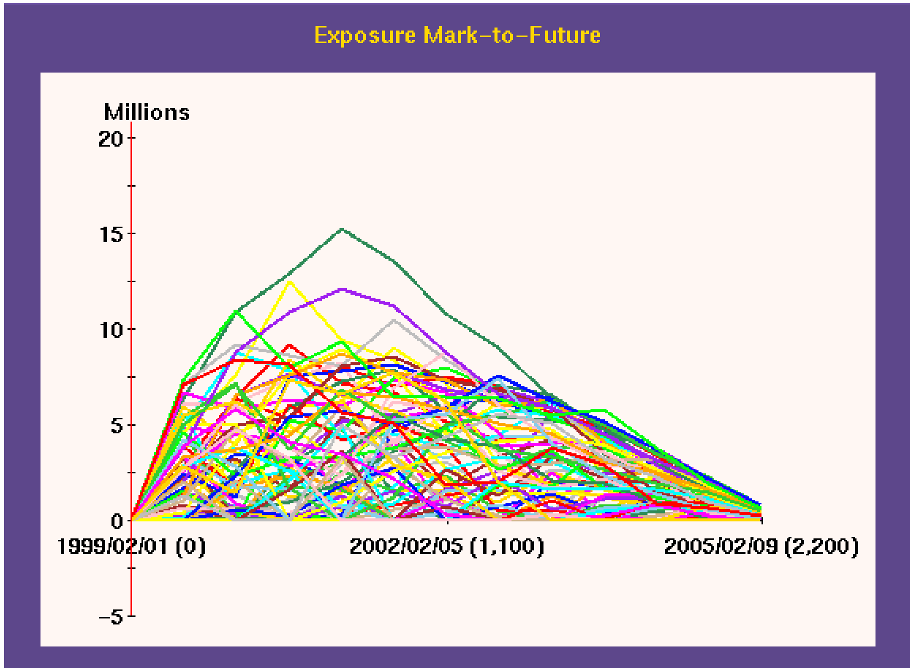
- The first step to manage risk in an integrated fashion is to understand and measure accurately the various components
  - Various risks must be accurately captured and their interactions understood

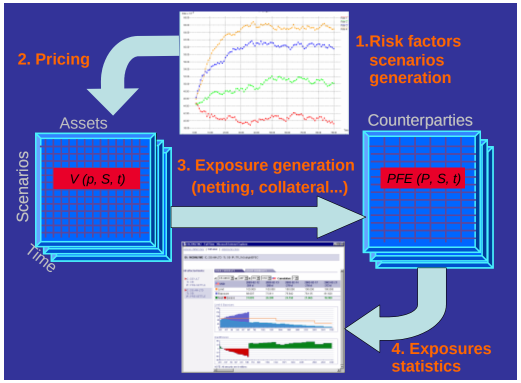
Counterparty Credit Risk Evolution

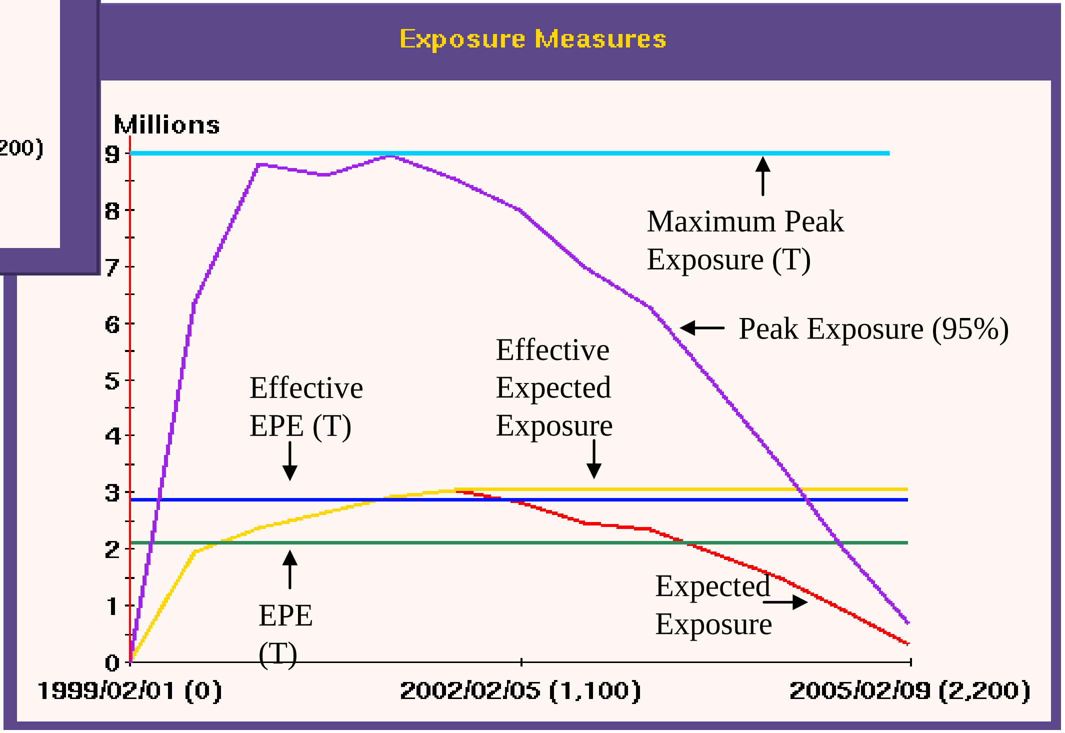
Counterparty exposures and limits

- Modelling
  - Notional
  - MtM + add-on
  - Stochastic exposures
- Credit mitigation
  - Collateral and margins
- Sophisticated limits and hierarchies

CCR and Potential Future Exposures (*PFE*s)





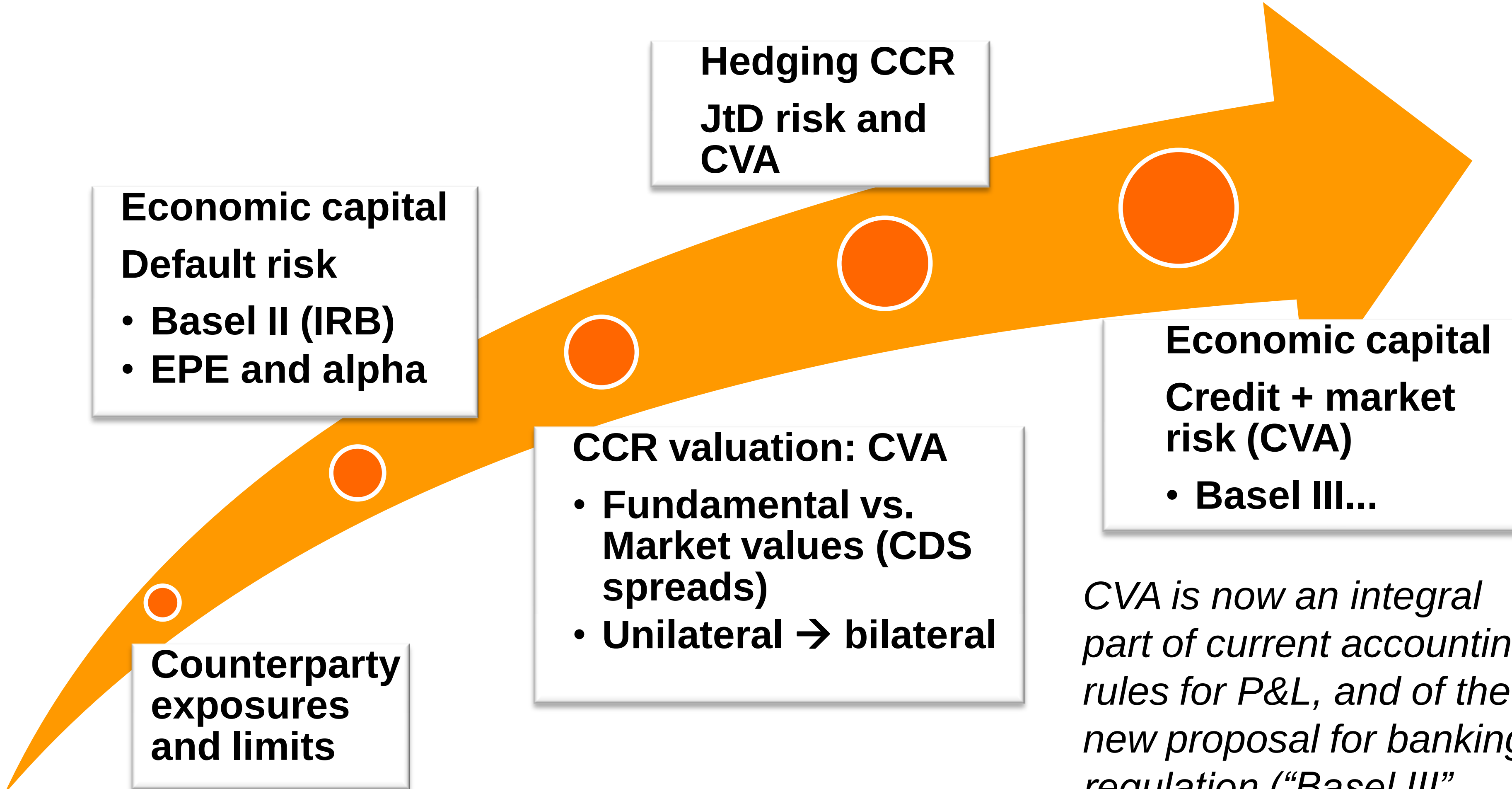


Source: de Prisco and Rosen (2005)

Counterparty Exposures, Limits and Mitigation

- Managing credit limits on a counterparty by counterparty basis has proven to be a simple, effective and actionable risk management tool
  - First level of portfolio credit risk analysis: get consolidated picture of the exposures from all the transactions with each counterparty
  - Major systems exercise – collection of all positions across instruments, geographies
- Exposures monitored through limits against each counterparty
  - Credit lines limiting maximum loss if counterparty defaults
- CCR mitigation: netting and margin agreements
  - Management of collateral

Counterparty Credit Risk Evolution



CVA is now an integral part of current accounting rules for P&L, and of the new proposal for banking regulation ("Basel III" rules)

2. Pricing CCR: Credit Value Adjustment (CVA)

- CVA is the market value of counterparty credit risk

  CVA = Risk-free portfolio value – true portfolio value accounting for counterparty's default

- CVA is now an integral part of current accounting rules for P&L, and of the new proposal for banking regulation ("Basel III" rules)
- Prior to mid-2007, CVA was either ignored by dealers, or too small to be noticed by customers
  - Treatment of CVA has changed dramatically since, also resulting in confusion
- CVA is measured at the counterparty level
  - In addition to credit spreads (and competition) the CVA charged *on a particular trade* is affected by:
  - Bank's existing portfolio of trades and the credit mitigation used in the deal
  - Methodology used to determine exposures

CVA Confusion

- The use of CVA is fairly new, and there is some way to go for the industry in defining, understanding, measuring, and hedging

"On a particular swap, the company (Virgin Media) invited 24 banks to quote on the credit exposure, receiving prices – for the same trade with the same counterparty – that ranged from single digits to more than 100 basis points … Even with the outliers lopped off,
the range of quotes covered roughly 60bp".
(Wood, 2010)

Unilateral vs. Bilateral CVA

- Two perspectives: unilateral and a bilateral
  - Unilateral CVA – counterparty that does the analysis (the *bank*) is default-free

    CVA = market value of future losses due to the counterparty's potential default
  - Bilateral CVA takes into account the possibility of both the counterparty and the bank defaulting
- Bilateral CVA prices the "gain" that is realized on the contract when the bank defaults while the exposure is negative – alwayslower than unilateral
  - Theoretically, the value is realized by debt-holders, not shareholders
  - Occurs in bankruptcy (shareholder value = 0), but difficult to realize in practice
- Can lead to somewhat bizarre profits/losses
  - We "made a lot of money" on CVA this quarter because our default probability went way up!
  - We "lost a lot" on CVA because we were upgraded by the rating agency!

Bilateral CVA

Hedge fund manager David Einhorn (in Too Big to Fail, by Andrew Ross Sorkin):

LEHMAN BROTHERS

"This is crazy accounting. I don't know why they put it in…It means that the day before you go bankrupt is the most profitable day in the history of your company, because you'll say all the debt was worthless. You get to call it revenue. And literally they pay bonuses off this, which drives me nuts."

Bilateral CVA

"Citigroup reported on Friday its first quarterly net profit in nearly two years, the latest US bank to see an improvement in its performance. It made a profit of 1.6 billion US dollars compared with a loss of 5.1 billion a year earlier. Revenues rose 99% to 24.8 billion… But it gained from an accounting rule that allowed the bank to post a one-time gain of 2.5 billion USD."

Source: en.mercopress.com

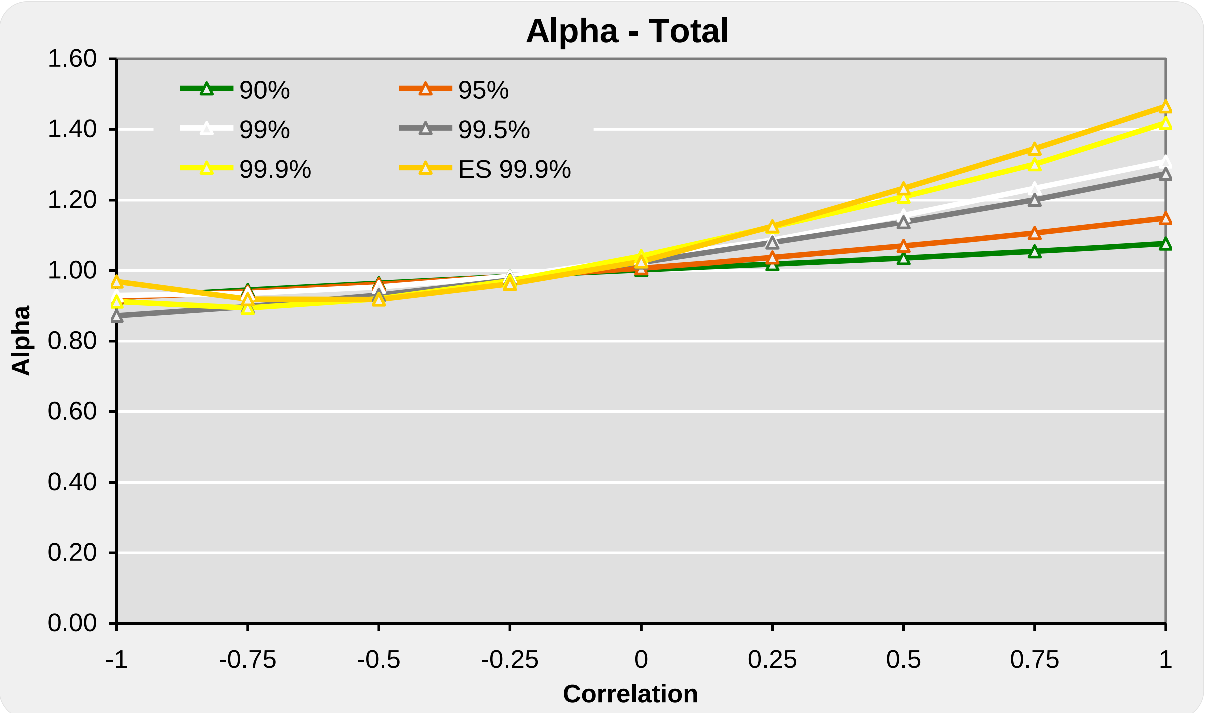
*"Fixed income markets revenues of $4.7 billion reflected strong trading performance, as high volatility and wider spreads in many products created favorable trading opportunities. Interest rates and currencies and credit products had strong revenue growth. Revenues also included (all reflected in Schedule B)**:*** ***A net $2.5 billion positive CVA on derivative positions, excluding monolines, mainly due to the widening of Citi's CDS spreads****. A net $30 million positive CVA of Citi's liabilities at fair value option."*

Source: Citi's Q1 2009 report

3. Wrong-Way Risk

- Wrong-way risk (WWR): Positive correlation between exposure of an instrument (or counterparty portfolio) and default of the counterparty
  - Right-way risk (negative exposure-default correlation) is also possible
- WWR can arise in many contexts. Examples include:
  - CDS: Systemic crisis increases default risk of CP and reference entity
  - IR: A pay-fixed swap with a highly leveraged CP that may default if interest rates increase
  - FX: Default of a CP (e.g. on an FX swap) may be more likely when its currency loses value
- Wrong-way risk has proven to be real throughout the crisis
  - It has a significant impact on valuation and risk calculations (EC)
- WWR and market-credit correlation are very difficult to measure
  - Stress-testing is an important tool

EC and CVA and WWR



- Stress testing is an important tool to understand and assess WWR

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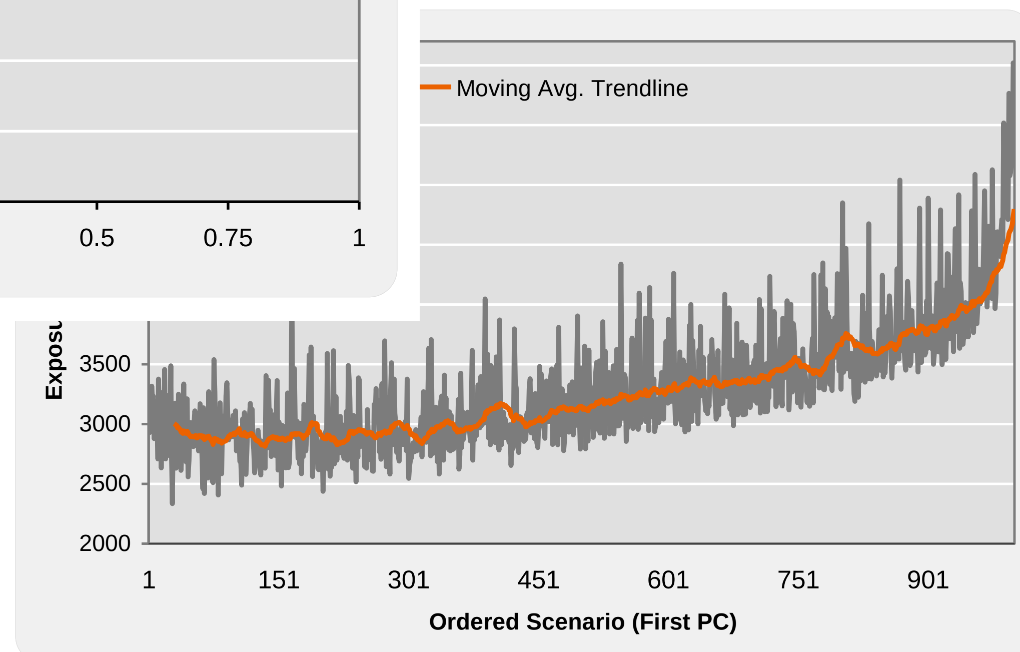


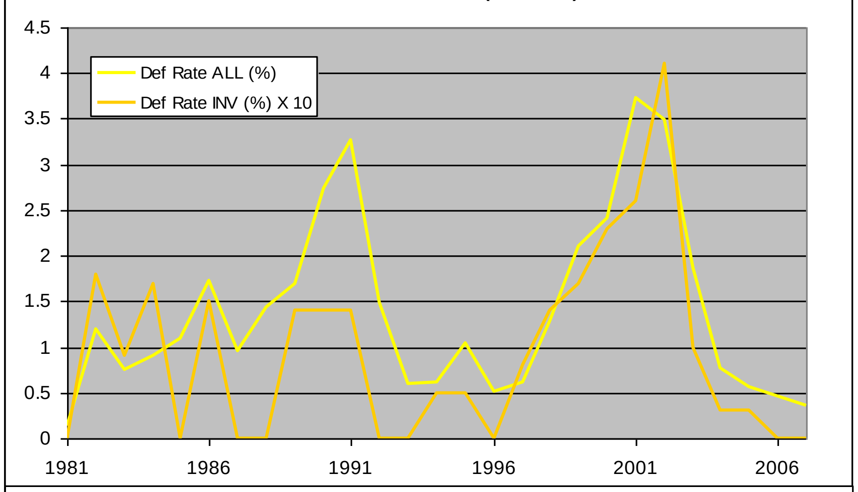
- Portfolio impact from WWR
  - Normally does not simultaneously occur to all the CPs in a portfolio

About Empirical Market-Credit Correlations

- Market-credit correlations are difficult to measure in practice
- Literature: e.g. Fleck and Schmidt (2005)
  - This study was part is part of the ISDA working group
  - R^2 = 0.19 (between default rates and interest rates – Moody's 1971-2003)
  - Alpha increased from 1.09 to 1.2… "on realistic portfolios, we find that the impact of general wrong-way risk on alpha is less pronounced…"
- Simple exercise (Rosen and Saunders 2010): regression of historical default rates vs. global equity index (MSCI global) and market factor in a model
  - Corporate default history between 1981-2007 (Standard and Poor's, 2008)
  - Correlation of index to "implied" credit driver = 20% for all ratings and 29% for investment grade only (less accurate estimation)
  - Correlation of market factor to credit drivers in model ranges 17% - 37%
  - Corr (market factor, credit driver) ~20-30%

Empirical Market-Credit Correlations

Historical time series: market index, implied credit driver and default rates (S&P data)



Historical Default Rates (1981-2007)

Correlation between all ratings and investment only

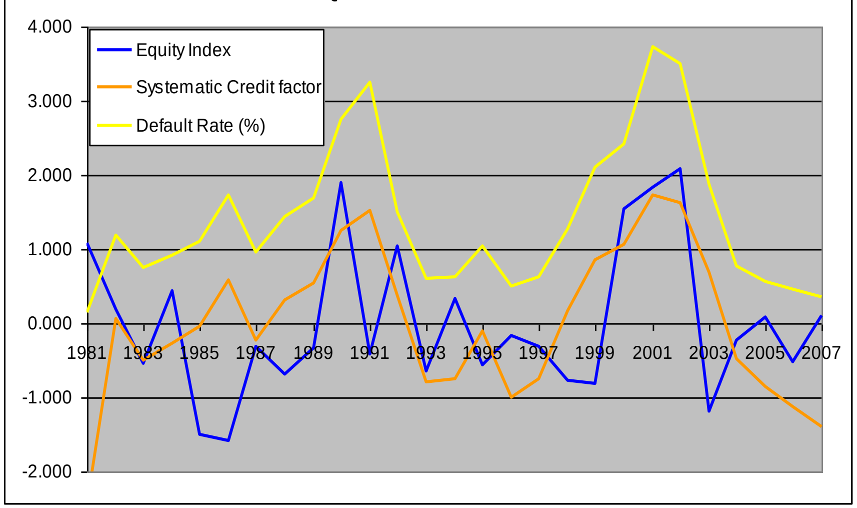
Default rates = 78%

Implied Credit factors = 70%

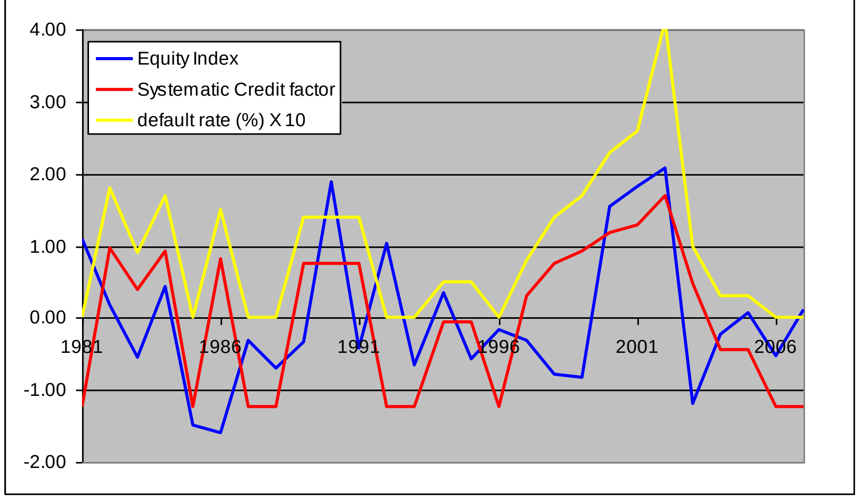
Correlation between credit factor and market index

<u>All ratings</u> = 23%

<u>Investment grade</u> = 29% *



EQ Index vs. ALL Grades



EQ Index vs. Investment Grade

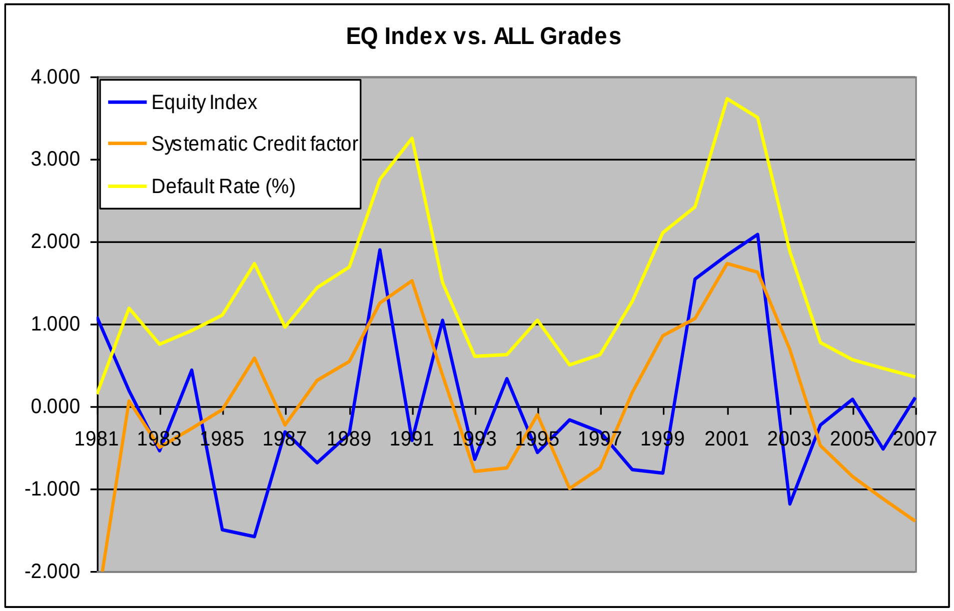
Empirical Market-Credit Correlations

<u>Correlation bounds</u>

- We have
  - Corr (CF, EQ) = 20%
  - Corr (EQ,MF) = 86%
- What can we say about

  Corr (CF, MF) ?
  - Correlation bounds

    (given only this information)
    - *Max Corr (CF,MF) = 68%*
    - *Min Corr (CF,MF) = - 34%*
    - *Corr (CF,MF) = 17%* (assuming uncorrelated residuals from both regressions)
  - A precise correlation can be obtained from looking directly at the MF and CF time series



4. Allocation of CCR

- Counterparty credit risk measurement and valuation are essentially portfolio problems
  - CVA is measured at the counterparty level – desirable also to determine contributions of individual trades to the CP-level CVA and to the total portfolio CVA
  - Similar problem to capital allocation on a portfolio (risk contributions)

- Example: CP portfolio with two positions, and allowing netting:
  - P1: IR Swap – pay fix
    - CVA(P1) = 10
  - P2: IR Swap – receive fix
    - CVA(P2) = 9
  - CVA(Portfolio) = 3

How do we allocate the CVA to the transactions?

CVA Contributions

- Example: CP portfolio with two positions, and allowing netting:
  - P1: IR Swap – pay fix: CVA(P1) = 10
  - P2: IR Swap – receive fix: CVA(P2) = 9
  - CVA(Portfolio) = 3

CVA Contributions:

- Stand-alone CVA
  - P1 → 10, P2 → 9
  - Total =19
- Incremental CVA – difference between portfolio CVA without and with trade
  - P1 → 6 (9 - 3), P2 → 7 (10 -3)
  - Total =13
- Marginal CVA – additive CVA contributions
  - CVA(P1) + CVA(P2) = CVA(Portfolio) …

CVA Contributions

- CVA Contributions:
  - *Stand-alone* CVA
  - *Incremental* CVA contribution – difference between portfolio CVA with and without the trade
  - *Marginal* CVA – additive CVA contributions
- Marginal contributions with a given CP give a clear picture how much each trade contributes to the CP-level CVA
  - But once **additive CVA contributions** have been calculated for each CP, the bank can calculate the price of CP credit risk for any collection of trades without any reference to the CPs
  - e.g, the CVA contribution of a business unit or product is simply the sum of CVA contributions of all trades booked by the business unit or of the product type
  - Similar problem arises for the allocation of CCR capital

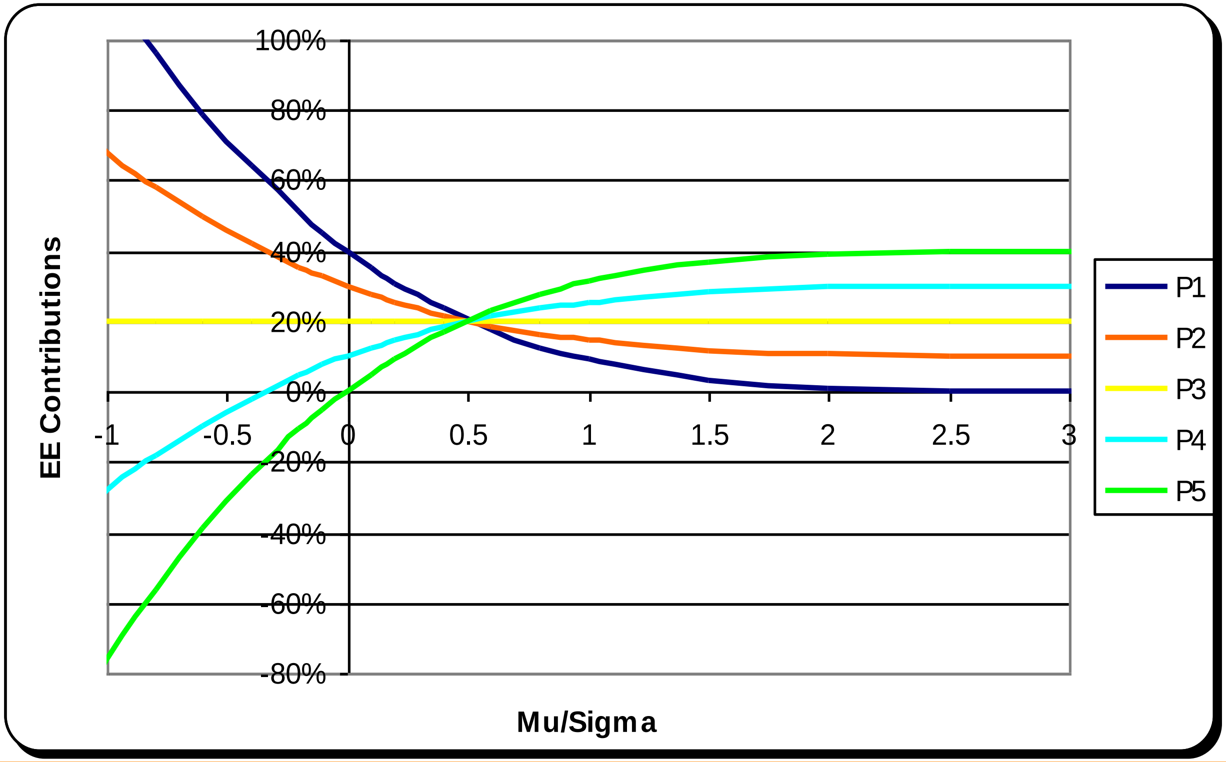
Computing CVA Contributions

- Pykhtin and Rosen (2010) - define and calculate marginal CVA contributions to individual trades composing a portfolio, in the presence of netting and margin agreements
  1. Problem reduced to calculating trade contributions of the CP-level expected exposure (EE) conditional on the counterparty's default
  2. Extension to the theory of marginal risk contributions (Euler Allocation)
     - Principle can be applied readily for CVA when the CP portfolio does not include collateral and margins
     - Extend this principle for collateralized/margined CPs
- Calculation of EE contributions easily incorporated into existing exposure simulation
  - Closed-form expressions when trade values are normally distributed
  - Solution for both market-credit independence and wrong-way risk

Example – No Collateral

- Contributions depend on: mean exposures *and* exposure volatility

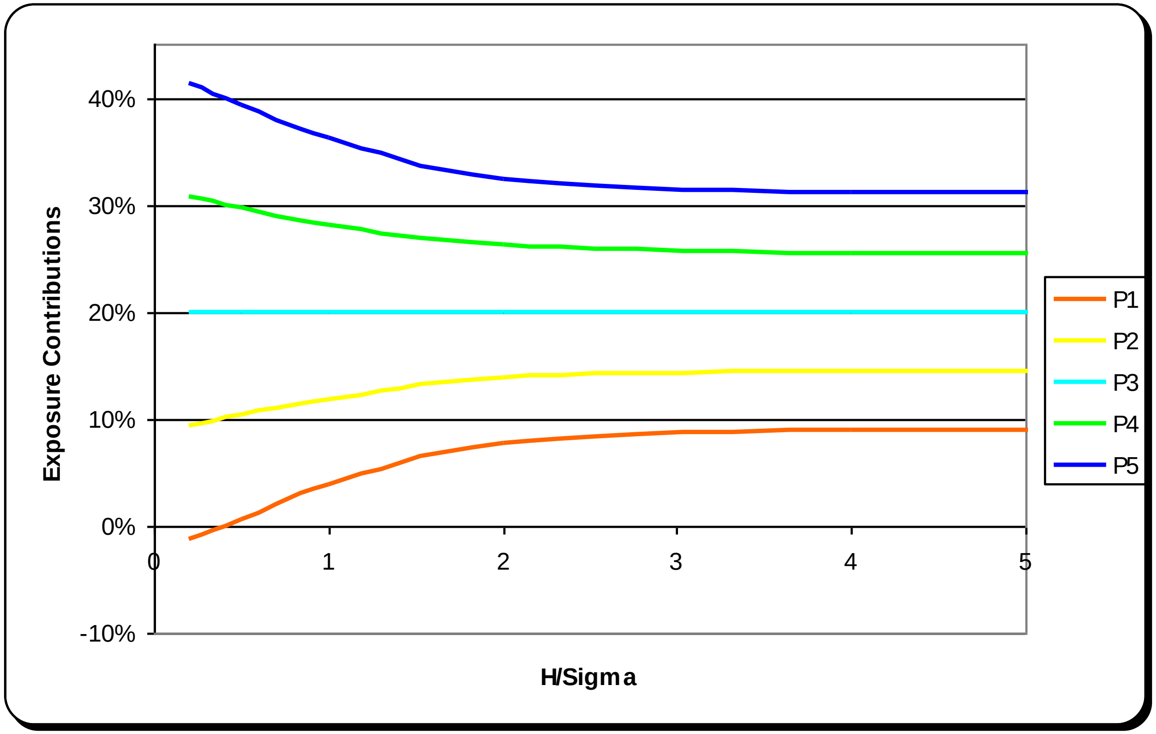
	P1	P2	P3	P4	P5	Total
μ	0	1	2	3	4	10
σ^2	4	3	2	1	0	10



- EE contributions as a function of *m/s*
- Shift in dominance between the mean and volatility components as the portfolio's mean value increases.

Example – Collateral and Margins

- EE contributions (*m/s* = 1) – function of standardized threshold, *H/s*.
  - High threshold (*H/s* > 4): trade contributions ~ uncollateralized contributions.
  - Low *H/s:* EE contributions ~ mean value contributions
  - Collateral affects each contribution differently
  - Tighter threshold increases % contributions of P4, P5 (highest means) while reducing the contributions of P1, P2 (lowest means)
  - Converge in the limit to mean value contributions



5. CCR Measurement and Central Clearing

Risk.net
Financial Risk Management News and Analysis

Industry disappointed by lack of clout in CCP standards

Source: Risk magazine | 12 May 2010

At the heart of the 38-page document, published today by the Basel-based Committee on Payment and Settlement Systems (CPSS) and the International Organization of Securities Commissions (Iosco), are 15 recommendations for CCPs, covering issues such as participation requirements, margin setting, default procedures and governance.

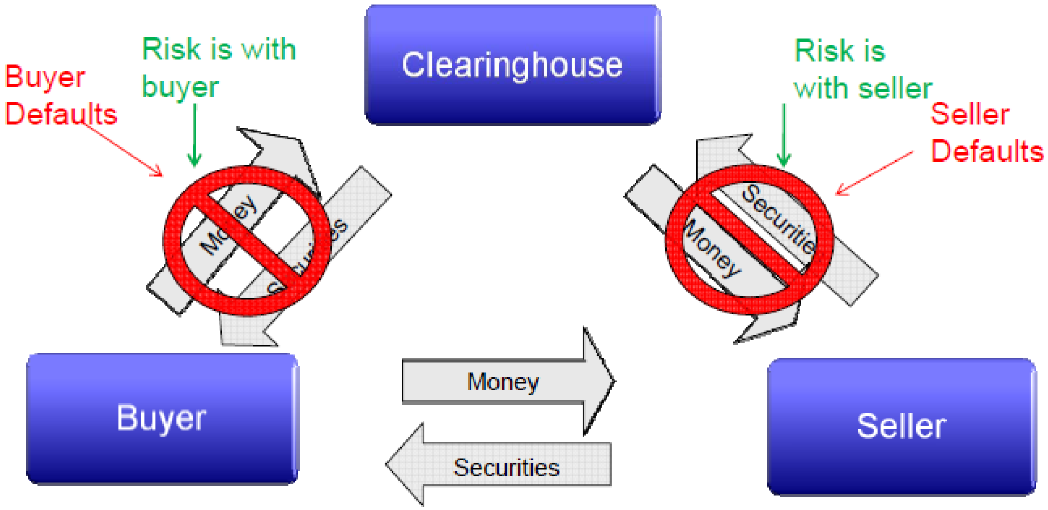
- *One of their biggest worries is the issue of margin, and the long-held concern that, as more OTC derivatives volume is pushed into a central clearing environment, commercially operated CCPs might undercut each other on margin to win business, so threatening the stability of the system...*
- *But the report only noted that **CCPs clearing OTC derivatives may need "more complex models and methodologies" to calculate risk exposure and margin requirements**, adding that the margin methodology "should be reviewed periodically by a qualified, independent internal group or third party".*

CCR Measurement in a Clearing House

- Settlement risk: in OTC transactions arises is either one of the two counterparties to fails to deliver on its obligation.
- A clearinghouse faces settlement risk as it retains its obligations toward the counterparty which has not defaulted
- In this context, the main responsibility of a clearinghouse is to retain enough capital, or have enough collateral so that can always meet its obligations towards

  counterparties that

  have not defaulted

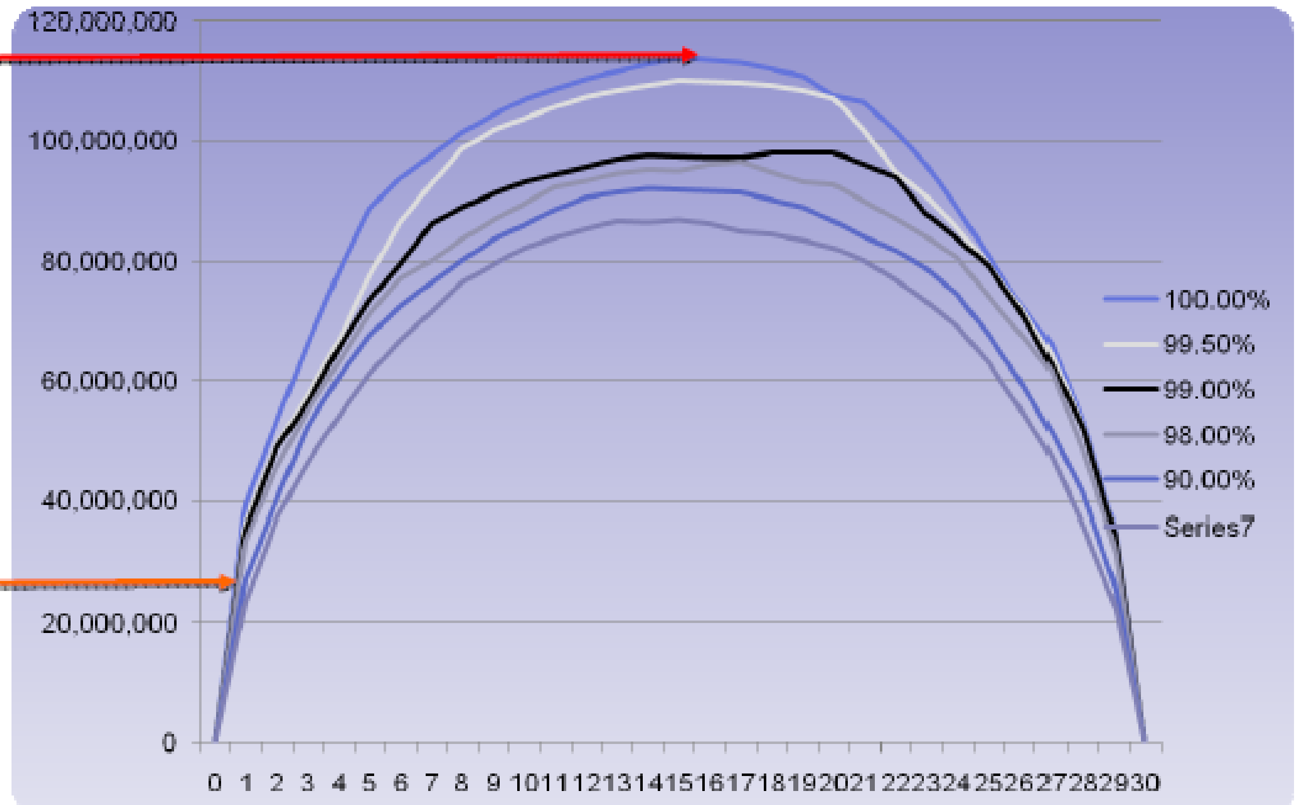


CCR Measurement in a Clearing House

- The clearinghouse's risk profile is obtained by simulating combinations of counterparty defaulting across different market scenarios
  - WWR has a big impact, but cannot simultaneously affect all counterparties

Maximum exposure Across any combination of simultaneous counterparty defaults

Maximum exposure if only one counterparty defaults



Summary

1. Market and credit risk are fundamentally interconnected in the trading book
2. Pricing of counterparty credit risk has is fairly recent and there is some way to go to define, understand, measure, and hedge
3. Wrong-way risk has proven to be real and has a significant impact on valuation and risk calculations (EC)
4. Allocation of counterparty credit risk (CVA and capital) has proven to be challenging and has important practical applications for managing, pricing and hedging CCR
5. Clearing houses CCR measurement requires detailed modelling of the CP positions, margins and a portfolio approach

Dan Rosen

Dr. Dan Rosen is the CEO and co-founder of ***R^2 Financial Technologies*** and acts as an advisor to institutions in Europe, North America, and Latin America on derivatives valuation, risk management, economic and regulatory capital. In addition, he is a visiting fellow at the ***Fields Institute*** *for Research in Mathematical Sciences* and an adjunct professor at the ***University of Toronto****'s Masters program in Mathematical Finance*.

Dr. Rosen lectures extensively around the world on financial engineering, enterprise risk and capital management, credit risk and market risk. He has authored numerous papers on quantitative methods in risk management, applied mathematics, operations research, and has coauthored two books and various chapters in risk management books (including two chapters of *PRMIA*'s Professional Risk Manger Handbook). In addition, Dr. Rosen is a member of the Industrial Advisory Boards of the *Fields Institute* and the *Center for Advanced Financial Studies* at the *University of Waterloo*, the Academic Advisory Board of *Fitch*, the Advisory Board, Educational and Credit Risk Steering Committees of the *IAFE* (International Association of Financial Engineers), the regional director in Toronto of *PRMIA* (Professional Risk Management International Association), and a member of the *Oliver Wyman Institute*. He is also one of the founders of *RiskLab*, an international network of research centers in Financial Engineering and Risk Management, initiated at the University of Toronto.

Up to July 2005, Dr. Rosen had a successful ten-year career at *Algorithmics Inc*., where he held senior management roles in strategy and business development, research and financial engineering, and product marketing. In these roles, he was responsible for setting strategic direction, new initiatives and alliances; the design and positioning of credit risk and capital management solutions, market risk tools, operational risk, and advanced simulation and optimization, as well as their application to industrial settings.

He holds an M.A.Sc. and Ph.D. in Chemical Engineering from the University of Toronto.

Selected Recent Publications

- Rosen D. and Saunders D. 2010, Structured Finance Valuation and Risk Management with Implied factor Models, in Advances in Credit Derivatives, Bloomberg Publications (forthcoming)
- Nedeljkovic, J., Rosen D. and Saunders D. 2010, Pricing and Hedging CLOs with Implied Factor Models, Journal of Credit Risk, forthcoming
- Rosen D. and Saunders D. 2009, Valuing CDOs of Bespoke Portfolios with Implied Multi-Factor Models, Journal of Credit Risk, Fall Issue
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- Rosen D. and Saunders D. 2010, Computing and Stress Testing Counterparty Credit Risk Capital, in Counterparty Credit Risk Modelling, (ed. E. Canabarro), Risk Books
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