Credit Risk Transfer and Credit Risk Management

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IXIS Corporate and Investment Bank

Credit Markets Symposium: Effectiveness of Credit Risk Markets in Allocating Risk
Charlotte, March 22-23, 2007

Agenda

I. Credit Portfolio Management

II. Sourcing / Mitigating Credit Risk Using Credit Derivatives and Securitization

I. Credit Portfolio Management

A New Paradigm:"Underwrite & Distribute"

A New Business Model: "Principal Finance"

Transformation of Credit Business

A New “Securities” Model For Credit

ORIGINATE & HOLD

UNDERWRITE & DISTRIBUTE

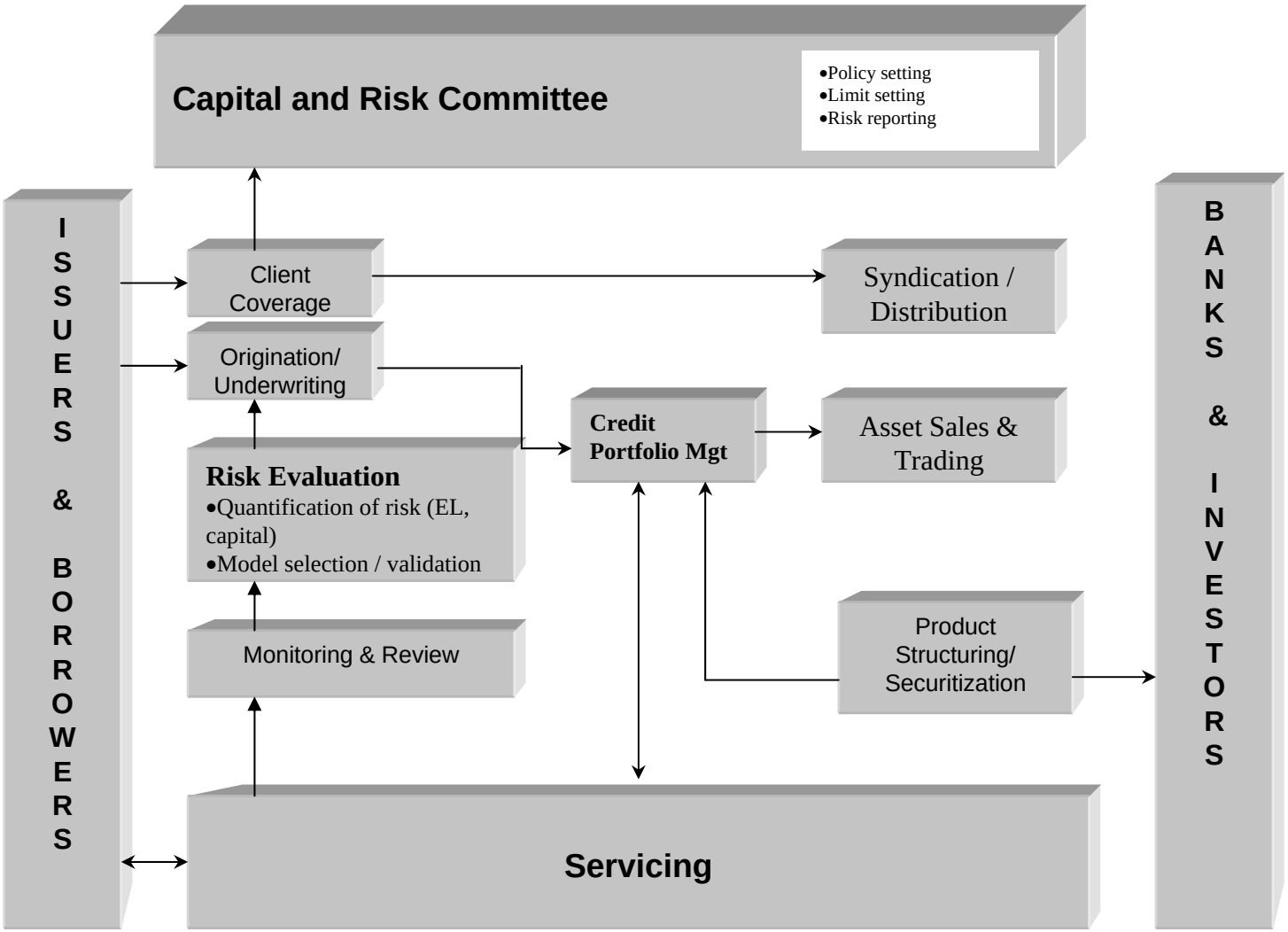
Increase Balance Sheet Turnover

- ***Concentrate on Origination, Distributing and Servicing Loans***
  - ***Banks have built solid business relationships***
  - ***Banks have huge complex back-offices that facilitate the efficient servicing of loans***
  - ***Banks have strong distribution networks that allow them to dispose of financial assets to retail and institutional investors either directly or through structured products***
  - ***Banks have developed a strong expertise in analyzing and structuring credits***

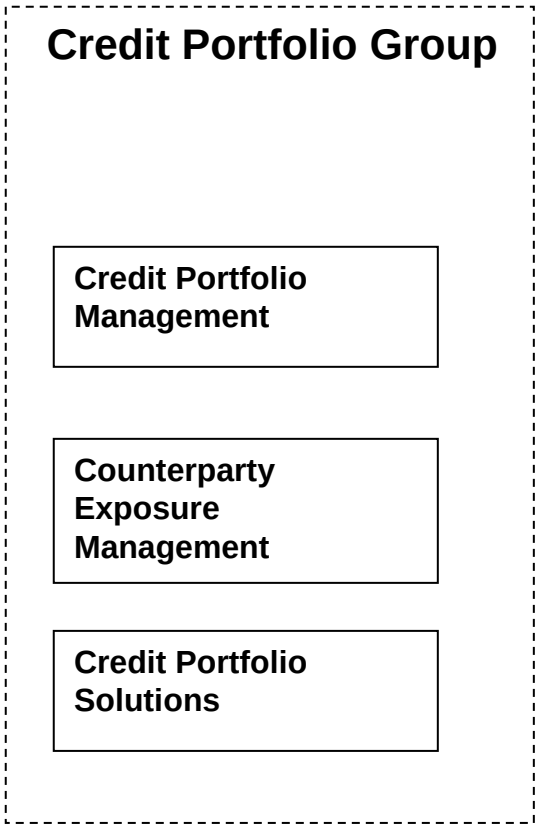
Changes in the Approach to Credit

	Traditional Credit Function	Porfolio-Based Approach
Investment strategy	**Originate and Hold**	**Underwrite and Distribute**
Ownership of the credit assets	**Business Unit**	**Portfolio Management or Business Unit / Portfolio Mgmt**
Risk measurement	**Use notional value of the loan Model only losses due to default**	**Use risk based capital Model losses due to default and risk migration (MTM)**
Risk Management	**Use a binary approval process at origination**	**Apply risk return decision making process**
Basis for compensation for loan origination	**Volume**	**Risk-Adjusted Performance**
Pricing	**Grid**	**Risk Contribution**

Originate to Sell Model



Credit Portfolio Management



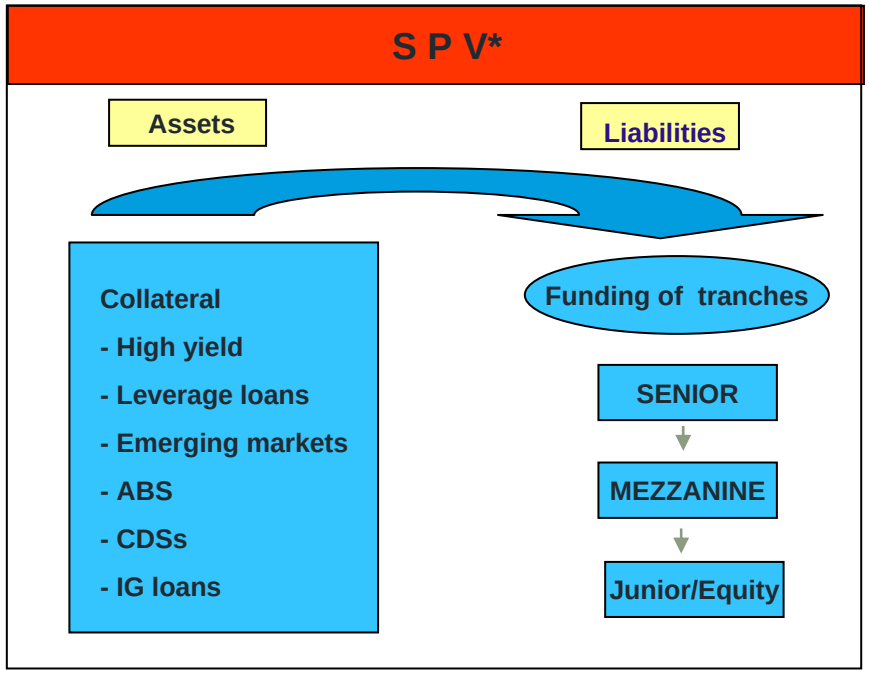
- **Increases the velocity of capital**
- **Reduces concentration and event risk**
- **Increase return on economic capital**
- **Responsible for financials, but not a profit center**

- **Hedges and trades retained Credit Portfolio**
- **Houses "public-side" Research Analysts, Portfolio Managers, Traders**

- **Manages counterparty risk of derivatives exposures**

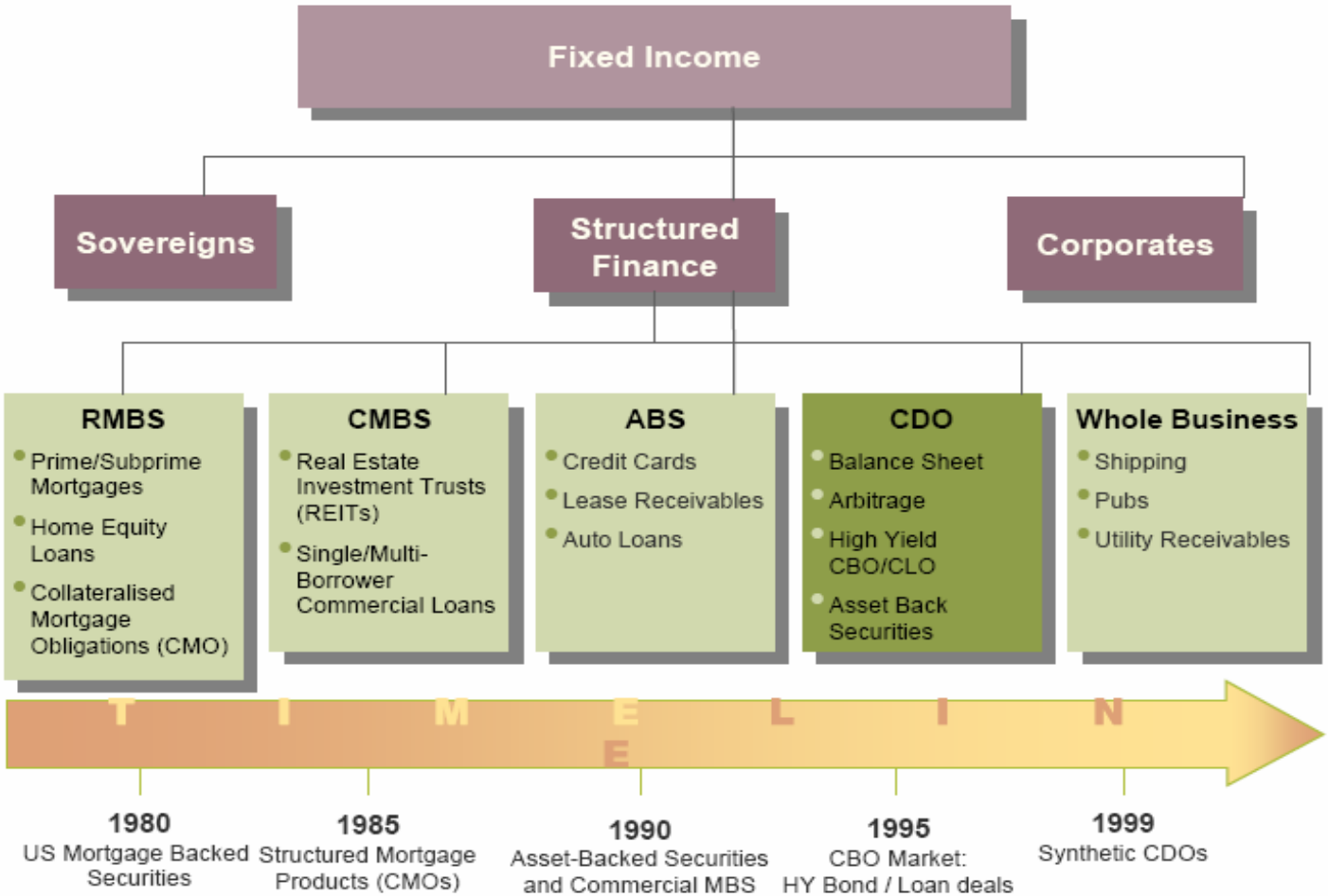
- **Provides advice to originators on structuring and credit risk mitigation**

Basics of Securitization



* Special Purpose Vehicule

Basics of Securitization

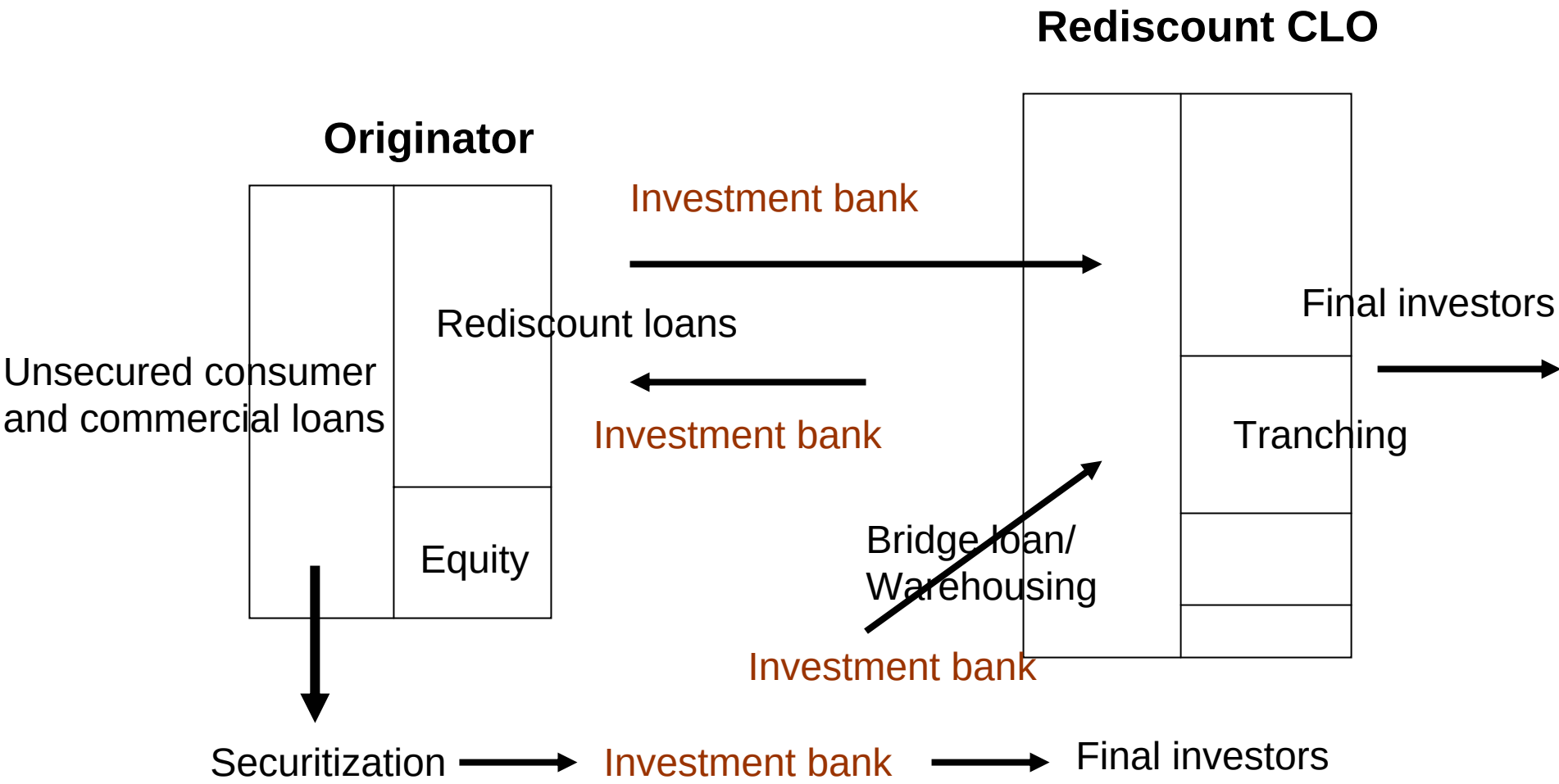


Transformation of Credit Business

A New “Business” Model For Credit

ORIGINATE & HOLD → UNDERWRITE & DISTRIBUTE → PRINCIPAL FINANCE

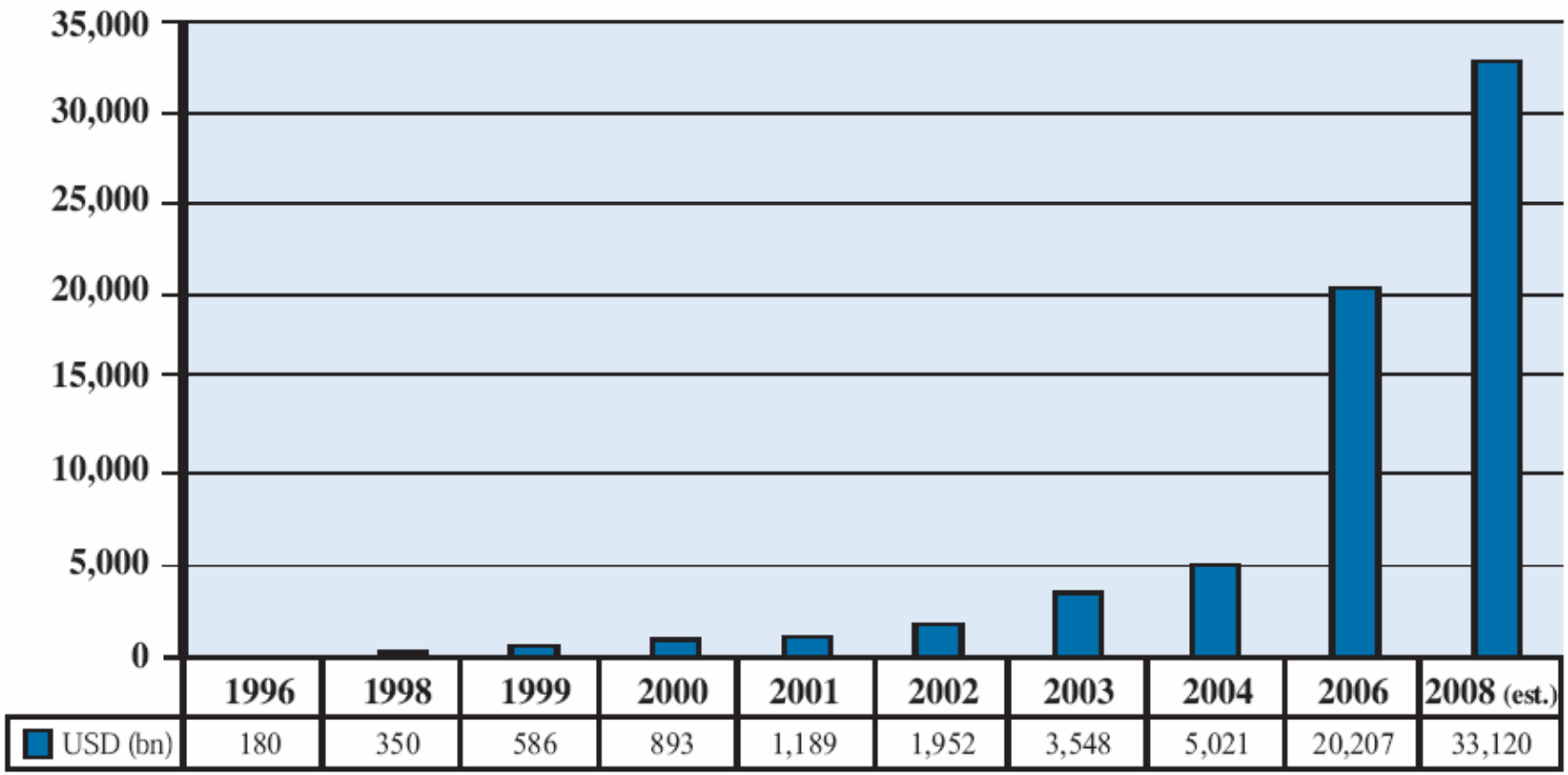
Principal Finance: An example



Rediscount loans: revolving credit facilities that finance originators (on a non-recourse basis) of secured and unsecured consumer loans, subprime mortgages, commercial real estate loans and commercial loans.

II. Sourcing / Mitigating Credit Risk Using Credit Derivatives and Securitization

The Credit Derivatives Market



	1996	1998	1999	2000	2001	2002	2003	2004	2006	2008 (est.)
USD (bn)	180	350	586	893	1,189	1,952	3,548	5,021	20,207	33,120

Global Credit Derivatives Market $bn

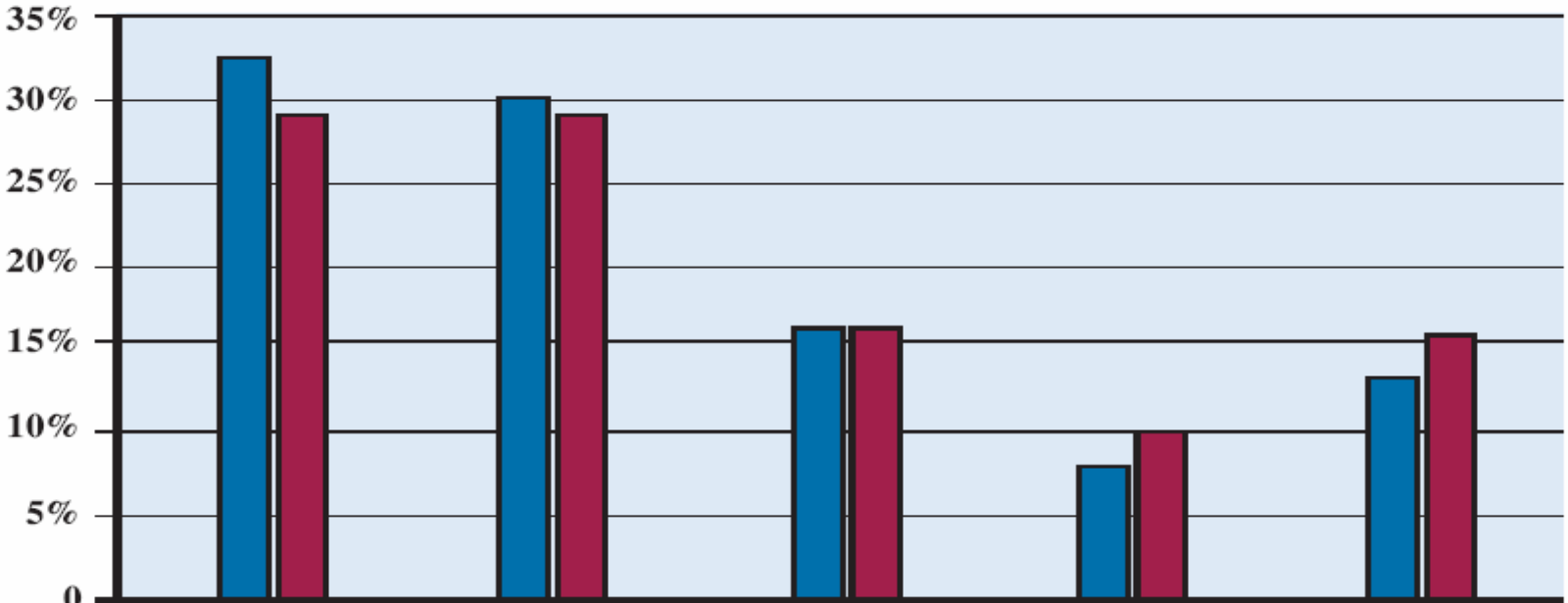
Source: BBA Credit Derivatives Survey – 2006 report

Credit Derivatives Products

Type	2000	2002	2004	2006
Basket products	6.0%	6.0%	4.0%	1.8%
Credit linked notes	10.0%	8.0%	6.0%	3.1%
Credit spread options	5.0%	5.0%	2.0%	1.3%
Equity linked credit products	n/a	n/a	1.0%	0.4%
Full index trades	n/a	n/a	9.0%	30.1%
Single-name credit default swaps	38.0%	45.0%	51.0%	32.9%
Swaptions	n/a	n/a	1.0%	0.8%
Synthetic CDOs – full capital	n/a	n/a	6.0%	3.7%
Synthetic CDOs – partial capital	n/a	n/a	10.0%	12.6%
Tranched index trades	n/a	n/a	2.0%	7.6%
Others	41.0%	36.0%	8.0%	5.7%

Source: BBA Credit Derivatives Survey – 2006 report

Credit Derivatives Products

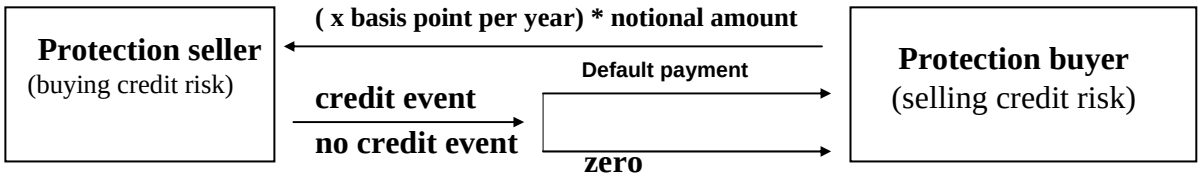


	Single-name credit default swaps	Full index trades	Synthetic CDOs	Tranched index trades	Others
End 06	33%	30%	16%	8%	13%
End 08	29%	29%	16%	10%	16%

Credit Derivatives Products

Source: BBA Credit Derivatives Survey – 2006 report

Credit Default Swaps



Credit event:

- bankruptcy, insolvency or payment default
- stipulated fall in the price of the underlying asset
- downgrade in the rating of the issuer of the underlying asset

Default payment:

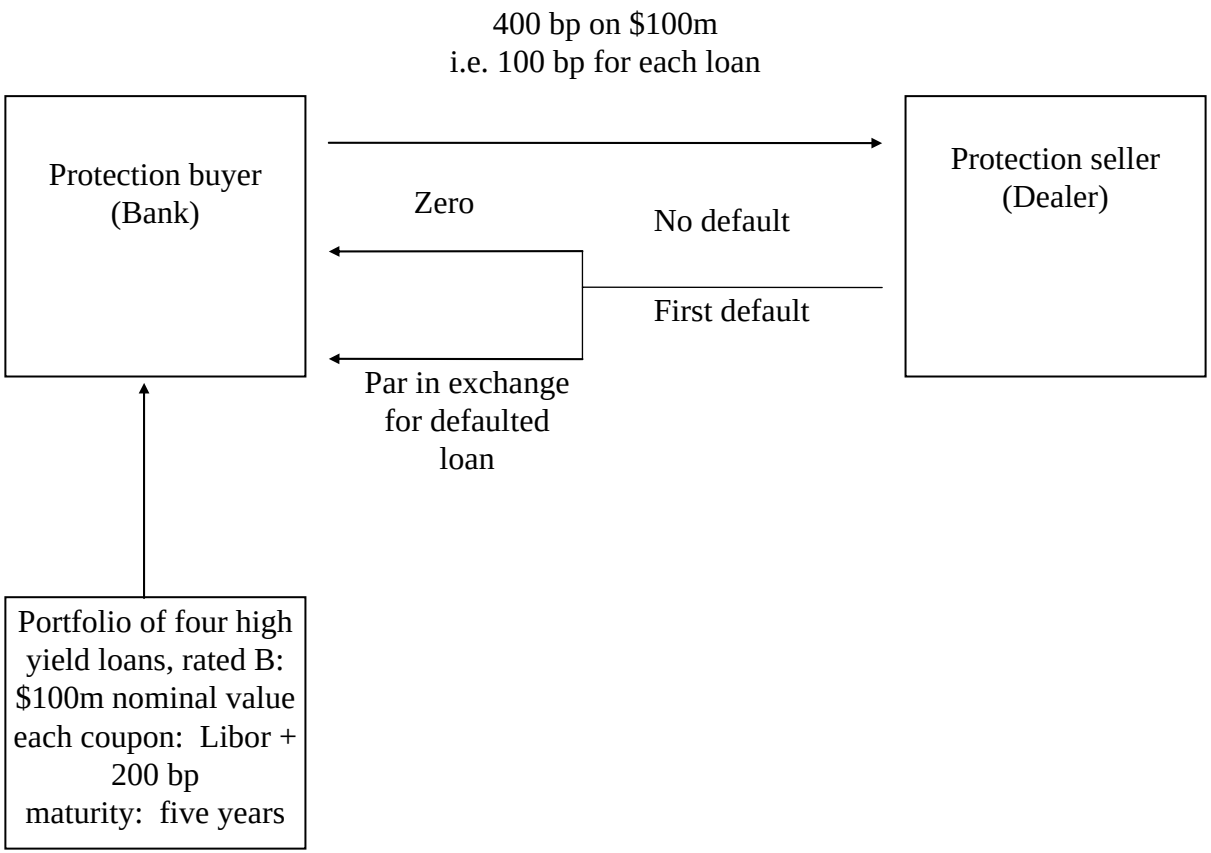
- par, minus post default price of the underlying asset as determined by a dealer poll
- par, minus stipulated recovery factor, equivalent to a predetermined amount (digital swap)
- payment of par by seller in exchange for physical delivery of the defaulted underlying asset

The Restructuring Debate: definition of credit event &"delivery option" on physical settlement

In September 2000, BoA and Chase granted an extension to Conseco on approximately $2.8 b of ST loans to prevent an immediate Conseco bankruptcy. It triggered a credit event on $2 b of CDSs. The buyer of protection played the "cheapest to deliver" game with the dealers and delivered longer term, lower priced bonds.

Basket Default Swaps

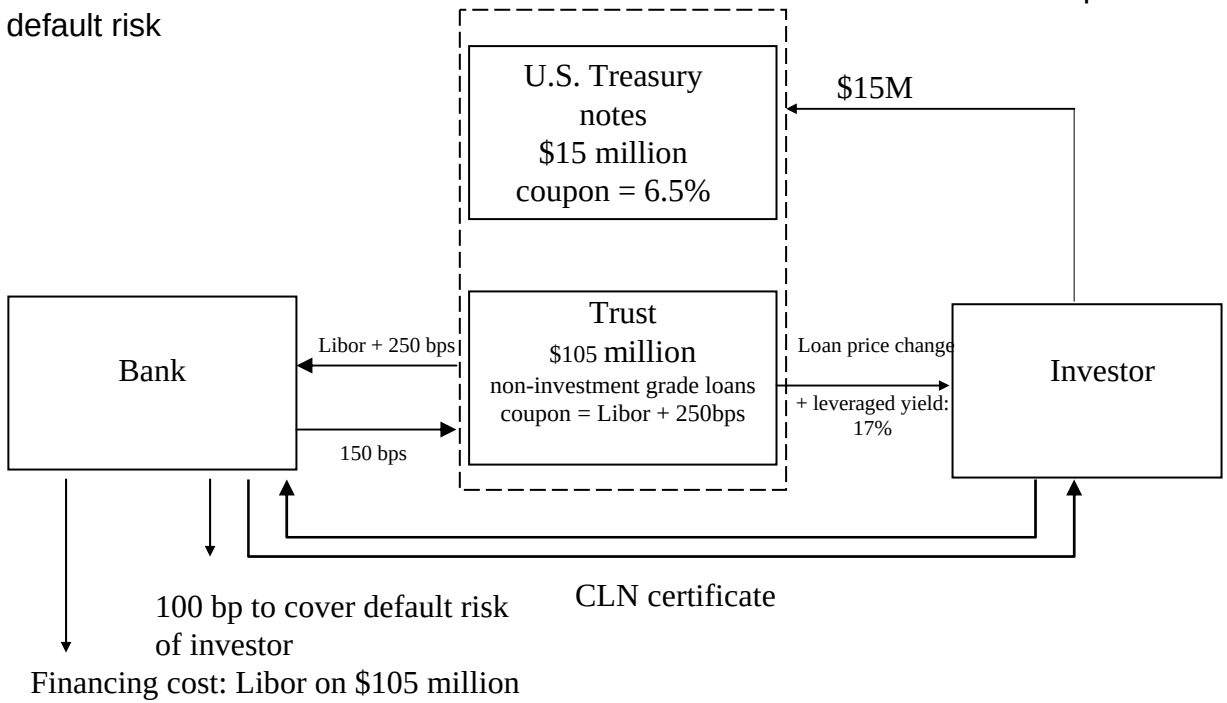
Example: First-to-Default Swap (nth-to-default as the trigger credit event)



Asset-Backed Credit-Linked Notes

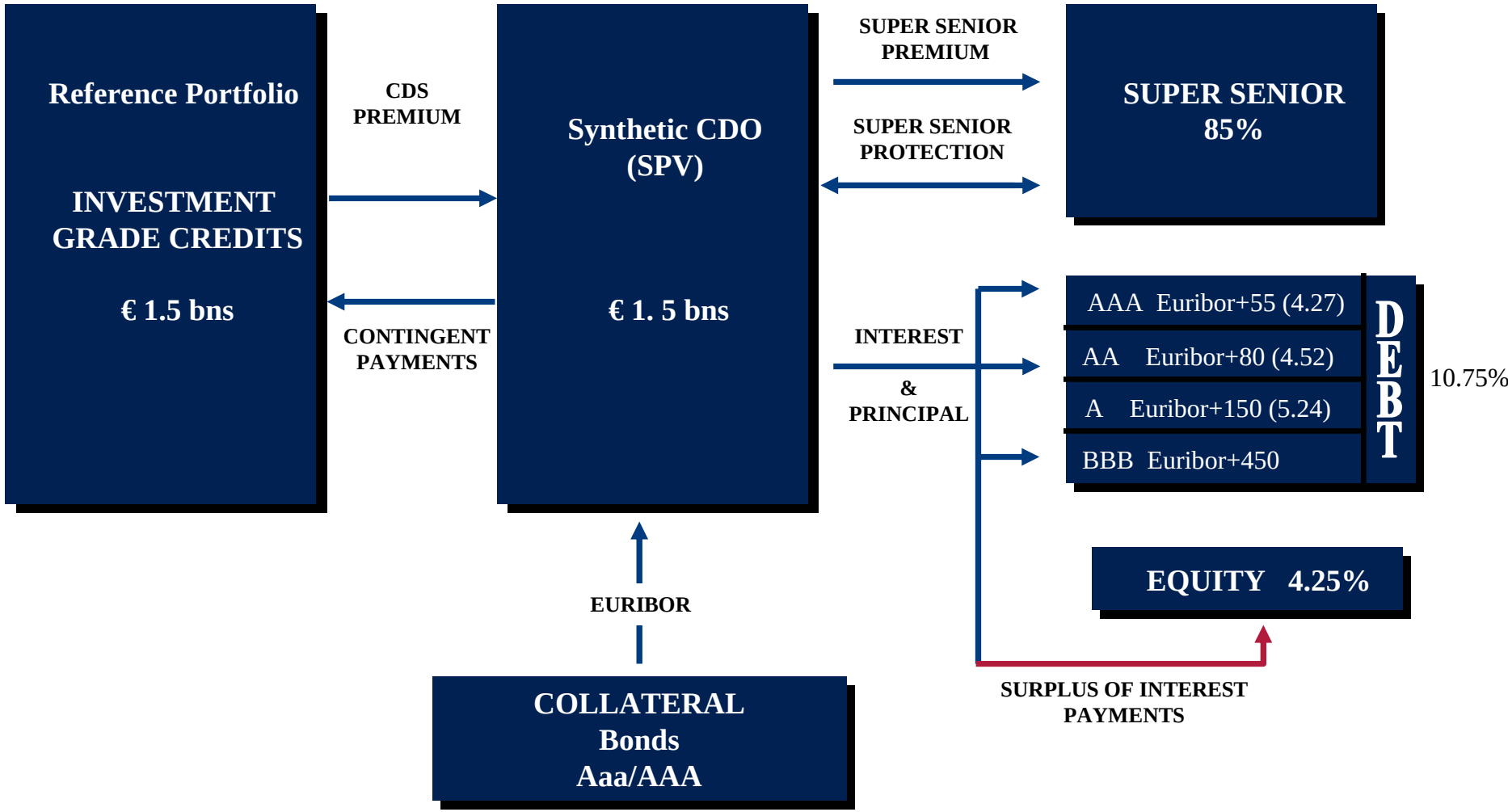
Structure:

- Investor seeks $105 million of exposure with a leverage ratio of seven, i.e. while investing only $15 million in collateral
- Investor purchases $15 million of CLN issued by a Trust
- Trust receives $105 million of non-investment grade loans which are assumed to yield Libor +250 BPS on average
- 15 million CLN proceeds are invested in U.S. Treasury notes which yield 6.5%
- Bank finances the $105 million loans at Libor and receives from the Trust Libor + 100 bps on 105 million to cover the investor's default risk



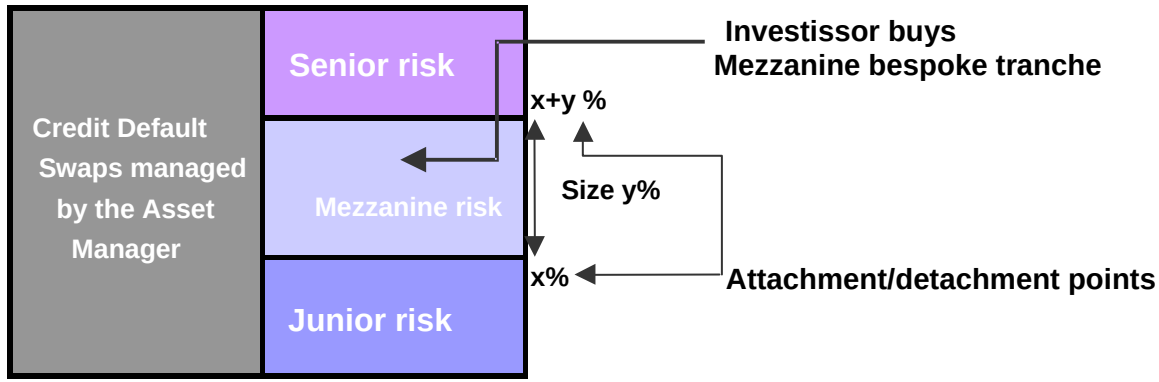
- Coupon spread on non-investment grade loans: 250 bp
- Leveraged yield: 6.5% (U.S. T-Notes) + 150 bp x 7 (leverage multiple) = 17%
- Option premium (default risk of investor = 100 bp
- Leverage: 7

Synthetic CDO : Typical Transaction

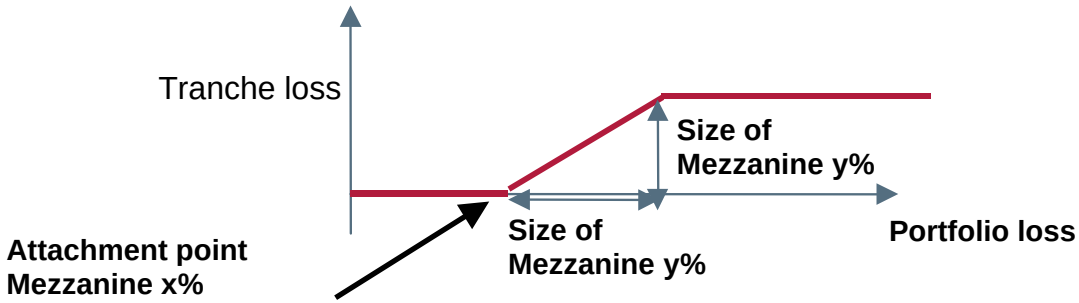


Bespoke Single Tranche CDO

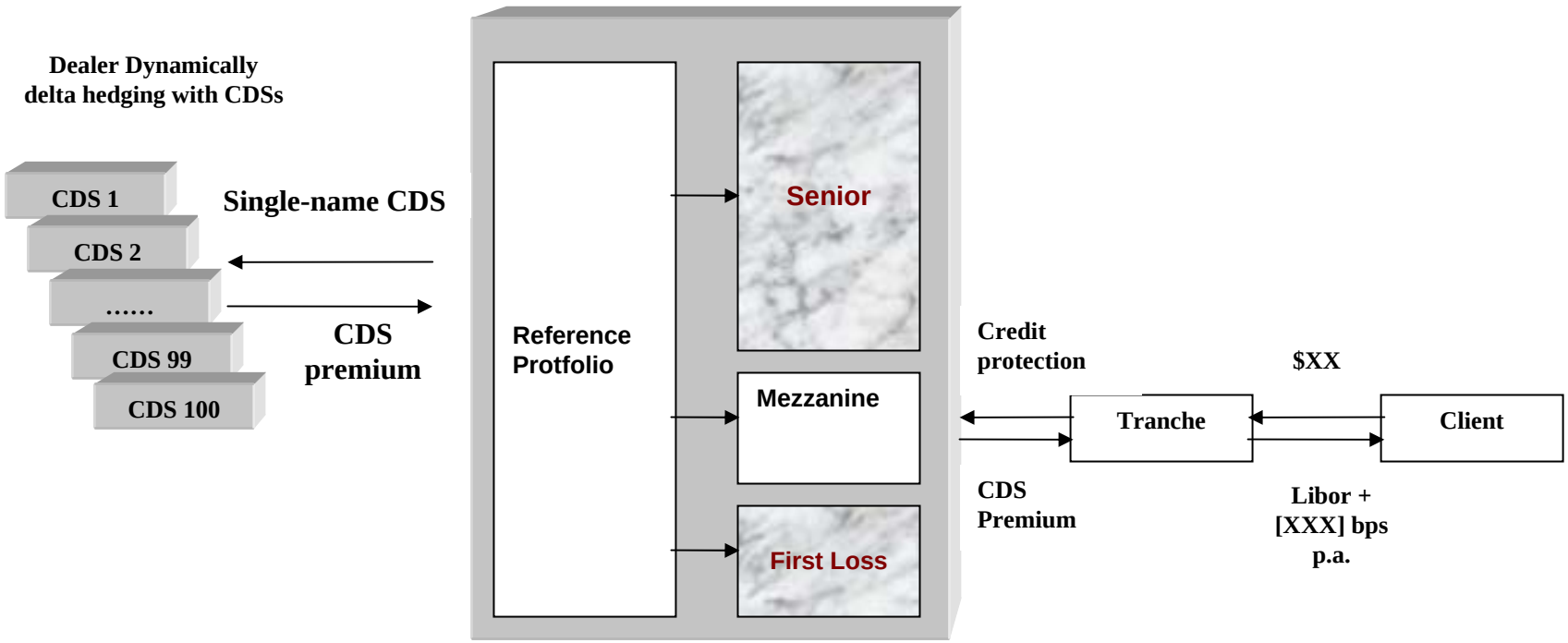
- Example of a ***mezzanine*** risk bought by an investor (the junior and senior risks being borne by the bank)



- The mezzanine tranche can be viewed as a call spread position on defaults in the underlying portfolio.



Bespoke Single Tranche CDO



Credit Default Swap Indices

Liquidity in the indicies has grown dramatically with a large pool of market makers and increased standardization

- The merger of iBoxx and Trac-X to create Dow Jones CDX in the US and iTraxx in Europe and Asia provides the market with a single family of credit derivatives indices.
- Standardization of indices is currently a significant driver of growth in the credit derivatives market.
- Multiplication of indices: ABX, CMBX,…

CDX and iTraxx: Mechanics

The DJ.CDX.NA.IG is the US benchmark for tradable 5, 7 and 10 year index products

- Static portfolio of 125 diverse names (CDSs) which are equally weighted at 0.8%.
- Tranching for CDX: 0-3% (equity tranche), 3-7%, 7-10%, 10-15%, 15-30%, 30-100%.
- Tranching for iTraxx: 0-3%, 3-6%, 6-9%, 9-12%, 12-22%, 22-100%.
- Tranching of the European and US indices is adjusted so that tranches of the same seniority receive the same rating.
- Active market for 5 and 10 year tranches.

CDX.IG

CDX.IG.7 7 market data from 1/22/07			
Maturity 12/20/13			
Protection Start	**Protection End**	**Premium**	**upFt fee**
0,00%	3,00%	5,000%	41,00%
3,00%	7,00%	1,895%	
7,00%	10,00%	0,365%	
10,00%	15,00%	0,155%	
15,00%	30,00%	0,060%	
30,00%	100,00%	0,031%	
0,00%	100,00%	0,450%	

iTraxx

Itraxx 6 - 7 market data from 1/22/07			
Maturity 12/20/13			

Protection Start	Protection End	Premium	upFt fee
0,00%	3,00%	5,000%	25,75%
3,00%	6,00%	1,120%	
6,00%	9,00%	0,338%	
9,00%	12,00%	0,163%	
12,00%	22,00%	0,054%	
22,00%	100,00%	0,021%	
0,00%	100,00%	0,320%	

iTraxx Europe Tranches

Quotation of iTraxx Europe Tranches: Series 4 - 5Y and 10Y par - BNP on November 8, 2005.

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BNP Paribas

Page 1 of 2

CDX NA IG Series 4 13:14 GMT

08-Nov-05

5Y Reference 53

Losses	Bid	Offer	Base Corr	Comp Corr	Delta
0-3%	5%+43.40%	5%+44.00%	7.7%	7.7%	19.1x
3-7%	121.0	126.0	23.3%	1.0%	6.1x
7-10%	25.0	27.5	32.3%	9.9%	1.5x
10-15%	12.0	14.0	43.9%	16.6%	0.7x
15-30%	5.5	7.0	68.3%	29.7%	0.3x

10Y Reference 76

Losses	Bid	Offer	Base Corr	Comp Corr	Delta
0-3%	5%+64.25%	5%+65.25%	6.3%	6.3%	5.5x
3-7%	703.0	718.0	13.0%	19.4%	10.6x
7-10%	136.0	143.0	23.5%	90.0%	4.6x
10-15%	64.0	70.0	36.6%	5.4%	2.2x
15-30%	20.5	23.5	67.2%	18.1%	0.8x

Trading : Tao Jin Tel: +1 212 471 8298

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2005 Bloomberg L.P.
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Pricing of CDOs

- The spread of each tranche is determined so that the risk-neutral expectation of the fixed leg is equal to the risk-neutral expectation of the loss:
  - Need to specify pricing model / risk-neutral probability;
  - Need to specify the joint default probabilities of the underlying pool of debt instruments;
  - Need a model for default correlations – the only “observable” default correlations are for standard baskets (iTraxx, CDX,…)

Pricing of Credit Derivatives

- Goal of credit derivative pricing models: assign prices to various credit-risky payoffs in a manner which is:
  - Arbitrage free
  - Consistent with market prices of benchmark instruments used for hedging (this is a calibration issue and many models don't satisfy this constraint)

Pricing of Credit Derivatives

In the case of credit risky payoffs involving an entity i the computation of

$$E^{\mathbb{Q}}[B(t,\tau_i)f(L_{\tau^i})]$$

involves knowledge of law under $\mathbb{Q}$ of two quantities:

- Time of default τ_i
- Loss given default L_{τ_i}

so two basic quantities we need to model are

- Risk-neutral conditional default probabilities:

$$q^i(t,T) \quad = \quad \mathbb{Q}(\tau_i \leq T) \tag{5}$$

- Recovery rate R defined by $L_\tau = (1-R)N$ or, in the random case, risk-neutral distribution of recovery rate.

We are looking for the joint risk-neutral distribution of time to default and loss given default.

Pricing of Credit Derivatives

« Historical » vs. « risk-neutral » probabilities

The quantity we need to price credit derivatives are risk-neutral conditional default probabilities:

$$q^i(t,T) \quad = \quad \mathbb{Q}(\tau_i \leq T) \tag{6}$$

These are NOT identical to 'objective' default probabilities forecasted, for example, using historical rating transition matrices.

The change of probability measure from 'objective' to risk-neutral measure does not leave default probabilities invariant.

Because of the a positive risk premium for default risk, risk-neutral default probabilities are in general much higher.

Pricing of Credit Derivatives

Specification of benchmark instruments

The set of benchmark instruments to which the model is calibrated is the set *relative to which* the pricing and hedging is done. This varies in different contexts:

Context	Benchmark instruments	Modeling approach
Equity-credit arbitrage	Stock/ Equity	Structural models
Pricing of CDOs	Underlying CDS	Reduced form models
Pricing of index CDO products	Standardized index tranches	Aggregate loss models

Pricing of Credit Derivatives

- Three main approaches:
  - Structural models: link credit risk to the dynamics of the balance sheet/capital structure of the firm. Debt is priced relative to equity. Credit spreads are output of the model.
  - Reduced form models: less ambitious approach that takes as given implied market information and tries to calibrate credit spreads from market prices of CDSs.The approach is not interested in the mechanism leading to default.
  - Aggregate loss models: this approach is not interested in default of individual names but only in the aggregate loss distribution.

Pricing of Credit Derivatives

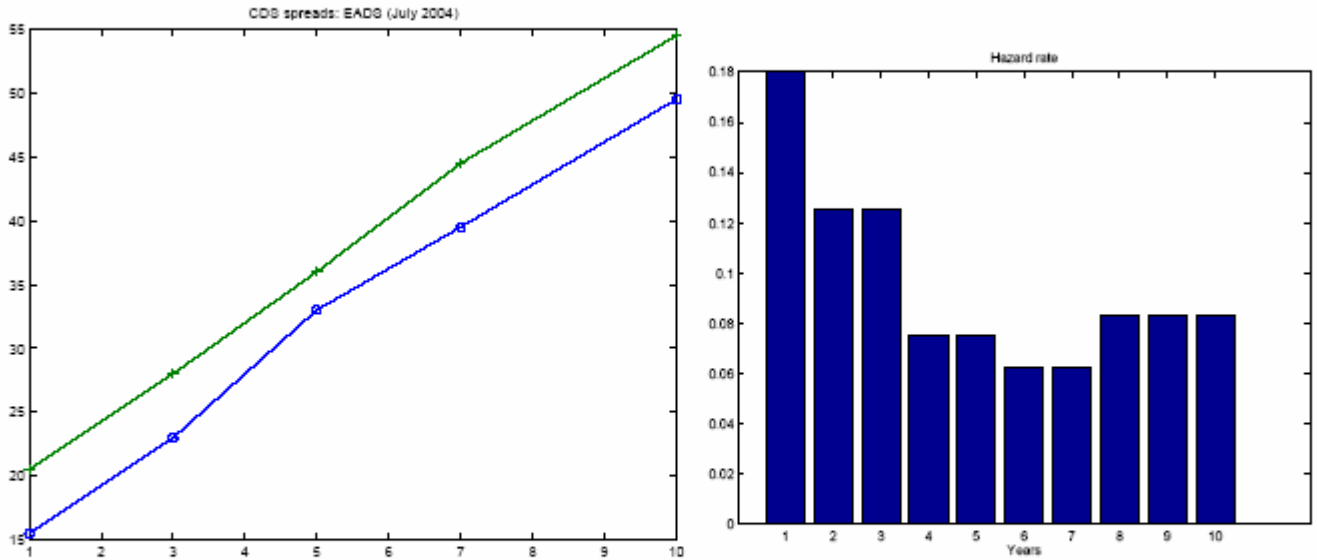


Figure 1: EADS (July 2004). Left: term structure of CDS. Right: Implied hazard rate.

Pricing of Credit Derivatives

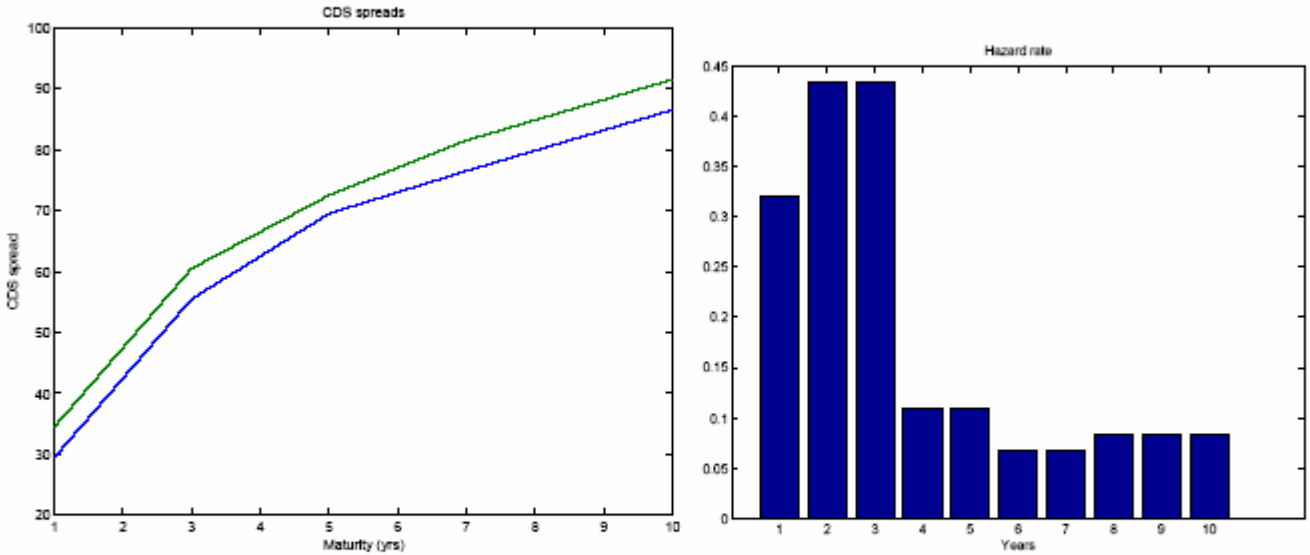


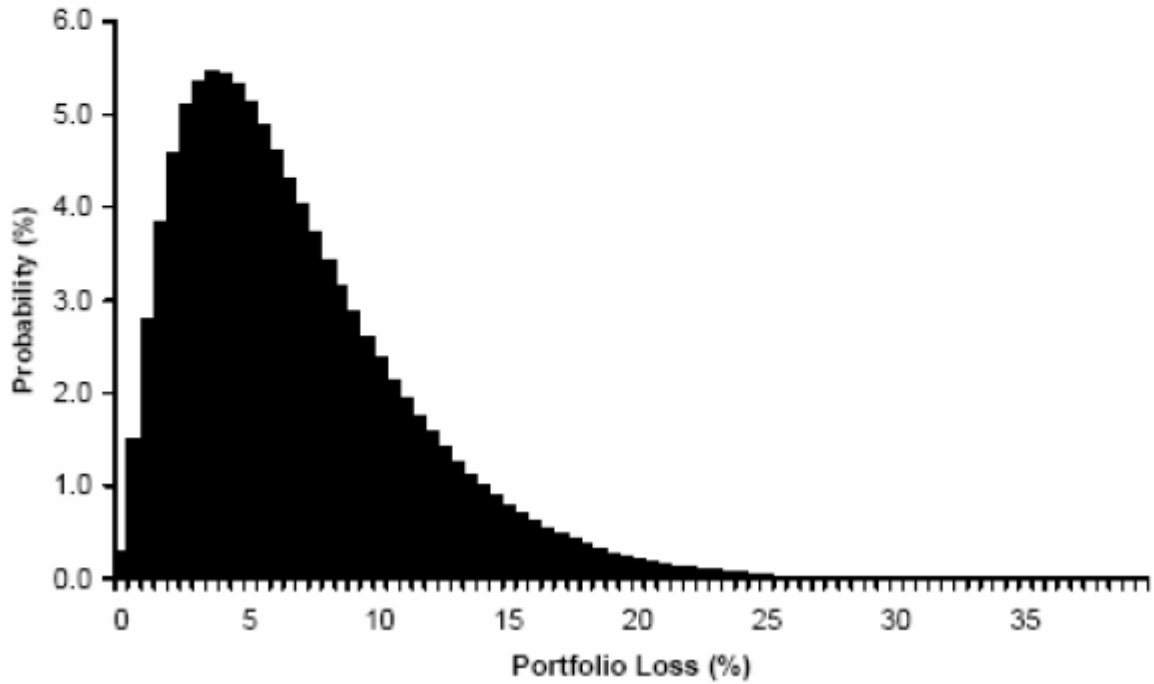
Figure 2: Volkswagen (July 2004). Left: term structure of CDS. Right: Implied hazard rate.

The Gaussian Copula Model

- Has become the market standard for quoting CDO tranche spreads
- Equivalent to the Black Scholes model for equity options
- Simple to implement, single parameter

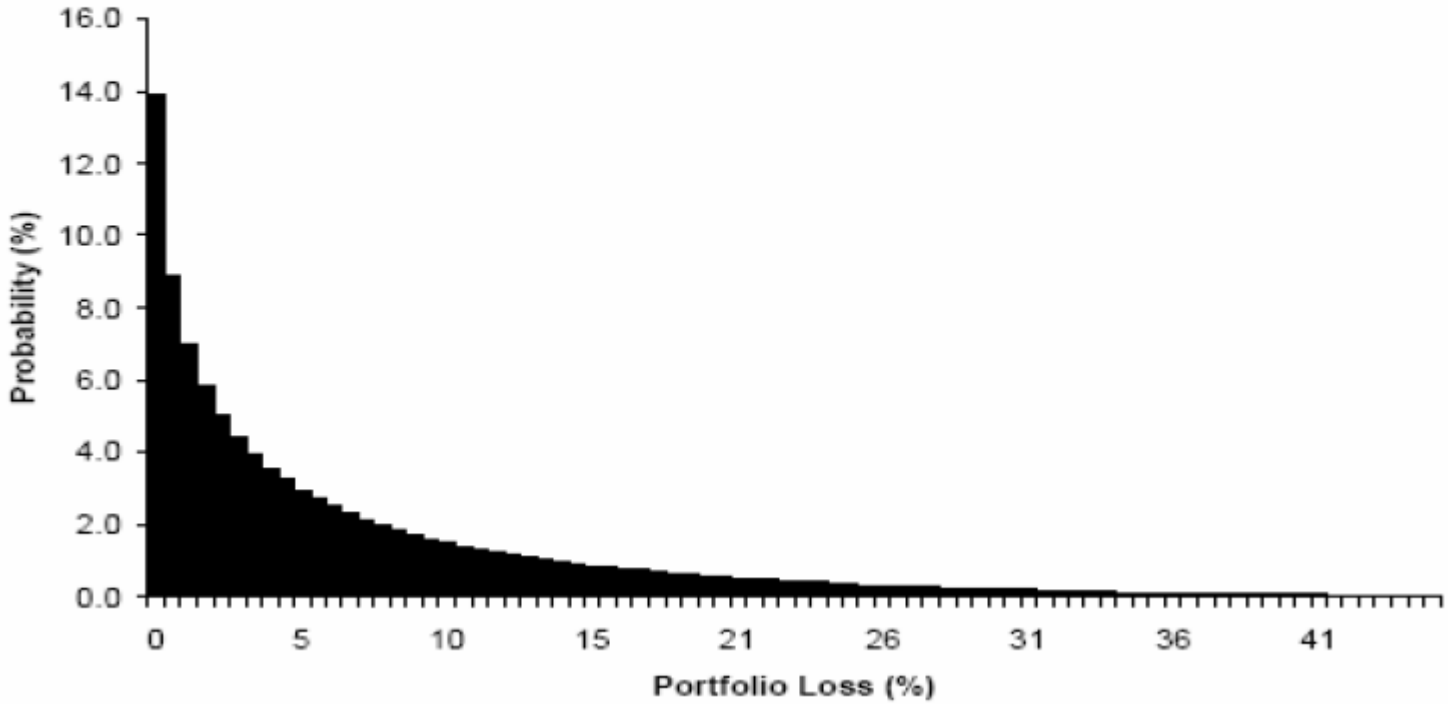
Effect of default correlation on loss distribution

Figure 32. **The Loss Distribution for a Portfolio of 100 Assets with a Default Correlation of 15%. Each Asset Has a 6-Year Default Probability of 14% and a Recovery Rate of 50%.**



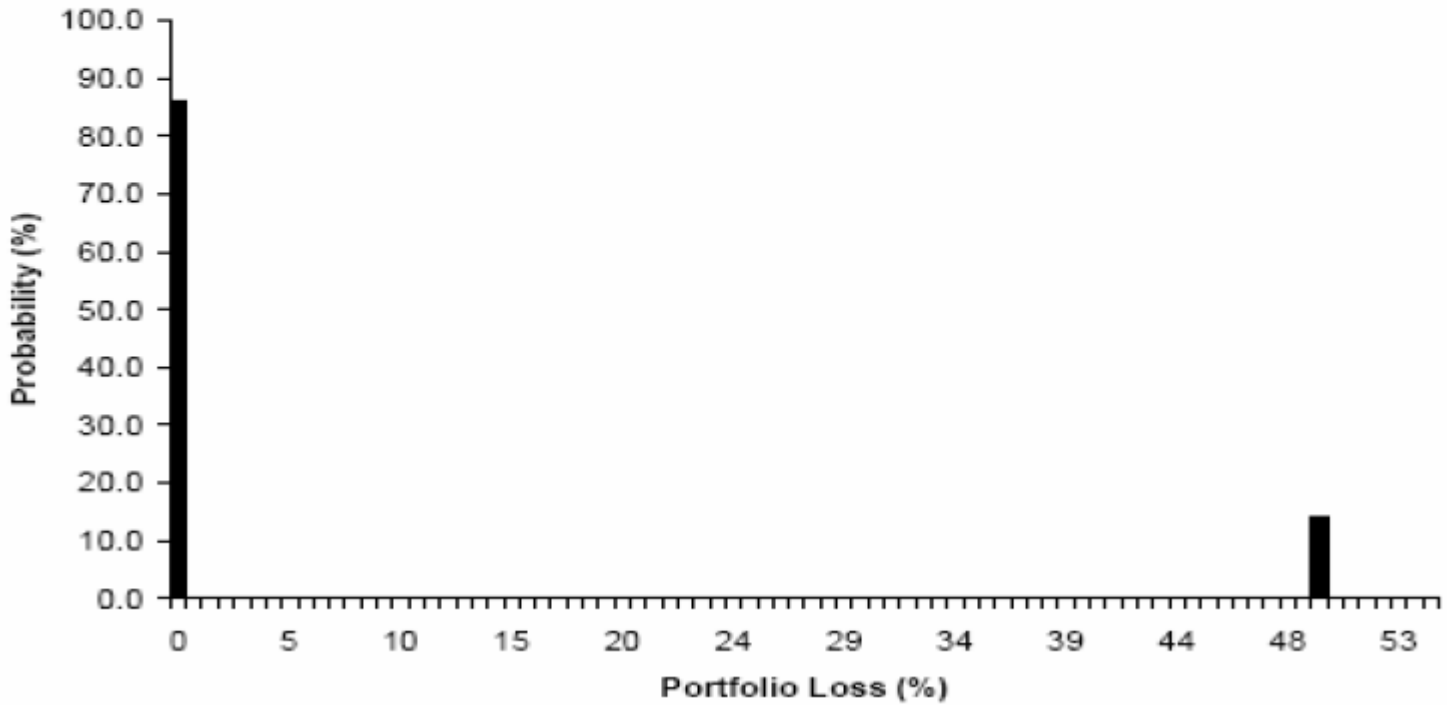
Effect of default correlation on loss distribution

Figure 33. **The Loss Distribution for a Portfolio of 100 Assets Each with a 40% Default Correlation**



Effect of default correlation on loss distribution

Figure 34. **The Loss Distribution for a Portfolio of 100 Assets with a 100% Default Correlation**

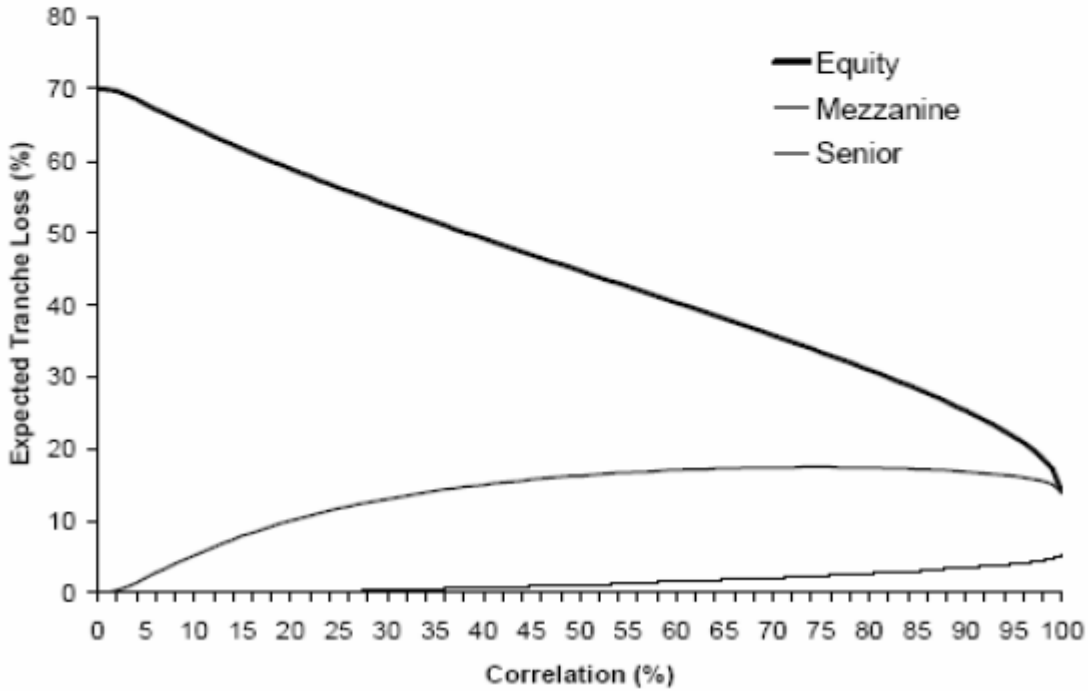


Effect of Correlation on Tranches

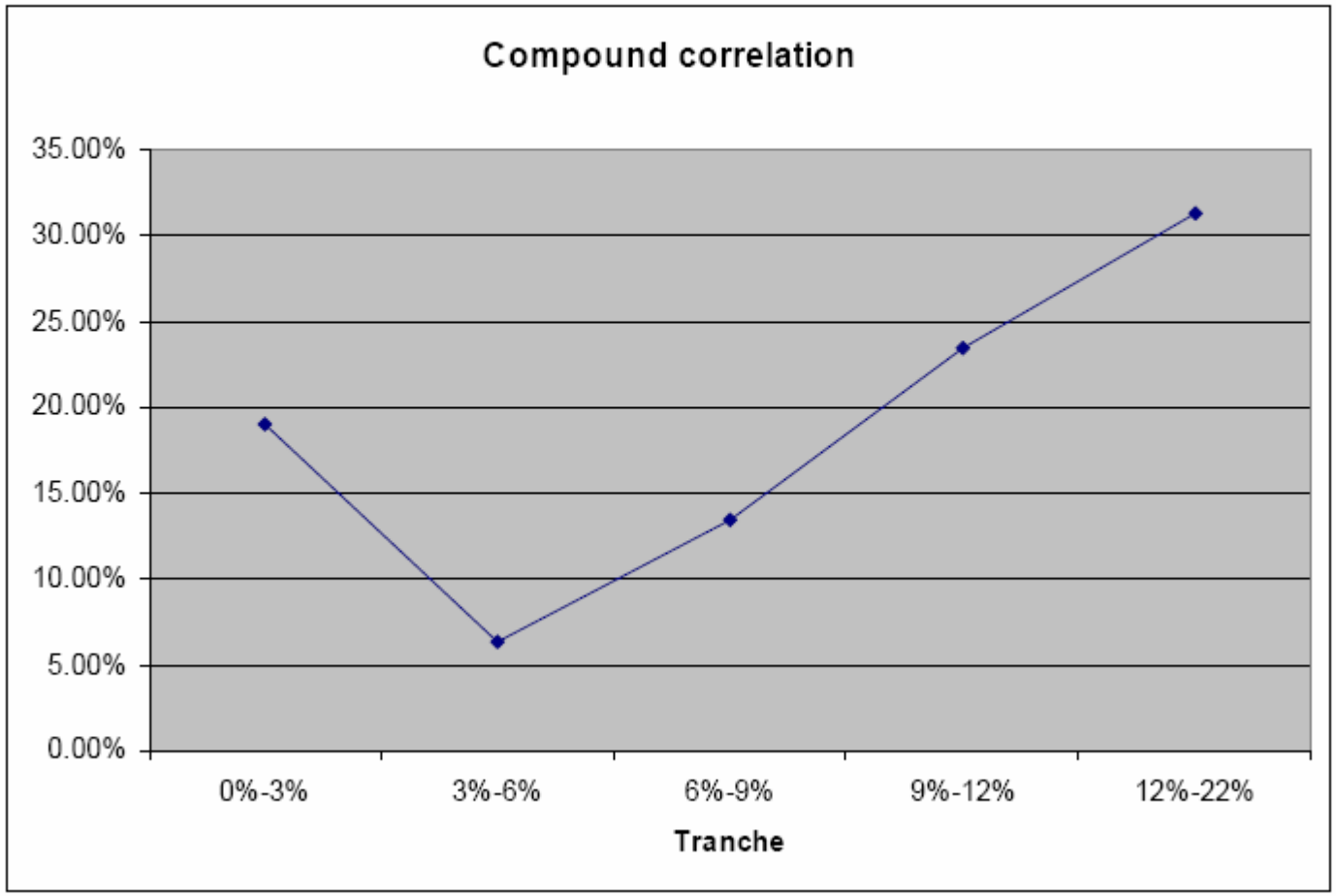
- At low correlation, there is very little likelihood that the mezzanine or senior tranche will be affected by defaults, so their expected loss is small.
- This is why senior tranches can receive high ratings even if the underlying portfolio is not investment grade.
- The higher the default correlation, the more likely it is that higher tranches will be affected by default.

Effect of correlation on tranche losses

Figure 35. **The Percentage Expected Loss of Each of the Tranches of the Portfolio as a Function of the Default Correlation Between the Assets in the Collateral Pool**

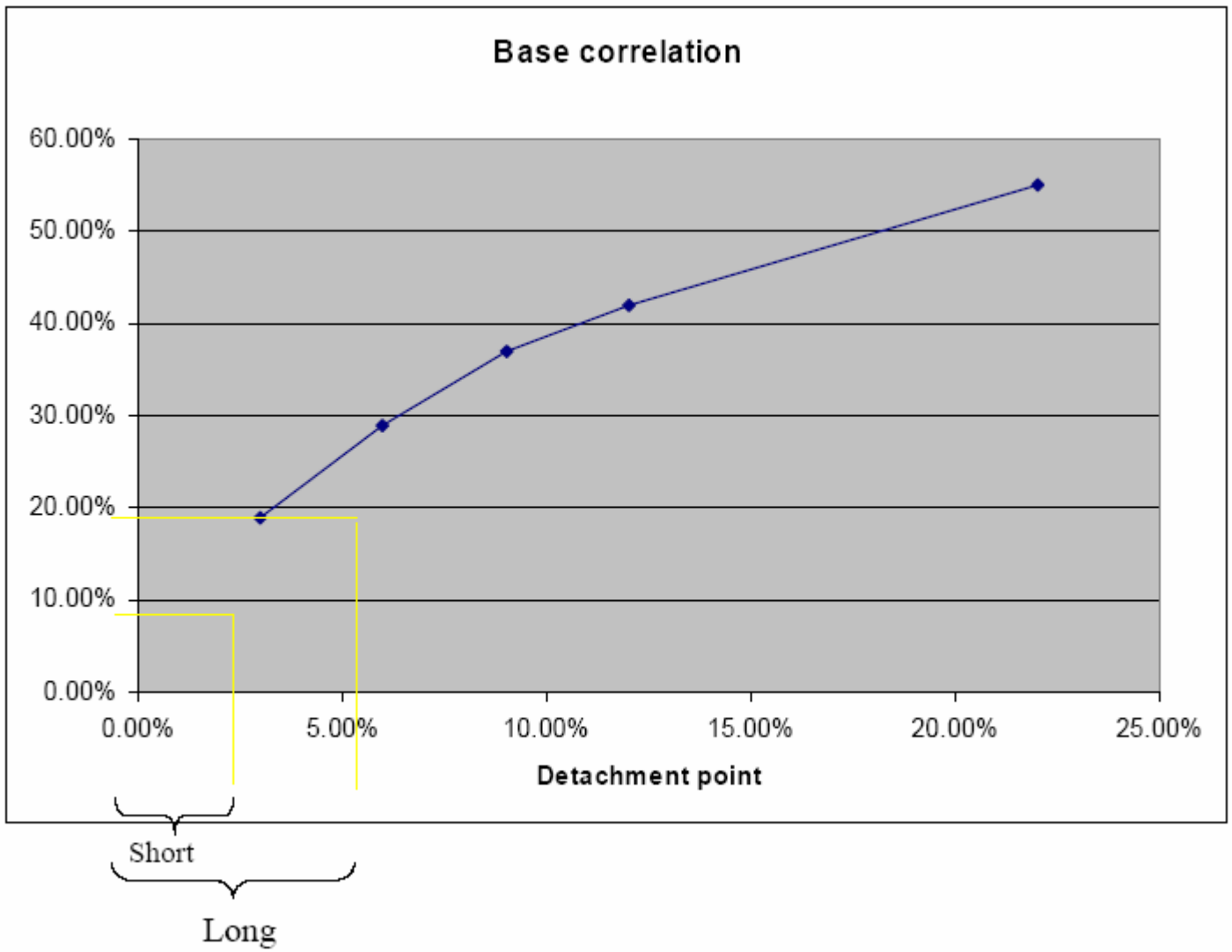


Correlation smile



Base correlations

- Started in spring 2004
- Quote correlation on all 0%-x% tranches
- Prices are monotone in correlation, i.e. uniqueness
- 2%-5% tranche calculated as:
  - Long 0%-5%
  - Short 0%-2%


Base correlation
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
0.00%
5.00%
10.00%
15.00%
20.00%
25.00%
Detachment point
Short
Long

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Disadvantages of default time copula models

- Copula models are unable to reproduce implied correlations for quoted CDO tranches in a simple manner.
- Static: no dynamics for spreads.
- Deltas with respect to CDS computed under these models are inconsistent since they do not contain spread risks.
- Unclear how new information should be incorporated into the model: conditional default probabilities?

Dynamic models

Many dynamic models have been proposed in the literature but very few have actually reached implementation stage:

- Multi-name default barrier models
- Multi-name random intensity models
- Aggregate loss models

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Advantages of aggregate loss models

Calibration to initial "base correlation skew" is automatic.

Standardized tranches are calibrated so model prices are consistent with tranche-based hedging.

Provides a joint model for spread and default risk.

Avoids the specification of cumbersome copulas.

Allows the pricing of more complex derivatives such as options on CDO tranches, forward start tranches,..

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Drawbacks of aggregate loss models

At present: just a framework, specification needs to be done.

Aggregate loss models are very new: little experience with specification/ implementation.

No deltas/ sensitivities to underlying portfolio.

Applicable to indices only, not to bespoke portfolios.

Portfolio-specific approach: non-transposable from one portfolio to another.

High dimensional (N=125) stochastic model: heavy Monte Carlo needed.

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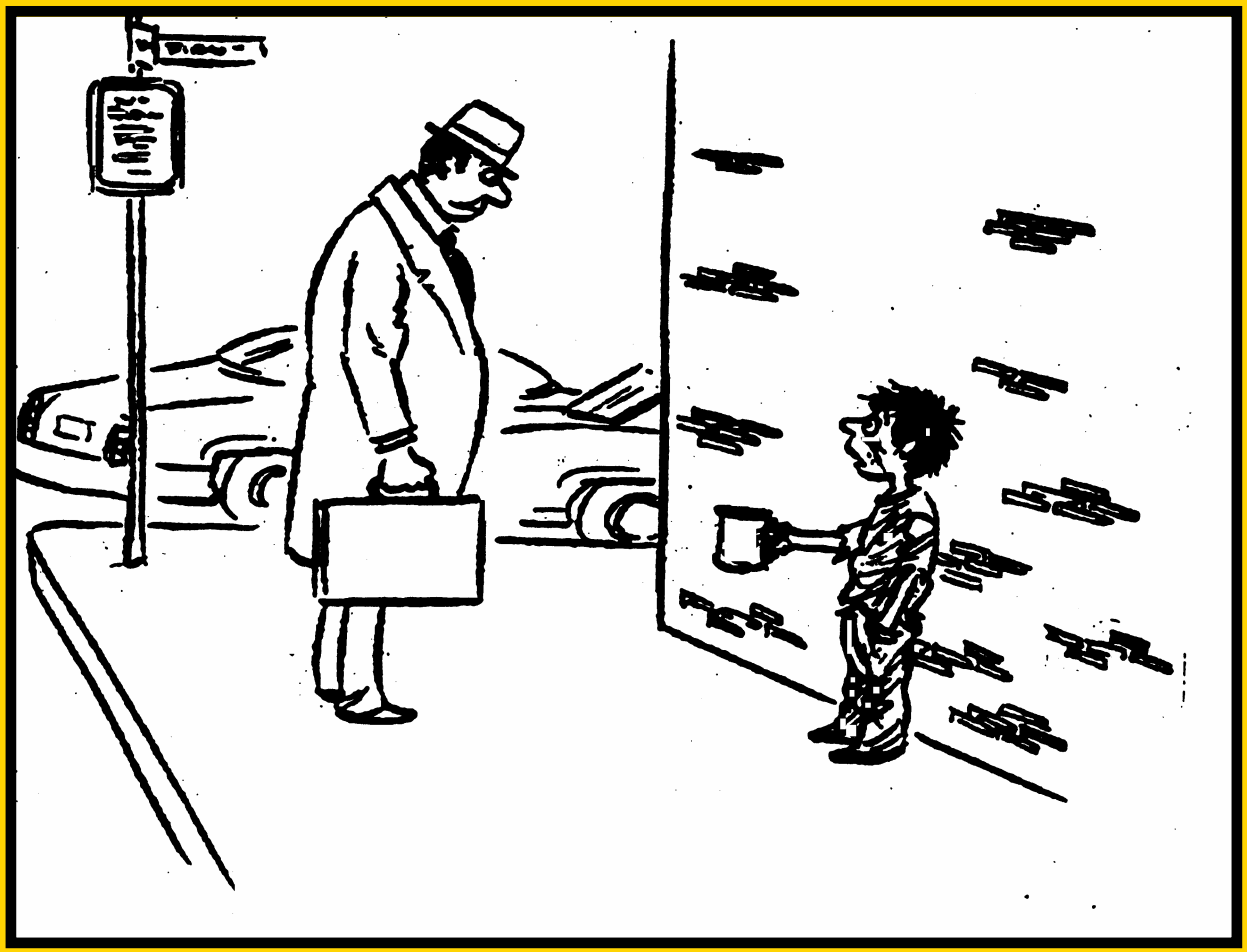
Open questions

- Good descriptions of default dependence across time.
- Good models for dynamics of term structures.
- Efficient pricing algorithms in dynamic models for loss term structure models.
- Hedging of spread and default risk with credit default swaps
- Hedging of "default correlation" risk.
- Efficient calibration algorithms for CDS in random intensity models.
- Efficient calibration algorithms for single tranche CDOs in all models.

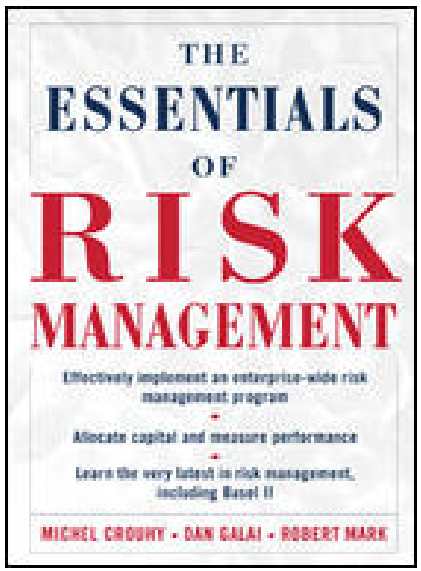
An exciting area for research!

Conclusion

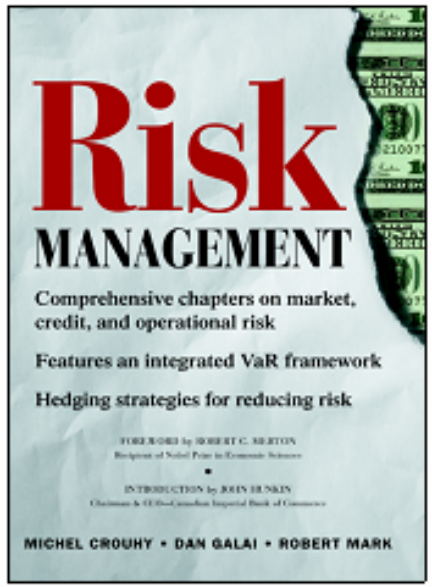


“Dad was in Credit Portfolio Management”

Recommended Value Added References



- Comprehensive user friendly description of Risk Management
- No Math



- Detailed technical description of Risk Management
- Analytical depth