SOCIETY OF ACTUARIES

ERM Symposium
April 2009

RA3-Call for Papers: Aspects of Credit Risk

Dan Rosen and **David Saunders**
Stephen D'Arcy
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Moderator
Fred Tavan

Enterprise Risk Management

ERM

Symposium

Where Cutting Edge Theory Meets State of the Art Practice

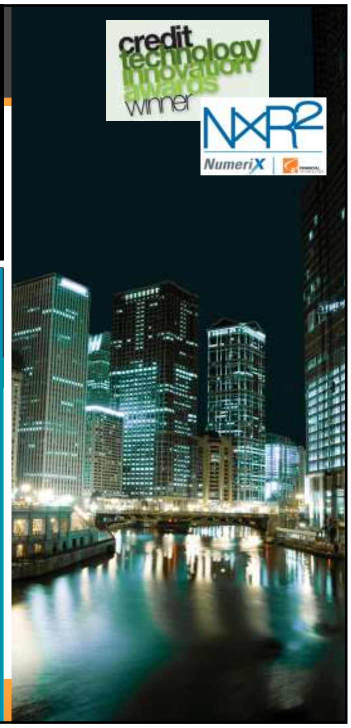
Advances in Credit Quantification

Introduction

Dr. Dan Rosen

R^2 Financial Technologies

April 30, 2009 Chicago, IL



Outline

Recent market events have brutally exposed the consequences of inadequate measurement and management of credit exposures.

This session will focus on recent advances in credit risk quantification

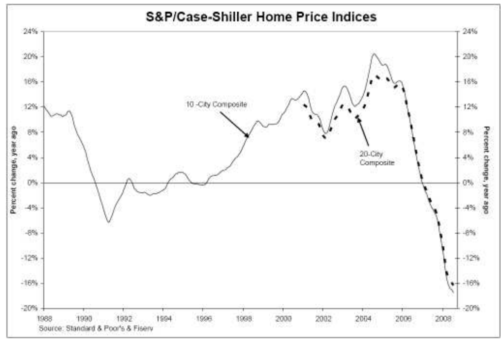
- Emerging best practices in concentration management, risk/reward trade-offs, valuation and portfolio theory

1. Credit Fundamentals and ERM
   - Thomas M. Farina, Deutsche Asset Management
2. Counterparty Credit Risk
   - Michael Pykhtin, Bank of America
3. Structured Credit and Valuation
   - Dan Rosen, R^2 Financial Technologies

Lessons Learned….

The current events have highlighted the need for ***transparency***

- Consistent valuation and risk methodologies across asset classes
- Detailed modeling of instruments and collateral
- Counterparty credit risk
- Concentration risk and risk contributions
- Model risk
- Stress testing
- Explicit modeling of the interaction of market, credit, and liquidity risk



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Structured Credit and Valuation

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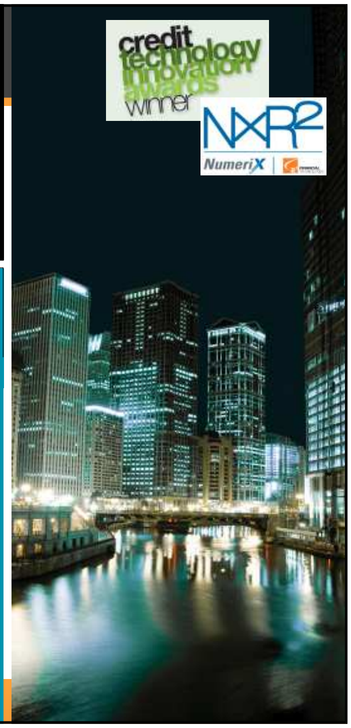


Lessons Learned….

*"… firms that performed better… had established, before the turmoil began, **rigorous internal processes**… and… had developed **in-house expertise to conduct independent assessments**… In contrast, firms that faced more significant challenges… generally **lacked relevant internal valuation models** and sometimes **relied too passively on external views of credit risk** from rating agencies and pricing services to determine values for their exposures."*

SENIOR SUPERVISORS GROUP, 2008
"Observations on Risk Management Practices during the Recent Market Turbulence"

Preface – in the news…

Banks' Subprime Market-Related Losses, Top $815 Billion

*Feb. 9 (Bloomberg) -- The following table shows the $815.6 billion in asset **writedowns** and **credit losses** at more than 100 of the world's biggest banks and securities firms as well as the $855.7 billion capital raised to cope with them.*

Firm	Writedown & Loss	Capital Raised
Wachovia	***97.9***	***11.0***
Citigroup Inc.	***85.4***	***109.3***
Merrill Lynch	***55.9***	***29.9***
UBS AG	***48.6***	***32.1***
Washington Mutual	***45.6***	***12.1***
Bank of America	40.2	78.5
HSBC Holdings	33.1	4.9
JPMorgan Chase	29.5	44.7
National City	26.2	8.9
Morgan Stanley	21.5	24.6
Wells Fargo	17.3	41.8
Lehman Brothers	16.2	13.9
Deutsche Bank	15.8	5.9
RBS	14.8	50.1
Barclays Plc	14.7	27.6
Credit Suisse	13.7	11.7
IKB Deutsche Ind.	13.4	11.0
ING Groep N.V.	12.3	19.0
HBOS Plc	9.3	23.2
Credit Agricole	8.9	11.6
…		
Goldman Sachs	7.1	20.5
TOTAL	***815.6***	***855.7***

Introduction – Structured Credit Products

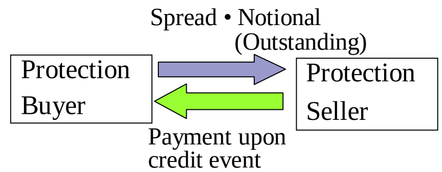
- Portfolio *P* consists of *N* credit risky obligations
  - Wholesale: corporate/financial/sovereign loans or bonds
  - Retail: mortgages (residential, commercial), small business/student loans, credit cards, etc…
  - Typically, *N*=50-300 for wholesale, *N*=1,000-100,000 for retail
  - Could include portfolios/structured products themselves as well (CDO^2)
- Credits available also in unfunded form – CDS
- Structured credit product

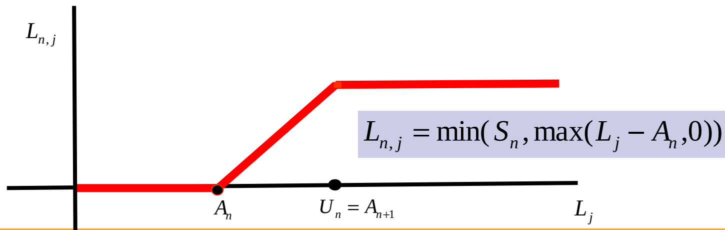
  Payoff (SCP) = f (CFs(P), market factors)
  - Market factors may include IRs (e.g. LIBOR), spreads, indices (e.g. inflation), FX rates, etc.
  - More generally, *f* ( ) may depend to other attributes of *P*
    - e.g. # of defaults, losses due to credit events, portfolio MtM, etc.

Structured Credit – Synthetic CDO

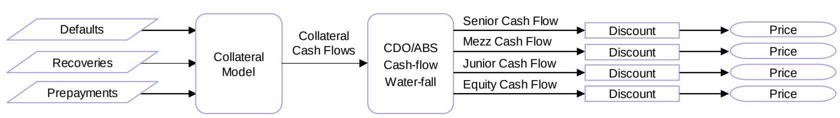
- Underlying pool of credit default swaps – divided into "tranches"
  - Example: CDX, iTraxx indices (125 corporate names)

Tranche	Attachment	Detachment
Equity	0%	3%
1st Mezzanine	3%	7%
2nd Mezzanine	7%	10%
Senior	10%	15%
Super Senior	15%	30%





Structured Credit – MBS, ABS, Cash CDO

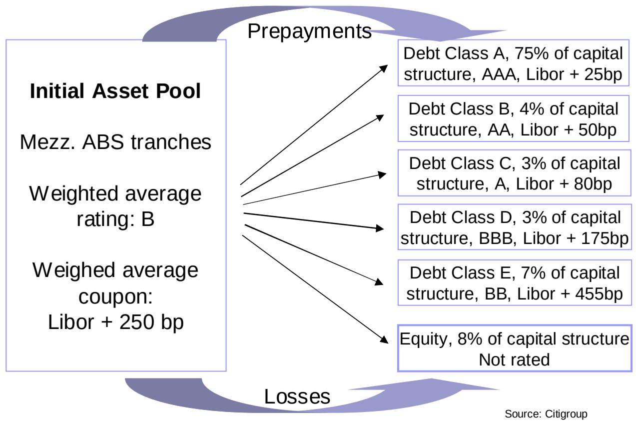


- Underlying collateral
  - Corporate loans, bonds
  - Retail loans (mortgages, credit cards, etc.)
  - ABSs
  - CDOs (CDO^2)
- Complex cashflows from collateral pool and structure waterfall
- In addition to default and LGDs: prepayment (applies differently to tranches)

Structured Credit – Cash CDO (ABS)

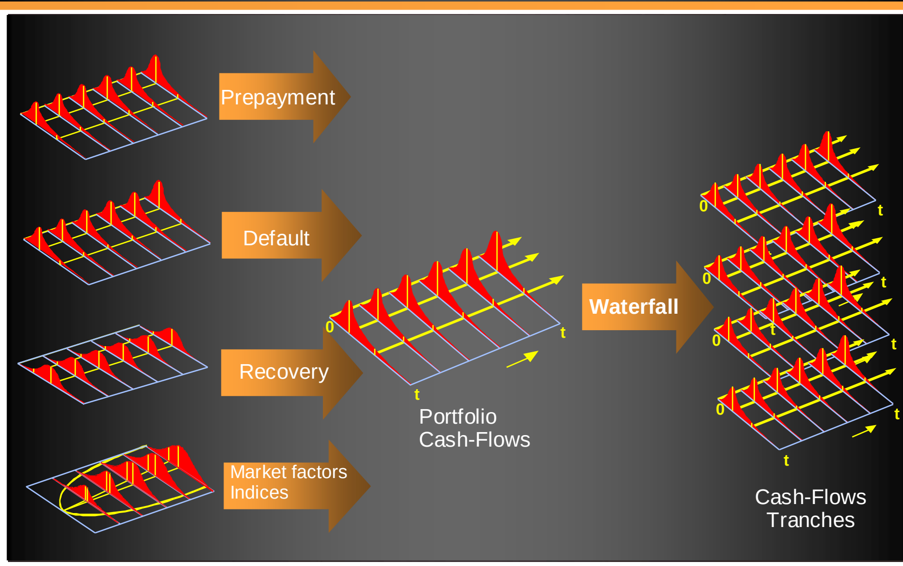
CDO distributes cash flows from the asset portfolio to tranches

- Tranche subordination defined by attachment/detachment points
- Cash flows depend on defaults, prepayments, overcollateralization (OC), fees, etc…



Source: Citigroup

General Risk Components for Valuation Model



Structured Credit Modelling – Current State

1. Valuation of synthetic CDOs
   - 1st generation models: Gaussian copula framework most prevalent approach
   - Pricing "bespoke" portfolios difficult – "mapping" models are generally ad-hoc
   - Application of dynamic models and detailed bottom-up models still in infancy
2. Valuation of structured credit (MBSs, cash CDOs, ABSs,…)
   - Structures: complex, non-standard, opaque – difficult, computationally intensive
   - Risks: IR, spreads, prepayment, default, and correlation
   - Simple "bond models" and matrix pricing generally used (e.g. ratings-based)
     - NAV / collateral market pricing for monitoring
   - Simplified collateral & waterfall CFs might be used with stochastic models
   - Advanced models are fairly new and standardized calibration is difficult

Structured Credit – Valuation & Risk

3. Lack of an integrated view of synthetic and cash products and single-name credit derivatives: pricing and risk management
4. Risk modeling is immature (market and credit risk)
   - Risk assessment and investment decision largely driven by ratings
   - Simple market risk sensitivities (e.g. CR01, etc.)
   - Hedging has proven to be difficult and prone to large model errors
   - Correlation is very important but difficult to assess – high systematic risk
   - VaR market and credit – not generally used in practice, difficult to compute
     - Losses due to default
     - MtM losses: defaults, downgrades, market moves (spreads, etc.)
   - Risk contributions are difficult to obtain (non-linear)
   - Computationally intensive risk applications (e.g. name-specific sensitivities)

Best-Practices – Valuation and Risk

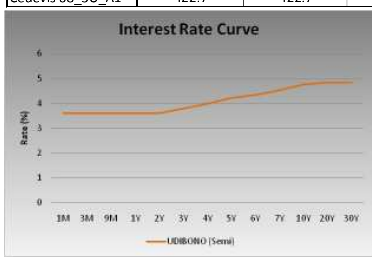
1. Transparent, detailed modelling of underlying collateral and deal structures
2. Application of bond pricing models run under multiple spread and risk scenarios, and adjusting for liquidity risk
   - Pricing matrices using reliable data from multiple data sources, which discriminate effectively between asset and risk classes
   - Adjustments for detailed collateral credit quality and concentrations
3. Cannot relay on ratings as main pricing indicators
4. Use of robust stochastic models to capture correlations and systematic risk effectively
   - Calibration to indices and quoted prices, where available
   - Modelling of fundamental values of risk parameters (real measures)
5. Valuation *and* risk – market, credit, liquidity… *and* model risk

The Need for Second Generation Models for Structured Credit Products

- Industry still largely relies on *first generation* models
  - Valuation of MBSs, cash CDOs and ABSs
    - Simple bond-models (deterministic cash-flows) and matrix pricing
    - OAS models for prepayment risk
    - Stochastic models with simplified waterfall and factor assumptions
  - Synthetic CDOs and Gaussian Copula model – well-documented practical and theoretical limitations: static, not arbitrage-free, issues with sensitivities
  - Risk measures and sensitivities are not effective in practice
  - Treatment of bespoke portfolios is generally ad hoc
- Generally Lack of integrated view of synthetic and cash products
- But… new developments of practical models for structured credit
  - ***Detailed bottom-up models*** *using Monte Carlo techniques – bespoke portfolios, cash CDOs, risk management –* *focus of this talk*
  - Application of dynamic models for pricing and hedging synthetic CDOs

CEDEVIS Overview

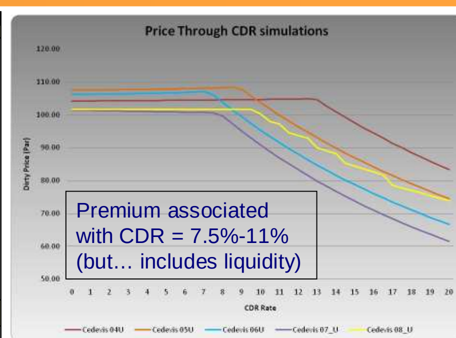
	Original Notional (MM)	Current Notional (MM)	Valmer's Price		R2 Implied Analytics					
			Dirty Price	Clean Price	Base Yield	***Imp Spread***	Total Yield	Maturity Date	***WAL***	***Duration***
Cedevis 04U	345.8	215.6	104.49	104.36	3.49	***0.18***	3.67	5.5	***2.31***	***2.23***
Cedevis 05U	326.7	239.0	107.04	104.88	3.52	***0.58***	4.10	6.7	***2.81***	***2.65***
Cedevis 05-2U	294.4	194.8	104.43	103.33	3.55	***0.82***	4.37	5.3	***2.30***	***2.20***
Cedevis 05-3U	290.0	215.7	104.30	104.17	3.59	***0.50***	4.09	6.5	***2.83***	***2.69***
Cedevis 06U	325.5	262.0	105.08	104.46	3.67	***0.75***	4.42	7.4	***3.47***	***3.25***
Cedevis 06_2U	273.3	219.7	109.61	106.79	3.71	***0.27***	3.98	7.1	***3.12***	***2.95***
Cedevis 06_3U	413.4	345.4	101.64	101.09	3.67	***1.03***	4.70	6.9	***3.09***	***2.90***
Cedevis 06_4U	597.4	498.7	100.59	100.48	4.02	***0.75***	4.77	6.5	***2.91***	***2.74***
Cedevis 07_U	631.3	573.9	99.40	98.93	3.78	***0.89***	4.67	7.9	***3.70***	***3.45***
Cedevis 07_2U	706.2	676.6	100.15	98.60	3.83	***0.82***	4.65	8.7	***4.14***	***3.81***
Cedevis 07_3U	603.6	551.4	99.77	98.99	3.76	***1.12***	4.88	7.8	***3.70***	***3.43***
Cedevis 08_U	336.6	336.6	100.37	99.90	4.12	***0.34***	4.46	3.4	***1.68***	***1.63***
Cedevis 08_3U_A1	422.7	422.7	102.53	100.35	4.14	***0.29***	4.43	4.6	***2.16***	***2.07***



Assumptions	Value
Salary	4.5%
VSM	4.5%
Inflation	4.5%

Stress Testing – CDR (Implied Rates & Break-Points)

Scenarios	Cedevis 04U	Cedevis 05U	Cedevis 06U	Cedevis 07_U	Cedevis 08_U
MKT Price	104.4884	107.0388	105.0849	99.3996	100.3732
0	104.15	107.45	106.23	101.30	101.67
0.5	104.16	107.48	106.26	101.27	101.67
1	104.18	107.52	106.29	101.24	101.67
1.5	104.20	107.55	106.33	101.20	101.67
2	104.22	107.58	106.37	101.16	101.67
2.5	104.24	107.62	106.41	101.12	101.68
3	104.26	107.65	106.45	101.08	101.68
3.5	104.29	107.69	106.49	101.03	101.68
4	104.31	107.73	106.53	100.97	101.68
4.5	104.33	107.78	106.58	100.91	101.68
5	104.36	107.82	106.63	100.85	101.68
5.5	104.38	107.87	106.71	100.79	101.69
6	104.40	107.93	106.81	100.74	101.68
6.5	104.43	107.98	106.95	100.70	101.68
7	104.45	108.04	107.14	100.65	101.68
7.5	104.47	108.12	106.04	100.60	101.68
8	104.50	108.24	103.74	99.57	101.68
8.5	104.52	108.41	101.52	97.25	101.68
9	104.55	107.68	99.38	95.02	101.67
9.5	104.58	105.63	97.32	92.87	101.67
10	104.61	103.64	95.32	90.80	100.38
10.5	104.64	101.71	93.40	88.80	97.94
11	104.68	99.85	91.54	86.88	97.24
11.5	104.71	98.05	89.75	85.02	94.56
12	104.77	96.30	88.01	83.23	93.74
12.5	104.86	94.61	86.33	81.50	92.92
13	104.51	92.97	84.71	79.83	90.02
13.5	102.70	91.38	83.14	78.22	89.15
14	100.93	89.83	81.62	76.66	88.29
14.5	99.23	88.34	80.15	75.15	85.27
15	97.57	86.88	78.72	73.70	84.37
15.5	95.96	85.47	77.34	72.29	83.51
16	94.40	84.10	76.00	70.93	82.67
16.5	92.89	82.77	74.70	69.61	81.81
17	91.41	81.48	73.44	68.33	78.64
17.5	89.98	80.22	72.21	67.10	77.79
18	88.59	79.00	71.03	65.90	77.00
18.5	87.24	77.81	69.87	64.74	76.23
19	85.93	76.65	68.76	63.61	75.43
19.5	84.65	75.52	67.67	62.52	74.65
20	83.41	74.43	66.61	61.46	73.92



Simulation parameters	
Discount	Interbank (UDIBONO Curve)
Default	0% to 40% CDR
Prepayment	0%
Severity	100%
Salary	4.5%
VSM	4.5%
Inflation	4.5%

CEDEVIS 08-U

Deal Characteristics

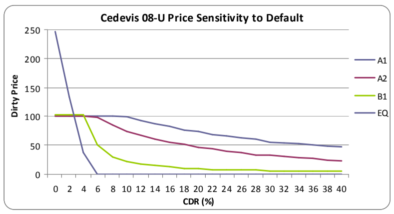
Deal Name	Cedevis 08U	Current # Assets	20,884	WANCoupon -Deal	4.1%
Collateral Type	VSM Loans	Original Deal Balance	856,424,200	WANCoupon -Coll	7.3%
Currency	UDI	Current Deal Balance	856,424,200	Excess Asset spread (%,Y)	3.2%
Issuer	Infonavit	Total Collateral Balance	989,468,711	Collateral Duration	6.25
Trustee	Infonavit	Cash Balance	72,899,924	Collateral WAL	7.08

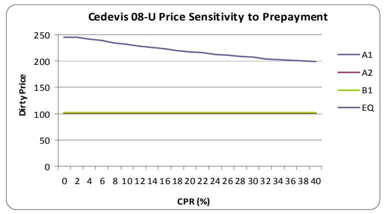
Tranche Characteristics

Tranche Info				Type	Coupon		Balance			Factor	Writedowns	DayCount	Day
Tranche		CUSIP	CUR			S&P	Orginal Balance	Current Balance	Difference		(Accumulated)		Accrued
					4.426%		856,424,200	856,424,200					
A1			UDI	Fixed	4.400%	AAA	336,627,700	336,627,700	0.00	1	0	ACT360	39
A2			UDI	Fixed	4.780%	AAA	445,536,100	445,536,100	0.00	1	0	ACT360	39
B1L			UDI	Fixed	5.440%	NR	74,260,400	74,260,400	0.00	1	0	ACT360	39

Pricing Anlaysis - Single scenario Approach

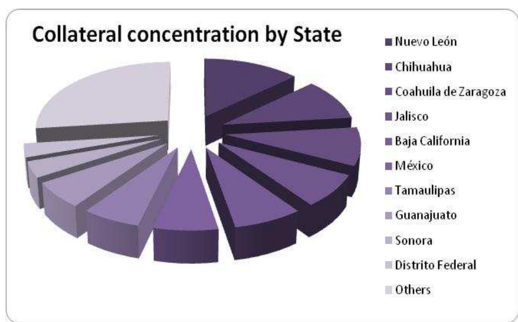
Tranche ID	Assumptions				Yield Analysis			Sensitivity		WAL	Maturity	Default	Cash flows	
Tranche	CPR	CDR	Severity	Delinq	Base Yield	DM	Total Yield	Duration	Convexity	WAL	Months	1st loss CDR	Total Cashflow	Interest Cashflow
A1	0%	0%	100%	0%	4.12%	0.34%	4.46%	1.63	3.77	1.68	41	11%	363,431,259	26,803,559
A2	0%	0%	100%	0%	4.12%	0.72%	4.84%	5.38	33.14	5.58	101	6%	580,134,181	134,598,081
B1L	0%	0%	100%	0%	4.12%	1.00%	5.12%	7.31	61.52	7.68	113	5%	111,645,686	37,385,287





Collateral Concentration

State	Balance	Balance (%)	Count
Nuevo León	324,559	13.33	2615
Chihuahua	242,119	9.95	2245
Coahuila de Zaragoza	217,665	8.94	1933
Jalisco	184,810	7.59	1509
Baja California	178,924	7.35	1547
México	164,794	6.77	1329
Tamaulipas	151,066	6.21	1345
Guanajuato	147,253	6.05	1242
Sonora	91,185	3.75	814
Distrito Federal	77,979	3.2	615
San Luis Potosí	75,877	3.12	650
Michoacán de Ocampo	75,025	3.08	654
Puebla	70,373	2.89	609
Sinaloa	68,927	2.83	608
Aguascalientes	63,356	2.6	557
Hidalgo	58,188	2.39	490
Quintana Roo	54,100	2.22	500
Querétaro Arteaga	43,346	1.78	347
Colima	26,661	1.1	226
Durango	24,535	1.01	218
Nayarit	22,057	0.91	189
Campeche	20,687	0.85	199
Chiapas	14,738	0.61	132
Baja California Sur	13,642	0.56	111
Oaxaca	12,607	0.52	118
Veracruz de Ignacio de la Llave	9,500	0.39	82

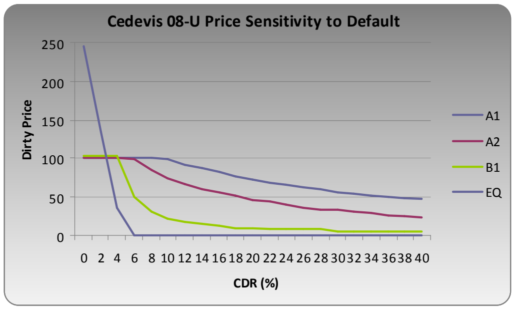


Salary (VSM per Day)	Balance	Balance (%)	Count
< 5	1,432,487	58.9	12800
5 - 20	975,894	40.1	7739
> 20	25,591	1.1	345

Balance Outstanding (VSM)	Balance	Balance (%)	Count
< 100	390,776	16.1	4657
100 - 125	883,359	36.3	8035
>125	1,159,736	47.7	8190

Coupon Rates	Balance	Balance (%)	Count
4-6 (0.04 - 0.06)	756,656	31.1	7351
6-8 (0.06 - 0.08)	556,226	22.9	4696
>8 (0.08 - 1.00)	1,121,071	46.1	8836

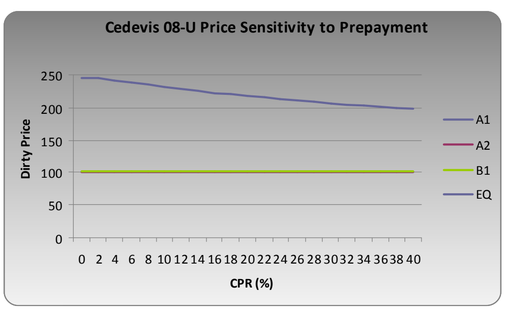
Stress Testing – Default



Simulation Parameters	
Discount	Interbank (UDIBONO) + Spread
Default	0% to 40% CDR
Prepayment	0%
Severity	100%
Salary	4.5%
VSM	4.5%
Inflation	4.5%

CDR	A1	A2	B1	EQ
0	100.38	100.19	102.89	245.5652
2	100.37	100.17	103.13	133.5357
4	100.37	100.13	103.54	36.93397
6	100.37	98.49	50.55	0
8	100.36	85.43	30.27	0
10	99.14	73.47	22.03	0
12	92.77	66.63	17.55	0
14	87.45	60.18	15.22	0
16	81.93	55.22	12.84	0
18	76.35	51.45	10.41	0
20	73.29	46.34	10.41	0
22	67.92	44.22	7.90	0
24	65.30	40.31	7.90	0
26	62.96	36.81	7.90	0
28	60.70	33.77	7.90	0
30	55.90	33.53	5.34	0
32	54.10	31.01	5.34	0
34	52.37	28.78	5.34	0
36	50.83	26.70	5.34	0
38	49.34	24.86	5.34	0
40	48.02	23.13	5.34	0

Stress Testing – Prepayment



Simulation Parameters	
Discount	Interbank (UDIBONO) + Spread
Default	0%
Prepayment	0% to 40% CPR
Severity	100%
Salary	4.5%
VSM	4.5%
Inflation	4.5%

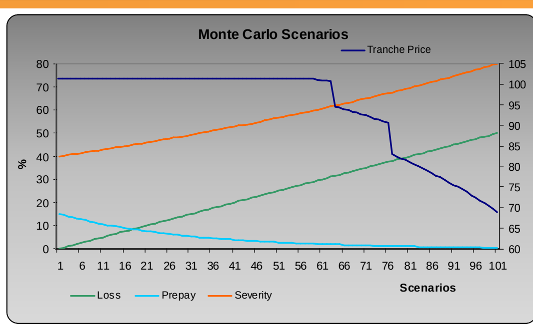
CPR	A1	A2	B1	EQ
0	100.38	100.19	102.89	245.57
2	100.38	100.19	102.89	245.57
4	100.38	100.21	102.81	241.81
6	100.39	100.22	102.74	238.24
8	100.39	100.24	102.68	234.84
10	100.40	100.25	102.61	231.64
12	100.40	100.26	102.55	228.57
14	100.40	100.27	102.49	225.68
16	100.41	100.28	102.43	222.92
18	100.41	100.29	102.38	220.28
20	100.41	100.30	102.32	217.79
22	100.41	100.31	102.27	215.42
24	100.42	100.31	102.22	213.14
26	100.42	100.32	102.16	211.00
28	100.42	100.33	102.13	208.90
30	100.42	100.33	102.08	206.94
32	100.42	100.34	102.03	205.07
34	100.42	100.35	102.01	203.25
36	100.43	100.35	101.95	201.56
38	100.43	100.36	101.91	199.93
40	100.43	100.36	101.89	198.34

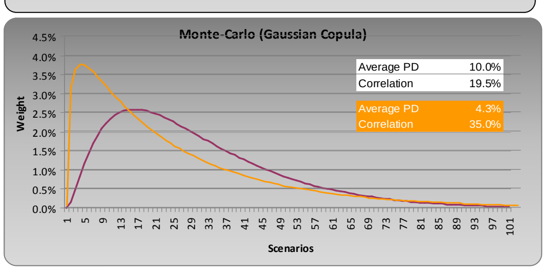
Stress Testing – Economic Scenarios (A1 Tranche)

Metrics	Very Bad	Bad	Base	Good	Very Good
Value	303,116,628	333,502,867	337,892,004	340,955,003	342,860,100
P&L	-34,775,375	-4,389,136	0	3,062,999	4,968,096
P&L (%)	-10.3%	-1.3%	0.0%	0.9%	1.5%
Price	90.05	99.07	100.38	101.29	101.85

Scenarios	Very Bad	Bad	Base	Good	Very Good
Base Yield	4.46	4.46	4.46	4.46	4.46
Yield shift	1.5	0.75	0	-0.75	-1.5
Total Yield	5.96	5.21	4.46	3.71	2.96
Prepay	0	0	0	5	10
Loss	10	5	0	0	0
Severity	100	100	100	100	100
UDI	5.5	5	4.5	4	3.5
VSM	3.5	4	4.5	5	5.5
Salary	3.5	4	4.5	5	5.5

CEDEVIS 08 – Weighted Monte Carlo





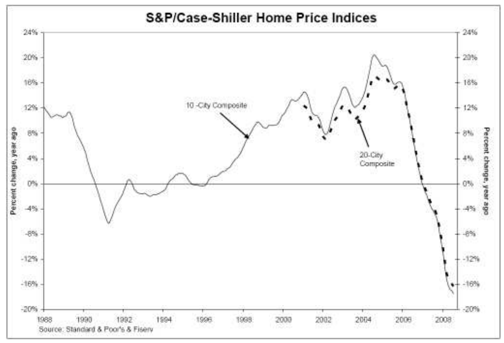
Price = 100.37

	Price	P&L	P&L (%)
Average	100.37	0.0	0.0
Best	101.29	-0.92	0.91
95 %	100.29	0.08	-0.08
5%	93.66	6.71	-7.16
Worst	68.93	31.44	-45.61

Concluding Remarks

The current events have highlighted the need for ***transparency***

- Consistent valuation and risk methodologies across asset classes
- Detailed modeling of instruments and collateral
- Counterparty credit risk
- Concentration risk and risk contributions
- Model risk
- Stress testing
- Explicit modeling of the interaction of market, credit, and liquidity risk



Industry Best Practices Beyond the Credit Crisis

Independent Valuation and Internal Modeling and Risk Capabilities

- *Even when an institution continues to rely largely on externally provided prices, it is important that it also develops internal analysis capabilities and that risk management is actively engaged in the valuation process*

Transparency

- *The current events have highlighted the need for transparency for the contents and structure of these securities as well as for the valuation and risk methodologies.*
  - Structured credit products are complex: underlying collateral, structure, underlying risks (credit, prepayment, market, liquidity)
  - High-level, top-down models → misleading results, lack of ability to manage risk & invest

Good Models based on Fundamentals

- Need for internal modeling infrastructure – check valuations and compare quotes
  - Dealer quotes have proven to be unreliable under stressed markets and illiquidity
  - Models heavily depended on ratings, have led to severe valuation issues
  - Importance of correlations and systematic risk
- Consistency across asset classes – capture all the risks and based on reliable data

Industry Best Practices Beyond the Credit Crisis

Model Risk Framework

- *Limitations of of our models and underlying data, and the illiquidity in the market → develop a systematic approach for capturing and communicating model risk.*
  - *Model application documentation, development process, independent review, testing and approval*
  - *Model risk methodology*
- Valuations should be challenged continuously – processes, knowledgeable resources, analytical tools and data (many price sources)
  - Comparison to indices, e.g. iTraxx or ABS, ABX
  - Stress testing is fundamental – scenarios for default, recovery and prepayment; spreads; downgrades and defaults; correlations

Risk Management Fundamentals

- Over a decade of great performance, we abandoned risk management fundamentals when dealing with structured credit investments
- Required effective tools:
  - Comprehensive stress testing
  - Risk metrics and concentration risk; risk contributions and performance attribution

Presenter's Bio

Dr. Dan Rosen is the co-founder and CEO 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. He is a research 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.

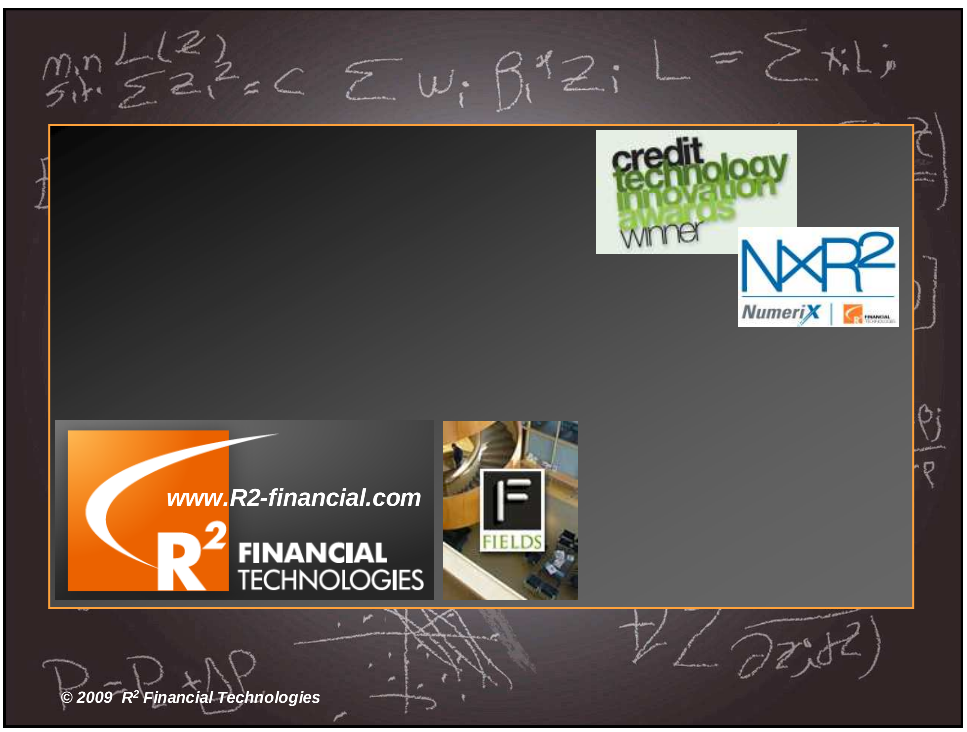
Dr. Rosen lectures extensively around the world on financial engineering, enterprise risk and capital management, credit risk and market risk. He has authored numerous papers on quantitative methods in risk management, applied mathematics, operations research, and has coauthored two books and various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

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 the strategic direction, new initiatives and strategic alliances. He headed up the design and positioning of credit risk and capital management solutions, market risk management tools, operational risk, and advanced simulation and optimization techniques, as well as their application to several industrial settings.

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

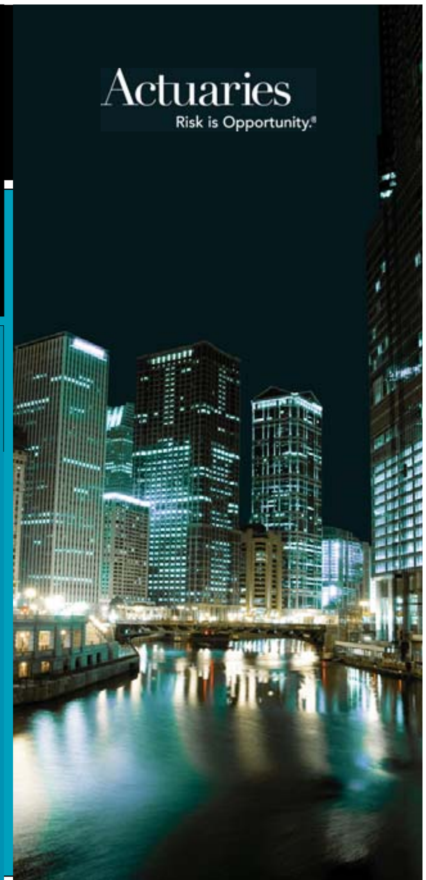
Selected Recent Publications

- Rosen D. and Saunders D., 2009, *Valuing CDOs of Bespoke Portfolios with Implied Multi-Factor Models*, Journal of Credit Risk, forthcoming
- Nedeljkovic, J., Rosen D. and Saunders D., 2009, *Valuing and Hedging CLOs with Implied Factor Models*, Working Paper, Fields Institute and University of Waterloo
- Rosen D. and Saunders D., 2009, *Analytical Methods for Hedging Systematic Credit Risk with Linear Factor Portfolios*, Journal of Economic Dynamics and Control
- Rosen D. and Saunders D., 2008, *Measuring Capital Contributions of Systemic Factors in Credit Portfolios*, Working Paper Fields Institute and University of Waterloo
- Garcia Cespedes J. C., de Juan Herrero J. A., Rosen D., Saunders D., 2007, *Effective modelling of Counterparty Credit risk and Alpha*, Working Paper, Fields Institute and University of Waterloo
- Mausser H. and Rosen D., 2007, *Economic Credit Capital Allocation and Risk Contributions*, forthcoming in Handbook of Financial Engineering (J. Birge and V. Linetsky Editors)
- Garcia Cespedes J. C., Keinin A., de Juan Herrero J. A. and Rosen D., 2006, *A Simple Multi-Factor "Factor Adjustment" for Credit Capital Diversification*, Special issue on Risk Concentrations in Credit Portofolios (M. gordy, editor) Journal of Credit Risk, Fall 2006
- De Prisco B., Rosen D., 2005, *Modelling Stochastic Counterparty Credit Exposures for Derivatives Portfolios*, Counterparty Credit Risk (M. Pykhtin, Editor), Risk Books, London
- Aziz A., Rosen D., 2004, *Capital Allocation and RAPM*, in Professional Risk Manager (PRM) Handbook, Chapter III.0, PRMIA Publications
- Rosen D., 2004, *Credit Risk Capital Calculation*, in Professional Risk Manager (PRM) Handbook, Chapter III.B5, PRMIA Publications



Enterprise Risk Management
ERM
Symposium
Where Cutting Edge Theory Meets State of the Art Practice

Actuaries
Risk is Opportunity.



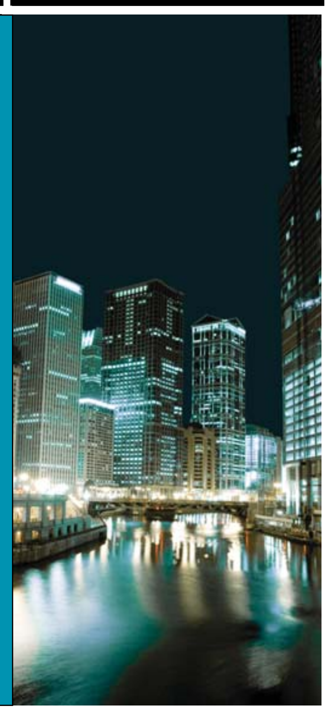
Risk Factor Contributions in Portfolio Credit Risk Models

David Saunders,
University of Waterloo
Joint work with D. Rosen,
R^2 Financial Technologies

CAS · Canadian Institute of Actuaries / Institut canadien des actuaires · PRMIA · Society of Actuaries

Outline

- Factor Models of Credit Risk
- Risk Contributions for Instruments and Sub-Portfolios
- Risk Contributions for Systematic Factors
- Defining and Calculating Factor Contributions
- Conclusions and Future Directions



Actuaries
Risk is Opportunity.

Factor Models of Credit Risk

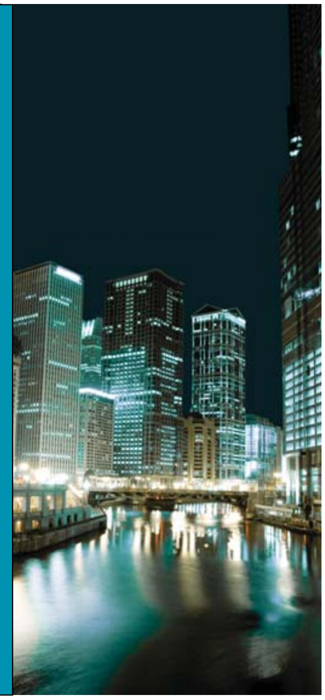
- **Portfolio Loss:**

$$L = \sum_{n=1}^{N} w_n L_n$$

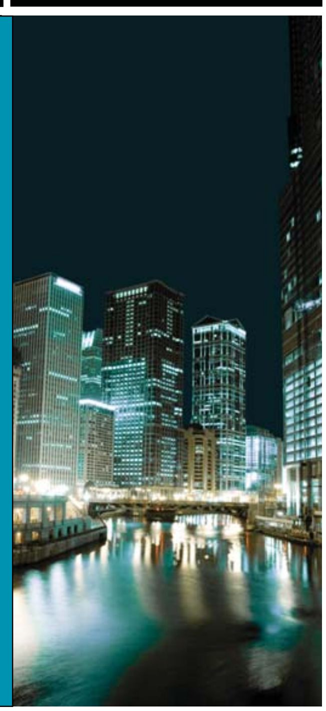
- **Systematic Factors: Z_k, k=1,…,K.**
  - **L_n are independent given Z.**
  - **Under technical conditions, as $N \rightarrow \infty$**

$$L \rightarrow L_S = E[L \mid Z]$$

Actuaries
Risk is Opportunity.



Actuaries



A Primer on Credit Derivatives

Stephen P. D'Arcy – University of Illinois

Jim McNichols – Aon Risk Consultants

Xinyan Zhao – Tianjin University of Finance and Economics

April 30, 2009

What are Credit Derivatives?

"Credit derivatives are derivative instruments that seek to trade in credit risks."

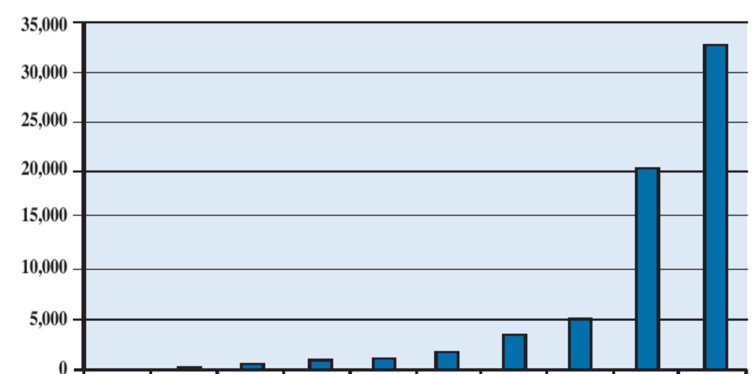
http://www.credit-eriv.com/meaning.htm

Credit Derivatives

- Rapidly growing area of risk management up through 2008
- Banks used credit derivatives to reduce risk and lower capital requirements
- Insurers are also involved in this market
- Credit derivatives caused significant problems for many financial institutions
- Remain a useful risk management tool, if used properly

Growth in Credit Derivatives

Source:BBA Credit Derivatives Report 2006



	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

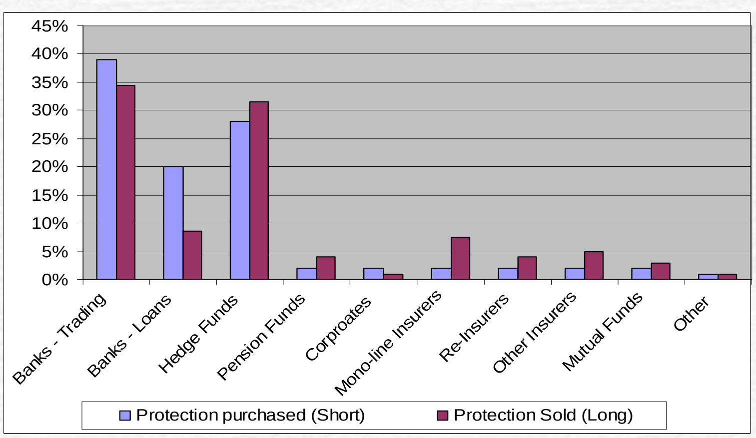
Global Credit Derivatives Market $bn

Global Credit Derivative Market - 2008

- BBA projection - $33 trillion
- Actual market size
  - June 2008 - $57 trillion
  - December 2008 - $27 trillion

Comparison of 2006 Market Share, Buyers v. Sellers

Source: British Bankers' Association Credit Derivatives Report 2006



CREDIT DERIVATIVE PRODUCT TYPES & KEY TERMS

Credit Derivative Volumes by Product Type

Product Type	**2004**	**2006**
Single-name credit default swaps (“CDS”)	51.0%	32.9%
Full index trades	9.0%	30.1%
Synthetic Collateralized Debt Obligations (“CDOs”)	16.0%	16.3%
Tranched index trades	2.0%	7.6%
Credit linked notes	6.0%	3.1%
Others	16.0%	10.0%

Source: British Bankers’ Association Credit Derivatives Report 2006.

Types of Credit Derivatives

- Credit Default Swap
- Collateralized Debt Obligations
- Credit Index Trades

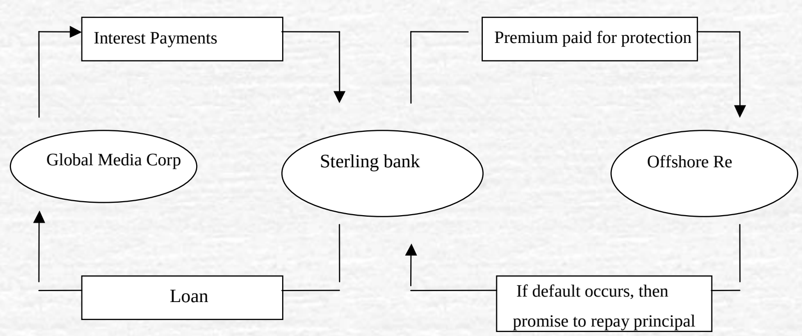
What is Credit Default Swap?

Credit default swaps allow one party to "buy" protection from another party for losses that might be incurred as a result of default by a specified reference credit (or credits).

The "buyer" of protection pays a premium for the protection, and the "seller" of protection agrees to make a payment to compensate the buyer for losses incurred upon the occurrence of any one of several specified "credit events."

EXAMPLE of a CDS MARKET TRANSACTION

Credit Default Swap on a Single Corporate, Between a Bank and a Reinsurer



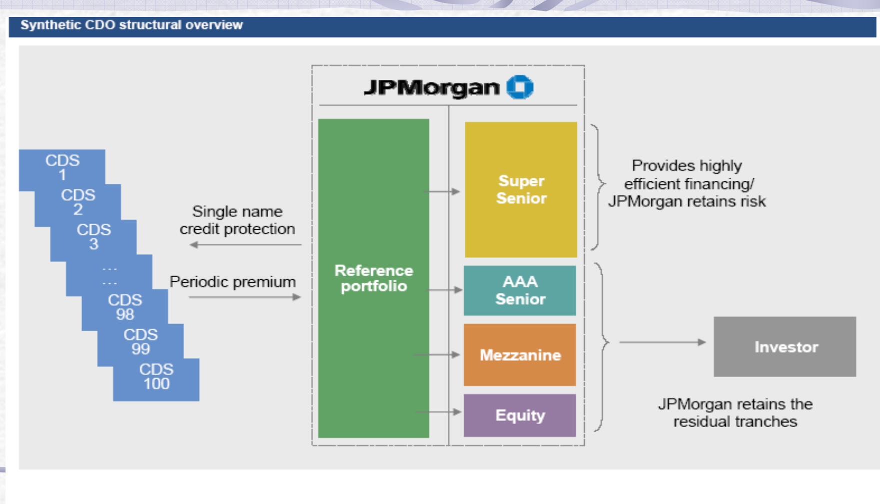
What are Synthetic CDOs ?

Synthetic CDOs are typically "structured" transactions in which a special purpose entity (SPE) is established to sell credit protection on a range of underlying assets via individual credit default swaps.

Synthetic CDOs provide a way for banks and other financial institutions to transfer credit risk on pools of loans or other assets without selling the assets and for investors to obtain the returns on the loans without lending the funds to individual borrowers.

Example of CDOs

Source: " Structured Credit workshop",JP Morgan



Synthetic CDO tranche mechanics

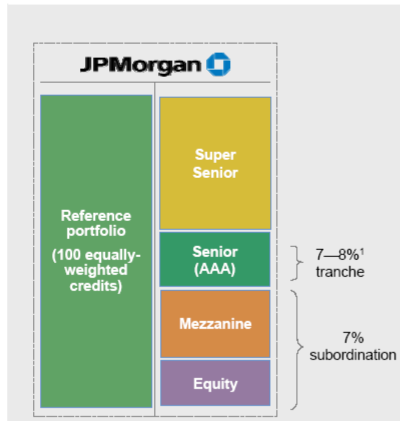
- Synthetic CDO typically apply a linear write down methodology to determine loss
- Assuming a 1% tranche, with 7% subordination, the investor can withstand x defaults (at a 40% recovery rate) without losing principal
- Default calculation:

$$\text{Number of defaults investor able to withstand} = \frac{\text{Subordination}}{1\% * (1 - \text{Recovery}\,\%)}$$

$$= \frac{7\%}{1\% * (1 - 40\%)}$$

$$= 11.67$$

Default math example



What are Credit Index Trades?

Credit derivative index trades are usually comprised of a generic basket of single name swaps with standardized terms.

It allows investors to buy and sell a customized cross section of the credit market much more efficiently than they could if they were dealing in individual credit derivatives.

Example of Dow Jones CDX NA IG Index

Source:www.sec.gov/rules/proposed/s72104/bma092204.ppt

Credit Event Example - Counterparty buys $1 million Dow Jones CDX.NA.IG Exposure in Unfunded / CDS Form

- No Credit Event
  - The fixed rate of the Dow Jones CDX.NA.IG is [70] basis points per annum quarterly
  - Market maker pays to counterparty [70] bps per annum quarterly on notional amount of $1 million
  - With no Credit Events, the counterparty will continue to receive premium on original notional amount until maturity

Credit Index Settlement Price Formula

Final Settlement Price = $\sum_{i=1}^{n} E_i * W_i * F_i$

Where:

n = Number of constituents referenced in the Index

Ei =A binary Credit Event Indicator …

IF credit event declared for constituent i THEN Ei=1

IF credit event is not declared for Index constituent i THEN Ei=0

Wi = Weight of Index constituent i as established by the Exchange

Fi = Final Settlement Rate for Index constituent i

- Credit Event
  - If a Credit Event occurs on Reference Entity, for example, in year 3
  - Reference Entity weighting is 4.25%
  - Final Settlement Rate is 80%
  - Final Settlement Price is 3.4%

Final Settlement Value= National Value of Contract *
Final Settlement Price
=34,000

Credit derivatives in insurance companies

Why insurance companies use credit derivatives

What risk insurance companies bear after selling credit derivatives

Why do insurance companies use credit derivatives?

Diversify insurance company's portfolios risk to include credit risk.

Enhance the return on their portfolio.

What risk will insurance companies bear after selling credit derivatives?

"Financial weapons of mass destruction"

- Derivatives as described by Warren Buffett

" Short squeeze"

- Insurers short sell equities to hedge credit derivative exposure when the bonds are not traded
- As credit standing of firm declines, insurer sells more stock
- Can be exposed to selling stocks in falling market

"Moral hazard"

- Banks deal directly with borrowers
- Insurers depend on banks to evaluate loans consistently
- If banks can shift risk to others, they may become less concerned about the risk of defaults

Example of Insuring Selling Index CDS to Enhance Yield

Insurer has $10 million to invest

Income:	invest in Ginnie Mae	5.63%
	sell Dow Jones CDX.NA.IG	.70%
Outgo:	Default range	0~100%
	Expected value	0.30%

Potential Return on Investment

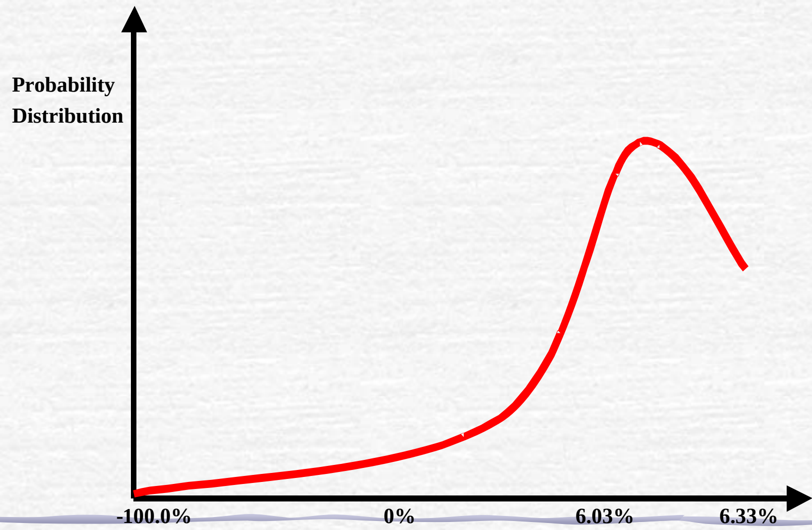
Expected return = 5.63%+0.70%-0.30%=6.03%

Max return = 6.33% (if there are no defaults)

Min return = -100%

(all the bonds in the portfolio default and nothing can be recovered)

Income Exhibit



Credit Derivatives in Bloomberg

Bloomberg uses credit default swap function to evaluate the price of credit default swaps.

They base calculations on the credit default swap model of Hull and White (2000).

Notation

T : Life of credit default swap

$q(t)$: Risk-neutral default probability density at time

$\hat{R}$: Expected recovery rate on the reference obligation in a risk-neutral world. This is assumed to be independent of the time of the default and the same as the recovery rate on the bonds used to calculate $q(t)$

$u(t)$: Present value of payments at the rate of $1 per year on payment dates between time zero and time t

$e(t)$: Present value of an accrual payment at time t equal to $t - t^*$ when t^* is the payment date immediately preceding time t

$v(t)$: Present value of $1 received at time t

Notation

w : Total payments per year made by credit default swap buyer

s : Value of that causes the credit default swap to have a value of zero

π : The risk-neutral probability of no credit event during the life of the swap

$A(t)$: Accrued interest on the reference obligation at time as a percent of face value

The CDS spread:

$$s = \frac{\int_0^T \left[1 - \hat{R} - A(t)\hat{R}\right] q(t) v(t) dt}{\int_0^T q(t)\left[u(t) + e(t)\right] dt + \pi u(T)}$$

Bloomberg CDSW function using Hull-White pricing model

Characteristics of Modified Hull White Model

- Assumes independence among
  - Interest rate
  - Default rate
  - Recovery rate
- These are not likely to be independent
  - Housing market
    - Rising interest rates
    - Increased default rates
    - Tightened credit standards
    - Falling housing prices

Summary of Paper

- Purpose
  - To increase insurance practitioners' understanding of credit derivatives
- Major findings
  - Credit defaults are positively correlated with underwriting losses
  - Correlation reduces diversification potential

Some Firms Damaged by Credit Derivatives

- Bear Stearns
- Lehman Brothers
- Merrill Lynch
- AIG

Lessons for ERM

- Manage for risk, not for regulation
  - Regulatory risk loads may be insufficient – don't rely on those levels
- Understand all significant risks an organization is assuming
  - Comprehension cannot be delegated
- Link incentives to risk
  - Don't reward the positive outliers without penalizing the negative ones