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ERM Symposium
April 2009

Q1-Advances in Credit Risk Quantification

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Deutsche Insurance Asset Management: Credit Fundamentals & ERM

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April 2009

Deutsche Insurance Asset Management
Deutsche Bank Group

Summary

Fundamentals are important in current market environment and within ERM specifically

Current credit market characterized by:

- Multiple factors have a disproportion impact on risk
- Government policy taking a major role
- Historically extreme level of volatility

Given market backdrop, fundamental analysis and insights can assist in two ways:

- Measurement. Fundamentals can provide valuable insight in accessing market risk variables in their inclusion in ERM measurement
- Management. Fundamentals can provide tactical insights and assistance in the management of risk within an ERM framework

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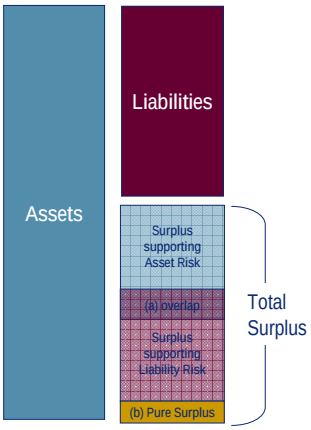
ERM – Overall thoughts

1. ERM remains a vital aspect of risk measurement and management
   - Facilitates the capital optimization process within Financial Institutions
2. Difficulties within risk measurement aspects of ERM are a consequence of the unique market environment:
   - Higher levels of volatility persist while remaining resistant to mean reversion tendencies
   - Credit ratings are not telling the whole risk story
   - Markets are in imbalance and signals/inputs from key market factors are conveying misleading conclusions
3. Fundamental analysis provides input alternatives to the process while allowing tactical insights

ERM - Vital aspect of risk measurement and management

Overview of the goal of ERM – minimize required surplus



- Surplus exists to support risk from assets and liabilities
- Diversification provides benefits, particularly among risks with negative correlation
  - Allows for "overlap" whereby no capital is needed to support either risk
  - Frees up surplus that would otherwise be needed to support risk
- "Pure Surplus" is the ultimate goal of ERM and ALM, allowing management to:
  - To take on additional risk to generate additional return
  - Return surplus to shareholders and improve return on surplus

ERM - Vital aspect of risk measurement and management

Objectives of ERM

For our purposes, ALM is the subset of ERM focused on specific risks to the balance sheet, primarily interest rates and equity returns

Measure risk

- Risk exposure of different facets of the enterprise (primarily assets and liabilities)
  - By risk category
  - In aggregate

Assess capital needs

- Surmise amount of capital that should be maintained to support the chosen level of risk
- Capital costs money
- Lines of business, products, or other segments that take on more risk need more capital and should pay for it

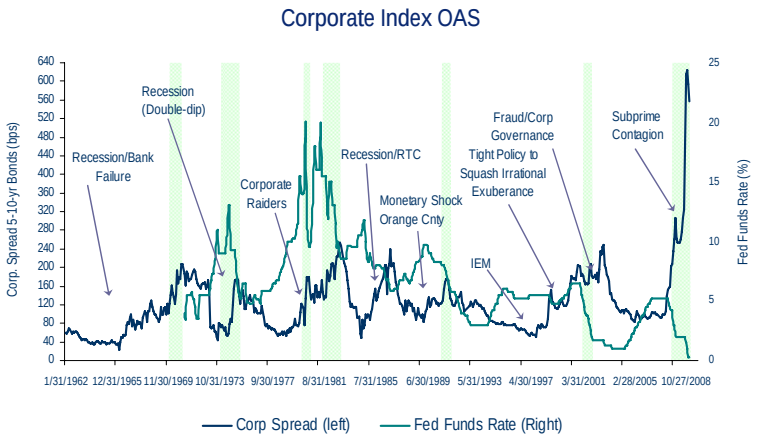
Establish or modify investment behavior to minimize net risk

Identify areas where risks have less than perfect positive correlation; these are the sources of diversification and correlation benefits

ERM risk measurement difficulties: Unique market environment

Where we are in Investment Grade Corporate Credit

Like most markets, credit risks has increased significantly and in some markets have reached historically peak levels



Source: Barclay's Capital

ERM risk measurement difficulties: Unique market environment

Where we are in Investment Grade Corporate Credit

Even looking at more constrained time periods which will better adjust for volatility, the move higher in risk remains significant

Source: Barclay's Capital

ERM risk measurement difficulties: Unique market environment

Continuing risk factors support further dislocations

Persistent economic and fundamental deterioration

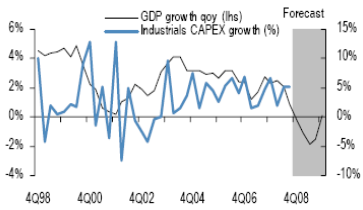
Systemic risk concerns persist

Continued deleveraging

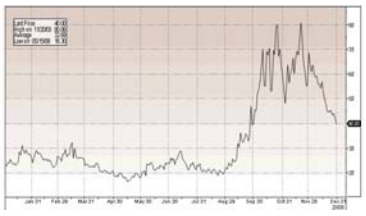
- Banks
- Consumer

Technicals continue to skew markets

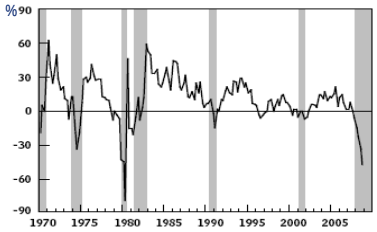
Weak GDP leads to expected decline in CAPEX



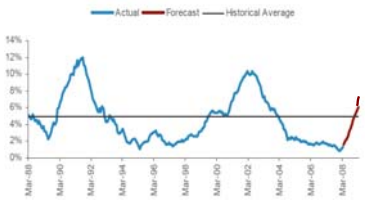
Volatility (VIX Index*) remains elevated



Banks willingness to lend sharply lower**



Moody's Default Levels increasing



Sources: Federal Reserve, Conference Board, U of Michigan, Congressional Budget Office, Bloomberg, Capital IQ, JP Morgan, Moody's

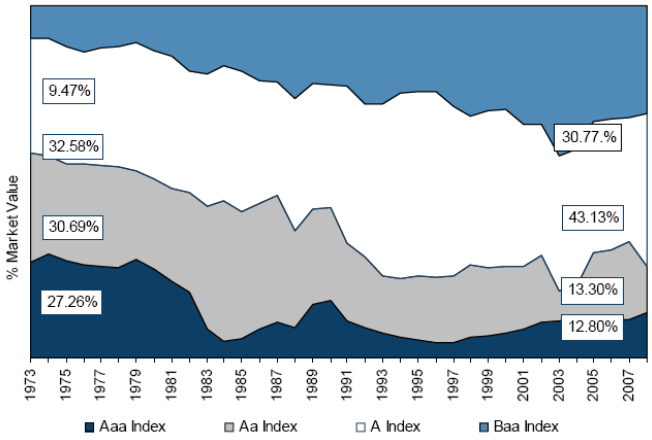
*The GDP Gap is the difference between real (inflation-adjusted) GDP and its estimated potential level (which corresponds to a high level of resource – labor and capital – use)

** Report on willingness to make consumer installment loans as reported in Fed's, *Senior loan Officer Opinion survey on Bank Lending Practices*

ERM risk measurement difficulties: Unique market environment

Degrading of credit quality

Quality analysis of Barclays Capital credit index
1973 - 2008



Source: Barclays Capital

ERM risk measurement difficulties: Unique market environment

Ratings are not telling the whole story

- Risk as measured by credit ratings are now showing to be more procyclical
  - Potentially less reliable for the ultimate risk embedded within securities
- Risk reflected within ratings seem be more backward looking
- Questions the historic loss rates which have been very stable for a very long period of time

Average Cumulative Credit Loss Rates by Letter Rating, 1982-2007 [1]

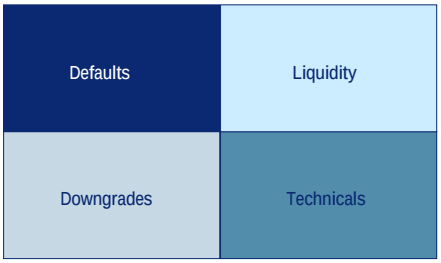
Rating	Year 1	Year 2	Year 3	Year 4	Year 5
Aaa	0.000	0.000	0.000	0.001	0.034
Aa	0.000	0.008	0.033	0.050	0.107
A	0.012	0.046	0.119	0.195	0.263
Baa	0.103	0.289	0.514	0.844	1.099
Ba	0.677	1.928	3.519	4.856	6.305
B	2.908	6.460	9.424	11.664	13.274
Caa-C	11.145	17.666	22.753	26.050	32.346
Investment Grade	0.037	0.106	0.211	0.338	0.462
Speculative Grade	2.775	5.605	8.092	9.885	11.468
All Rated	0.971	1.923	2.749	3.365	3.887

[1] *Data are in percent based on issuer-weighted average default rate and on issuer-weighted average senior unsecured bond recovery rates.*

ERM risk measurement difficulties: Unique market environment

Many risk factors are driving the market

Although markets are reflecting increasing levels of credit risk, there are more risk factors present in the market which is driving assets pricing (and some of these factors are playing a dominant role)



ERM risk measurement difficulties: Unique market environment

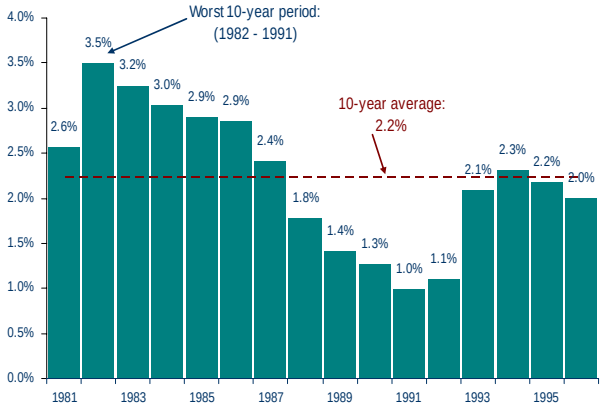
The downside is priced in

Peak defaults were 10% starting in 1982 for a 10-year period

Assuming a 35% recovery this equates to a spread of 36bps

Current spread levels are reflecting a default rate greater than 40% with a 0% recovery

If prices are reflecting one aspect of risk and ratings may be under representing risk, then does the truth lie in between?



Source: JP Morgan

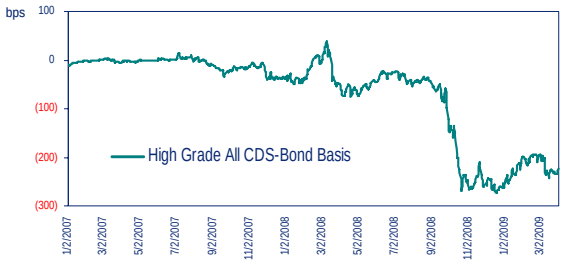
ERM risk measurement difficulties: Unique market environment

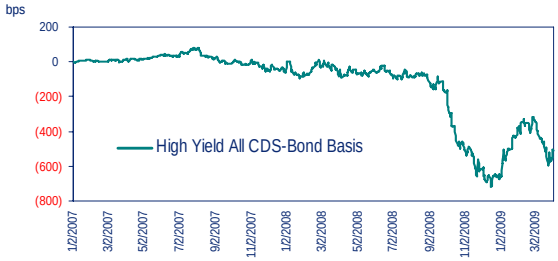
But the market is not telling the whole story

Moves in CMBX as it relates to cash CMBS

CMBX moves as it relates to Corporate REITS

The Basis of CDS and Cash





Source: JP Morgan

ERM risk measurement difficulties: Unique market environment

We understand the challenges of effective ERM

- It is very difficult to identify meaningful correlations between claim liabilities and assets
  - Contractual terms (assets) compared to risk transfer (claims)
  - Lack of sufficient historical data
  - Highly homogenous (assets) compared to highly heterogeneous (claims)
  - Optionality of liabilities is difficult to assess (Life Companies)
- Correlations tend to break down in periods of economic stress – in collapse scenarios all correlations move to 100%
- Catastrophic conditions tend to invalidate most simple models
- Lack of vehicles for addressing identified correlations
  - Less of an issue with derivatives
  - However, man companies effectively can't use derivatives
- Statistical theory underlying ERM is still being developed

ERM risk measurement difficulties: Unique market environment

We understand the challenges of effective ERM (cont'd)

- Outside stakeholders (analysts, ratings agencies, regulators) are gradually given credit for doing it well
- Statistical concepts are complex and require management and board education
- Analysis (and data gathering) is resource-intensive (COSTLY!)
- Generating valid scenarios is very difficult and requires significant back testing to identify inter-correlations
- *However, within ERM, fundamental analysis can qualitatively enhance risk inputs by:*

  Measurement → *Justifying sensitivity factor to some key inputs*

  Management → *Provide tactical insights to the management of risk*

Use of Fundamentals within ERM

But certain areas could require more focus

Area of increasing focus	Health of the economy Company-specific credit risk
Traditional areas of ALM focus	Interest Rates Sector allocations

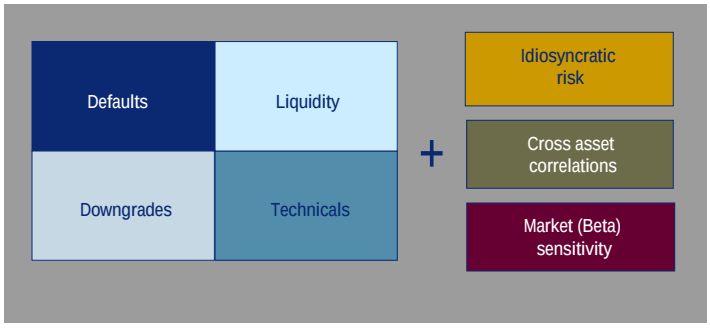
Use of Fundamentals within ERM

Finer analysis of risk factors driving market pricing

The risk dynamics underpinning credit investing have increased considerably over the last 18 months and factors must be monitored and controlled

Intensive fundamental research and ongoing relative value analysis is critical in the current environment

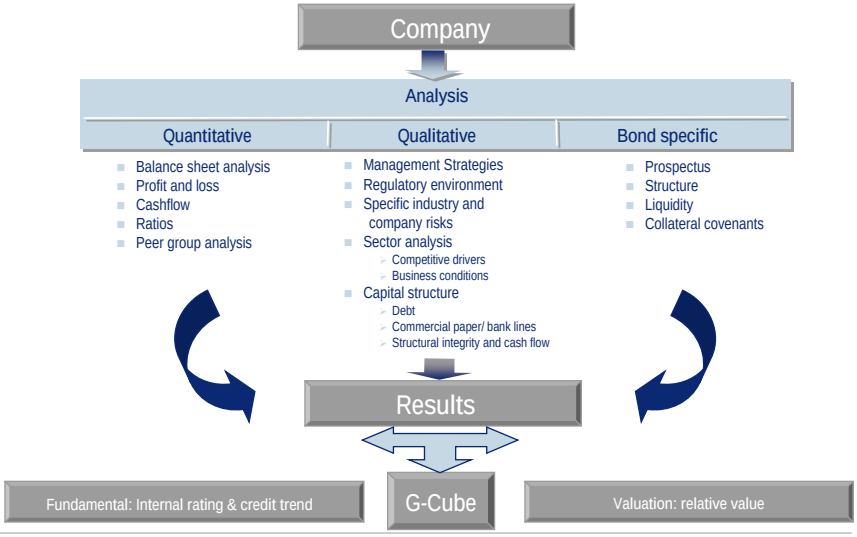
Risk Dynamics 2009



Fundamental analysis can qualitatively add value to particular risk coefficients and help differential credit from other risk factors

Use of Fundamentals within ERM

Granular approach to fundamental analysis can help...



Use of Fundamentals within ERM

...if the analysis can be measured and tracked

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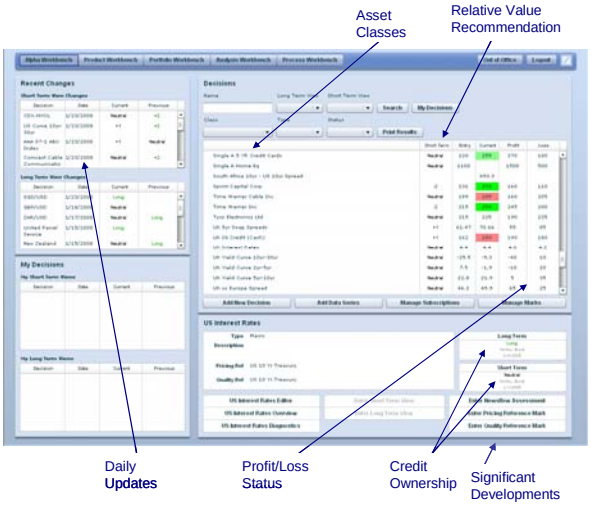
Provides an effective basis for ongoing fine-tuning of client portfolios



Source: DeAM
For illustrative purposes only. Issuers are not to be considered recommendations

Conclusions

- Market imbalances are skewing the signals from key market factors. Fundamentals can help by sensitizing key factors to some risk components:
  - Generation of Credit risk factor coefficients
  - Provide alternative sources of risk which are not currently be captured / appreciated
  - Allow qualitative context to facilitate more tactical approach to risk management
- Mindful that the inclusion of fundamental factors lacks industry wide acceptance, its
  - Qualitative appeal
  - Growing track record
  - General acceptance that number and intensity of risk factors in the market has grown considerably over the last 2 years

Should facilitate a greater inclusion in the ERM process gong forward

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Counterparty Credit Risk

Michael Pykhtin

Counterparty Credit Risk Analytics
Bank of America

ERM Symposium

Q1 – Advances in Credit Risk Quantification
Chicago; April 30, 2009

Bank of America Higher Standards

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Bank of America Higher Standards

Discussion Plan

- Counterparty credit risk and exposure
- CVA as the price of counterparty risk
- Pricing new trades with a counterparty

Bank of America Higher Standards

Counterparty credit risk and exposure

Bank of America Higher Standards

Introduction

- ***Counterparty credit risk*** is the risk that a counterparty in an ***OTC*** derivative transaction will default prior to the expiration of the contract and will be unable to make all contractual payments.
  - ***Exchange-traded*** derivatives bear no counterparty risk.
- The primary feature that distinguishes counterparty risk from lending risk is ***uncertainty of exposure*** at any future date.
  - **Loan**: exposure at any future date is the ***outstanding balance***, which is certain (not taking into account prepayments).
  - **Derivative**: exposure at any future date is the ***replacement cost***, which is determined by the market value at that date and is, therefore, uncertain.
- Since derivative portfolio value can be both positive and negative, counterparty risk is ***bilateral***.
- See **Canabarro & Duffie (2003)**, **De Prisco & Rosen (2005)** or **Pykhtin & Zhu (2007)**.

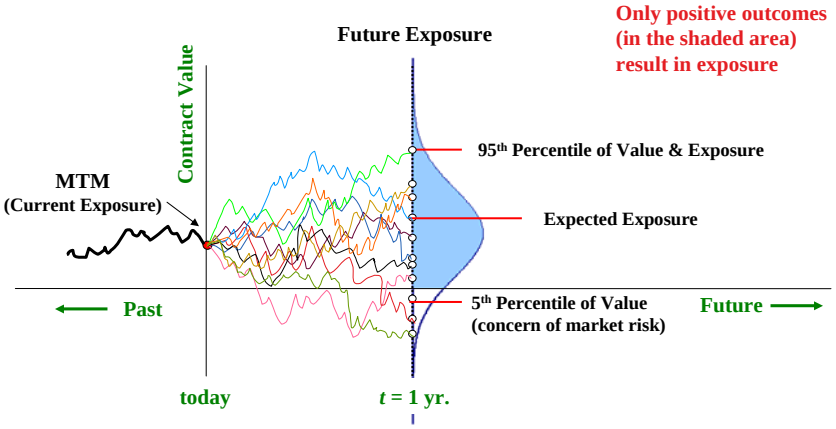
Exposure at Contract Level

- Market value of contract i with a counterparty is known only for current date $t = 0$. For any future date t, this value $V_i(t)$ is uncertain and should be assumed random.
- If a counterparty defaults at time τ prior to the contract maturity, economic loss is equal to the replacement cost of the contract
  - If $V_i(\tau) > 0$, we do not receive anything from defaulted counterparty, but have to pay $V_i(\tau)$ to another counterparty to replace the contract.
  - If $V_i(\tau) < 0$, we receive $V_i(\tau)$ from another counterparty, but have to forward this amount to the defaulted counterparty.
- Combining these two scenarios, we can specify ***contract-level exposure*** $E_i(t)$ at time t according to

$$E_i(t) = \max[V_i(t), 0]$$

Uncertainty of Future Exposure

- Future value and exposure are uncertain!



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Exposure at Counterparty Level

- ***Counterparty-level exposure*** at future time t can be defined as the economic loss experienced by the bank if the counterparty defaults at time t under the assumption of no recovery.
- If counterparty risk is not mitigated in any way, ***counterparty-level*** exposure equals the sum of ***contract-level*** exposures

$$E(t) = \sum_i E_i(t) = \sum_i \max[V_i(t), 0]$$

- If there are ***netting agreements***, derivatives with positive value at the time of default offset the ones with negative value within each netting set NS_k, so that ***counterparty-level exposure*** is

$$E(t) = \sum_k E_{\mathrm{NS}_k}(t) = \sum_k \max\left[\sum_{i \in \mathrm{NS}_k} V_i(t),\ 0\right]$$

  - Each non-nettable trade represents a netting set.

Bank of America Higher Standards

Modeling Future Counterparty Exposure

- Counterparty-level exposure distribution at future time points is usually obtained via ***Monte Carlo simulations***.
- Simulating counterparty-level exposure consists of three parts:
  - ***Scenario generation:*** simulating market risk factors (e.g., FX rates, interest rates, etc.) for a set of future time points
  - ***Valuation:*** valuing contracts at the future time points contingently on realization of market risk factors
  - ***Aggregation***: aggregating contract values to the counterparty level, taking into account all ***netting*** and ***margin*** agreements
- It is very important that aggregation is done correctly!
  - No matter how accurate scenario generation and valuation models are used, they may be invalidated by incorrect aggregation!

CVA as the price of counterparty risk

Arbitrage Pricing

- For counterparties with actively traded CDS, counterparty risk can be dynamically hedged.
- Types of hedges:
  - hedge of exposure against changes in market factors (any counterparty)
  - hedge against changes in counterparty's credit quality
  - hedge against counterparty's "jump to default"
- Therefore, the price of counterparty risk for liquid counterparties should be equal to the price of the hedging strategy.
- Thus, we have to apply arbitrage pricing (which amounts to risk neutral valuation) to counterparty risk.

Credit Value Adjustment (CVA)

- Suppose we have a portfolio of N trades with a counterparty.
- ***Credit-risk-free*** portfolio value is

$$V(t) = \sum_{i=1}^{N} V_i(t)$$

- Let us assume that we cannot default (***unilateral*** pricing).
- Since counterparty can default, the actual portfolio value $V^{CR}(t)$ (i.e., the amount one would pay to assume this portfolio with this counterparty) is ***less than*** the risk free value: $V^{CR}(t) < V(t)$
- The difference between the two quantities

$$\mathrm{CVA}(t) = V(t) - V^{CR}(t)$$

is known as ***credit value adjustment*** (CVA).

CVA as Expected Loss

- CVA is the price of counterparty credit risk.
  - Comprehensive references include: **Arvanitis & Gregory (2001)**, **Brigo and Masetti (2005)** and **Picoult (2005)**.
- CVA can be calculated as the ***risk neutral expectation of the discounted loss*** over the life of the longest transaction T

$$\mathrm{CVA}(0) = \mathrm{E}^{Q}\left[1_{\{\tau \le T\}} (1-R) \frac{B_0}{B_\tau} E(\tau) \right]$$

where

- τ is the counterparty's default time
- R is the counterparty-level recovery rate
- $E(t)$ is the counterparty-level exposure at time t
- B_t is the value of the money market account at time t

Expected Exposure is Conditional on Default!

- Assuming idiosyncratic recovery R, we can write

$$\mathrm{CVA}(0) = (1-\bar{R}) \int_0^T d\,\mathrm{PD}(t)\ \mathrm{E}^{Q}\left[\frac{B_0}{B_t} E(t) \,\middle|\, \tau = t \right]$$

where $\mathrm{PD}(t)$ is the ***risk neutral*** probability of default between today (time 0) and t

- **Important**: expectation under the integral is conditional on default at time t.
- Let us assume that both exposure and money market account are ***independent*** of counterparty credit state (there is no ***wrong-way risk***). Then, the conditioning is immaterial and we have

$$\mathrm{CVA}(0) = (1-R) \int_0^T d\,\mathrm{PD}(t)\ \mathrm{E}^{Q}\left[\frac{B_0}{B_t} E(t) \right]$$

Practical Approach to Calculating CVA

- CVA is usually calculated by approximating integral by sum:

$$\mathrm{CVA}(0) \approx (1-R)\sum_{j=1}^{J}\left[\mathrm{PD}(t_j)-\mathrm{PD}(t_{j-1})\right]\mathrm{EE}^{*}(t_j)$$

where $\mathrm{EE}^{*}(t)$ is counterparty-level ***discounted risk neutral EE***

$$\mathrm{EE}^{*}(t)=\mathrm{E}^{Q}\left[\frac{B_0}{B_t}E(t)\right]$$

and $\{t_j\}_{j=1}^{J}$ is a fixed set of dates.

- Counterparty-level risk neutral EE is typically impossible to calculate in closed form for non-trivial cases.
- Instead, $\mathrm{EE}^{*}(t_j)$ at each date t_j is usually obtained by calculating the expectation via Monte Carlo simulation of exposure

Pricing new trades with a counterparty

Pricing on Stand-Alone Basis (No Netting)

- If the new trade is ***not nettable***, stand-alone pricing can be applied
- Let us denote the ***risk-free*** price of the new trade with premium x at time t by $V_{\text{new}}(t;x)$
  - Fair counterparty-risk-free value of the trade at time zero is $V_{\text{new}}(0,0)$
- Assuming no netting, the ***credit-adjusted*** value is

$$V_{\text{new}}^{\text{CR}}(t;x) = V_{\text{new}}(t;x) - \text{CVA}_{\text{new}}(t;x)$$

  where $\text{CVA}_{\text{new}}(t;x)$ is the stand-alone CVA of the new trade
- Pricing new trade means finding premium $\bar{x}$ such that

$$V_{\text{new}}(0;\bar{x}) - \text{CVA}_{\text{new}}(0;\bar{x}) = V_{\text{new}}(0;0)$$

Portfolio Pricing for New Trades

- Suppose, we have a ***nettable*** portfolio of derivatives with a counterparty and we want to add a new trade
- The price of counterparty risk of the new trade is calculated as the ***incremental contribution*** to the portfolio CVA

$$\Delta\text{CVA} = \text{CVA}(\text{Portfolio} + \text{New Trade}) - \text{CVA}(\text{Portfolio})$$

- The fair value $\bar{x}$ of credit risk premium x is calculated from

$$V_{\text{new}}(0,\bar{x}) - \Delta\text{CVA}(0,\bar{x}) = V_{\text{new}}(0,0)$$

  - If the new trade reduces portfolio CVA, then ΔCVA is negative and the trade is priced at a discount (i.e., negative $\bar{x}$) to the risk-free price!
- See ***Chapter 6*** in **Arvanitis and Gregory (2001)** for details

References

- **A. Arvanitis & J. Gregory, 2001,** "Credit: The Complete Guide to Pricing, Hedging and Risk Management", Risk Books
- **D. Brigo & M. Masetti, 2005,** *Risk Neutral Pricing of Counterparty Risk* in "Counterparty Credit Risk Modelling" (M. Pykhtin, ed.), Risk Books
- **E. Canabarro & D. Duffie, 2003,** *Measuring and Marking Counterparty Risk* in "Asset/Liability Management for Financial Institutions" (L. Tilman, ed.), Institutional Investor Books
- **B. De Prisco & D. Rosen, 2005,** *Modelling Stochastic Counterparty Credit Exposures for Derivatives Portfolios* in "Counterparty Credit Risk Modelling" (M. Pykhtin, ed.), Risk Books
- **E. Picoult, 2005,** *Calculating and Hedging Exposure, Credit Value Adjustment and Economic Capital for Counterparty Credit Risk* in "Counterparty Credit Risk Modelling" (M. Pykhtin, ed.), Risk Books
- **M. Pykhtin and S. Zhu, 2007,** *A Guide to Modelling Counterparty Credit Risk* GARP Risk Review, July/August, pages 16-22