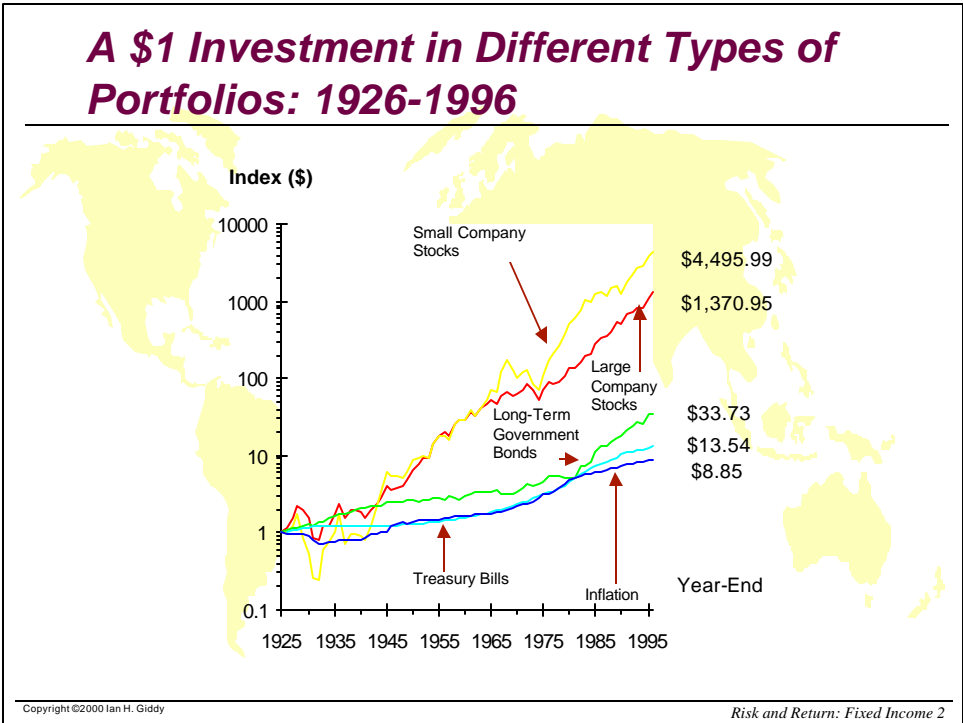


New York University
Stern School of Business

***Risk and Return
In Fixed-Income Securities***

Prof. Ian Giddy
New York University



Risk and Return Defined

- *Risk* is the chance of loss; the variability of returns; uncertainty associated with a given asset.
- *Return* is the total gain or loss expected - or experienced - by the owner of a financial asset or investment over a given period of time.

Return can be Computed (ex post) or Estimated (ex ante)

$$k_t = \frac{P_t - P_{t-1} + C_t}{P_{t-1}}$$

WHERE

k_t = Actual (ex post) or expected (ex ante) return

P_t = Price (value) of asset at time t

P_{t-1} = Price (value) of asset at time $t-1$

C_t = Cash Flow(s) received between time $t-1$ and time t

Calculating Return: Example

An investor bought a share of Sony Corp. stock one year ago for \$40. Today it can be sold for \$43.50. She received \$1.50 in dividends during the year. What is her actual return for the year?

What We Know:

$$P_t = \$43.50; P_{t-1} = \$40.00; C_t = \$1.50$$

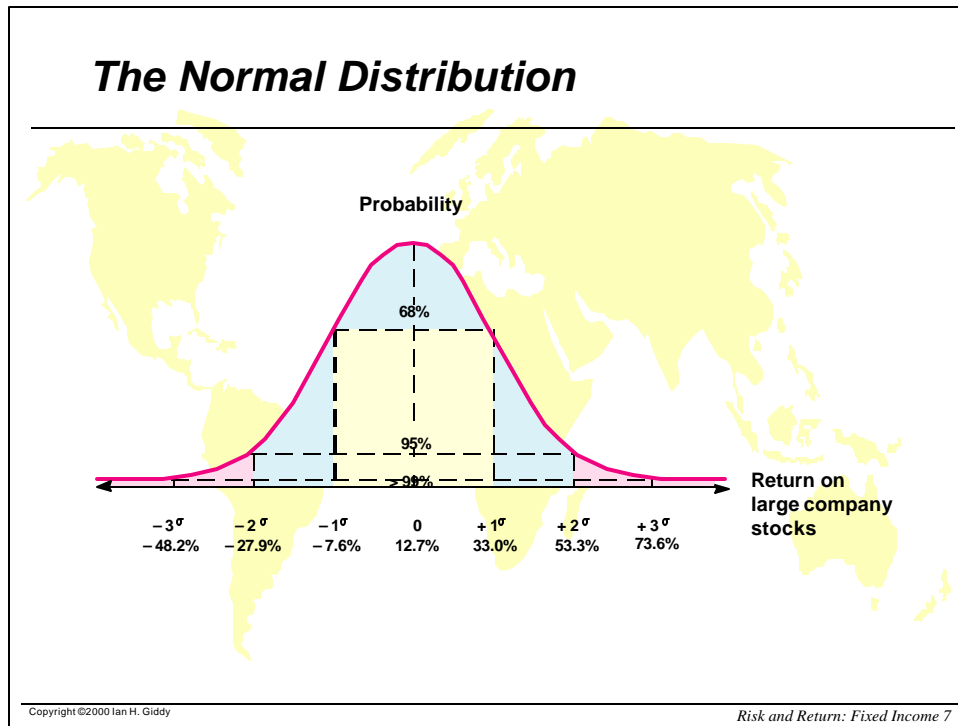
Plug into formula

$$k_t = \frac{\$43.50 - \$40.00 + \$1.50}{\$40.00} = \frac{\$5}{\$40} = 12.5\%$$

Standard Deviation (s_k)

$$s_k = \sqrt{\sum_{i=1}^n (k_i - \bar{k})^2 \times P_i}$$

- In general, the higher the standard deviation, the greater the risk.
- But are securities prices normally distributed?



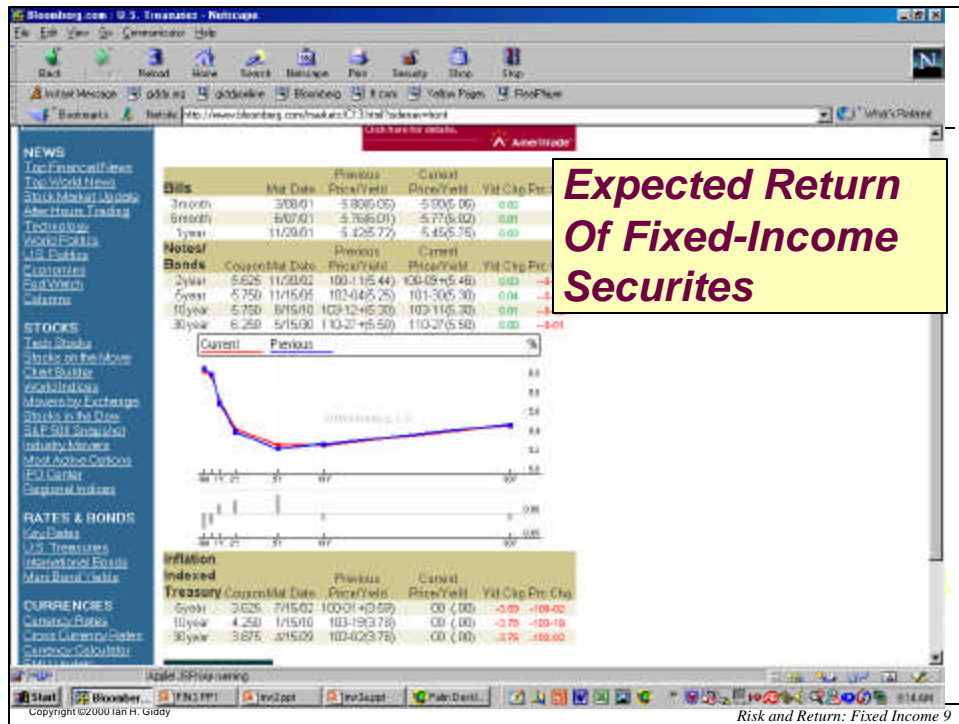
Measuring Empirical Volatility

Return Volatility:
 The usual measure of volatility is the **standard deviation**, which is the square root of the variance:

Year	Actual return	Average return	Return deviation	Squared deviation
1	.10	.05	.05	.0025
2	-.07	.05	-.12	.0144
3	.28	.05	.23	.0529
4	-0.11	.05	-.16	.0256
Total	.20		.00	.0954

The variance σ^2 or $\text{Var}(R) = .0954 / (N-1) = .0318$
 The standard deviation σ or $\text{SD}(R) = \sqrt{.0318} = .1783$ or 17.83%

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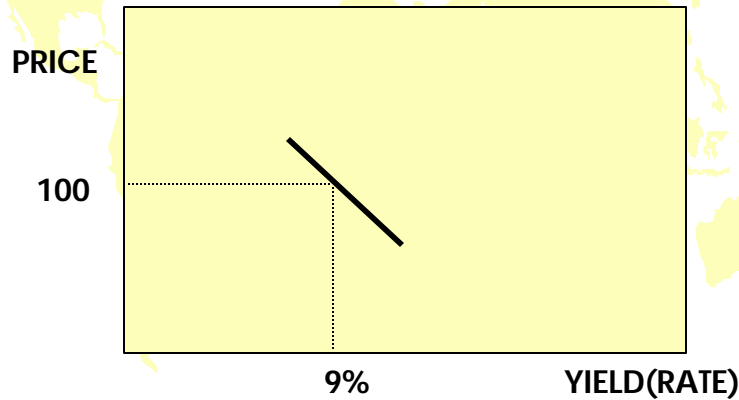
Price Risk of Treasuries

Treasuries differ:

- Liquidity - traders quote wider bid-ask spreads for illiquid bonds
- Duration - sensitivity of price to a change in interest rates - is based on the bond's coupon levels and maturity date (low duration means less risky)
- Convexity - measures how duration changes with a change in rates (high convexity is desirable)

The Price-Yield Relationship

Bond prices and interest rates have an inverse relationship:

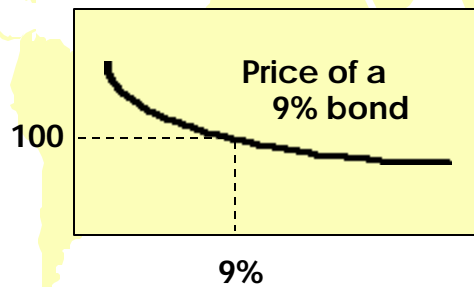


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The Price-Yield Relationship

But plotting price vs yield shows that the relationship is non-linear:



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Maturity

In general, the longer the maturity, the more sensitive is a bond's price to interest-rate changes, other things being equal:

	Price	
Required yield	9%, 5 year	9%, 25 year
8%	104.0554	110.7510
9%	100.0000	100.0000
10%	96.1391	90.8720

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The Coupon Effect...

But three bonds with the *same* maturity can have very different sensitivities, depending on their *coupon* levels:

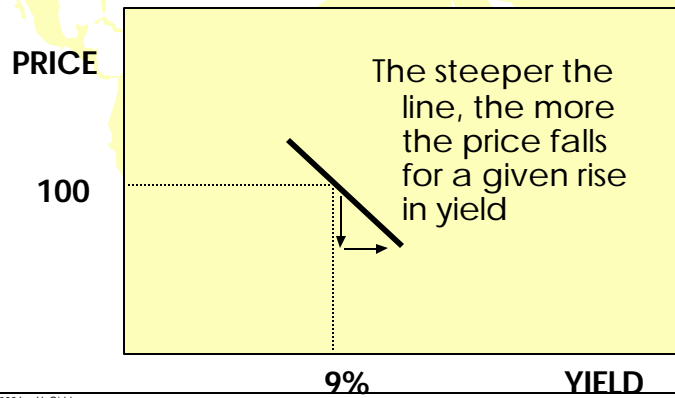
	Price		
Required yield	9%, 5 year	6%, 5 year	0%, 5 year
8%	104.05	91.88	67.56
9%	100.00	88.13	64.39
10%	96.13	84.56	61.39

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Duration as a Measure of Price Sensitivity

Duration measures the % price change for a given change in yield:

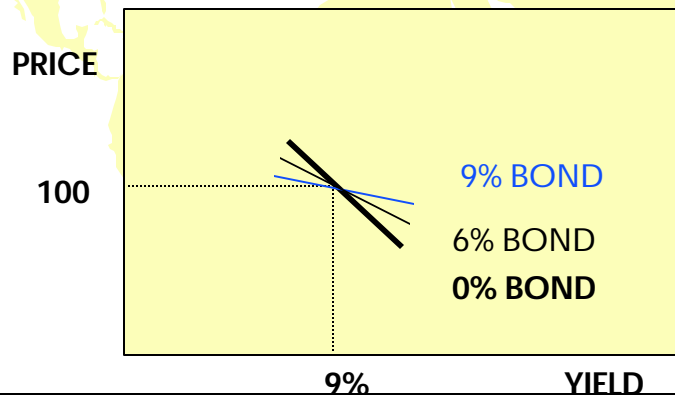


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Greater Duration, Greater Risk

Duration is measured as the PV-weighted average life, so low-coupon bonds have greater duration



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Calculating Duration: MacCauley and Modified

$$D_{MAC} = \sum_{t=1}^n \frac{tCF_t / (1+r)^t}{P}$$

$$D_{MOD} = \% \Delta P = \frac{dP}{P} = -\frac{D}{(1+r)}$$

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Calculating Modified Duration: Shortcut Method

The average percentage price change, relative to the initial price, per 1-basis-point change in yield:

$$ApproxD_{MOD} = \% \Delta P = \frac{P_- - P_+}{2(P_0)(\Delta yield)}$$

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Duration: An Excel Spreadsheet

Yield	8.0%				
Bond A	Time (year)	0.5	1	1.5	2
	Cash-Flows	4	4	4	104
	PV of CFs	3.84615	3.6982	3.556	88.9
	Price	100			
	Weighted CFs	4	8	12	416
	PV of weighted CFs	3.84615	7.3964	10.668	355.6
	Sum of weight. CFs	377.509			
	Semiannual duration	3.77509			
	Macaulay duration	1.88755			
	Modified	1.74773			

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About Duration:

- Duration is % price change for a 1% yield change
- The duration of a bond is the period for which the yield to maturity will be realized even if the yield curve shifts
- Duration is additive: a portfolio's duration is the weighted average of the assets' durations
- For zero's, Duration=Maturity (close).

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Unum

Assets (each \$10m):

- ◆ 1-year E\$ deposit
- ◆ 5-year, 6% T-note
Duration=4.6
- ◆ 9-year Strip

Fixed liabilities:

- ◆ \$10m 3 years
- ◆ \$10m 5 years
- ◆ \$10m 7 years

◆ Unum's risk?

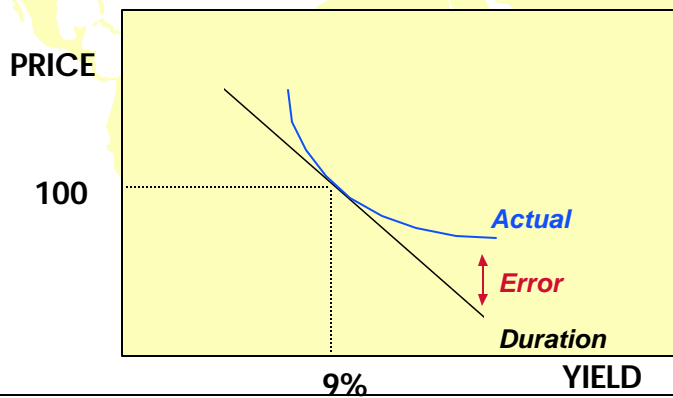
- ◆ Asset Duration = $10(1\%) + 10(4.6\%) + 10(9\%)$
- ◆ Liab Duration = $10(3\%) + 10(5\%) + 10(7\%)$
- ◆ Net duration is $1.46 - 1.50 = -4m$

Characteristics of Duration

- Except in the case of zero's, duration is less than maturity
- The lower the yield, the greater the duration
- The lower the coupon, the greater the duration
- The longer the maturity, the greater the duration
- Duration assumes parallel shifts in the yield curve.
 - ◆ Alternative measures of duration have been developed, measures that assume more realistic changes in the way the yield curve shifts

Bond Price Changes: Actual vs. Duration-Based

There's an error in duration-based estimation, because duration is linear.



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Convexity

Convexity, or curvature, helps correct duration's mispricing. Because duration itself changes, we need a measure of the price change due to a change in duration. This is the second derivative of the price change, annualized and divided by the price:

$$CONV = \left[\frac{mC}{y^3} \left(1 - \frac{1}{(1+y)^n} \right) - \frac{mCn}{y^2 (1+y)^{n-1}} + \frac{n(n+1)(100-C/y)}{(1+y)^{n+2}} \right] \frac{1}{m^2 P}$$

where C is the coupon, m the frequency, n the maturity and y the yield.

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Calculating Convexity: Shortcut Method

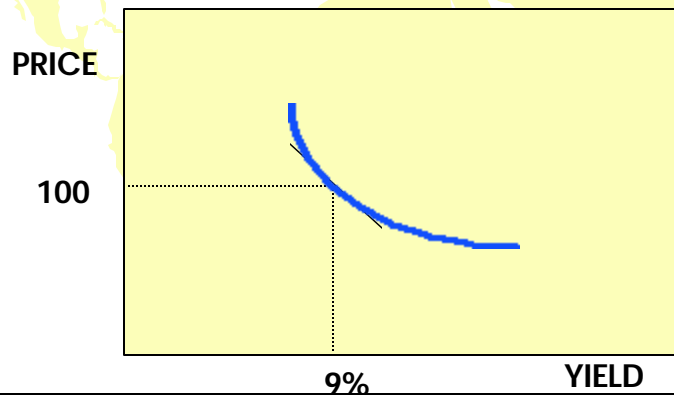
$$\text{ApproxConv} = \frac{P_- + P_+ - 2P_0}{P_0(\Delta\text{yield})^2}$$

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Convexity: The Change in Duration

The percentage price change in a bond can be approximated using both duration and convexity.

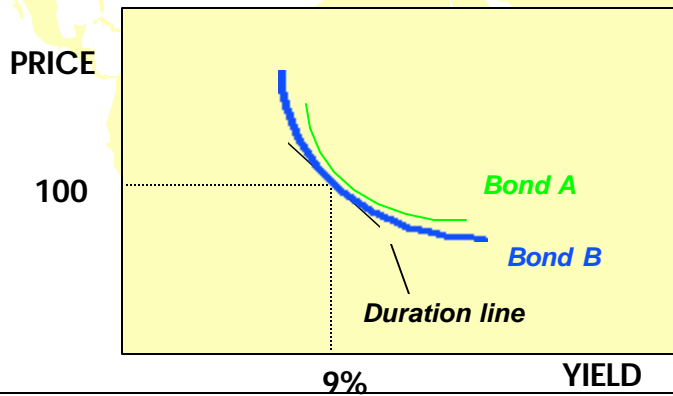


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Convexity for Different Bonds

Positive convexity is desirable, because it cushions a bond's price fall and accelerates its rise.

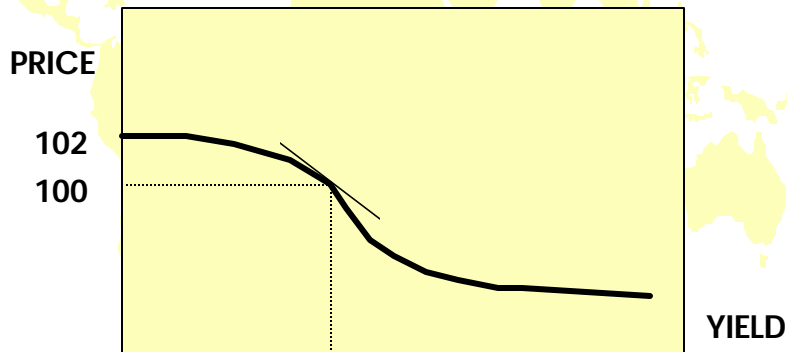


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Convexity of Callables

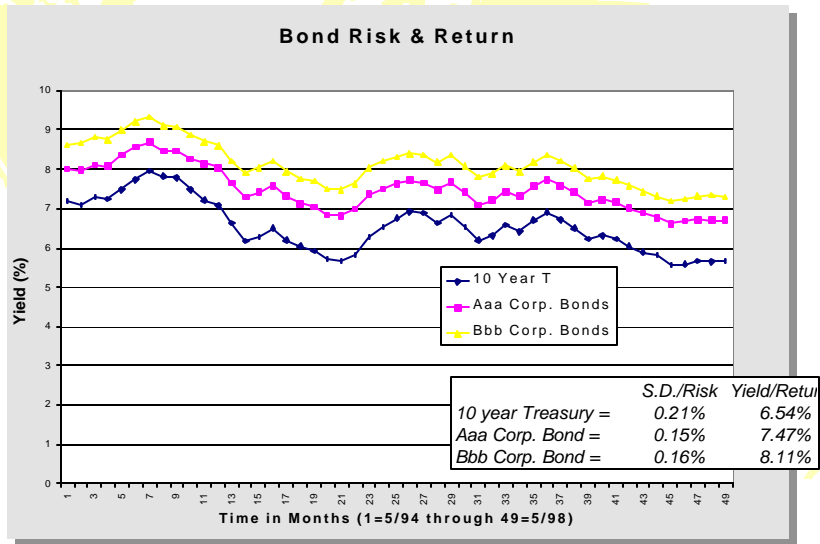
Mortgage-backed securities and other callable bonds may have negative convexity which cushions a bond's price rise and accelerates its fall!



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Riskiness of Bonds (Optional Assignment)



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Default Risk and Ratings

Rating companies

- ◆ Moody's Investor Service
- ◆ Standard & Poor's
- ◆ Fitch/Duff and Phelps

Rating Categories

- ◆ Investment grade
- ◆ Speculative grade

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Rating Agencies

- Moodys
- Standard & Poors
- Fitch

Why a rating?

- Compare alternatives across different ratings categories;
- Obtain a relative as well as an absolute measure of credit risk
- Be reasonably sure of a market to sell the security.

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Bond Credit Ratings

Moody's	Standard & Poor's	Interpretation
Aaa	AAA	High-quality debt instruments
Aa	AA	
A	A	Strong to adequate ability to pay principal and interest
Baa	BBB	
Ba	BB	Ability to pay interest and principal speculative
B	B	
Caa	CCC	
Ca	CC	
C	C	
	D	In default

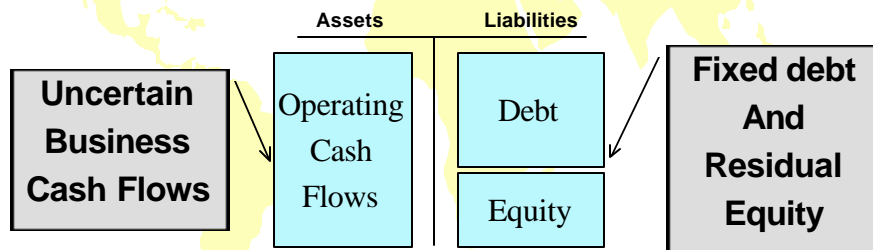
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Factors Used by Rating Companies

- Coverage ratios
- Leverage ratios
- Liquidity ratios
- Profitability ratios
- Cash flow to debt

The Options Approach

How can we determine the spread on a corporate bond?

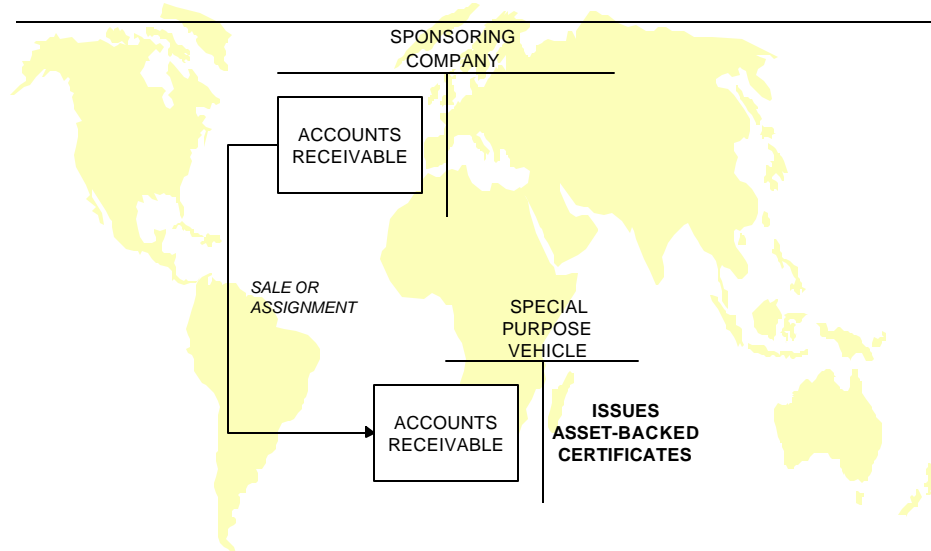


Owning debt is like writing a put

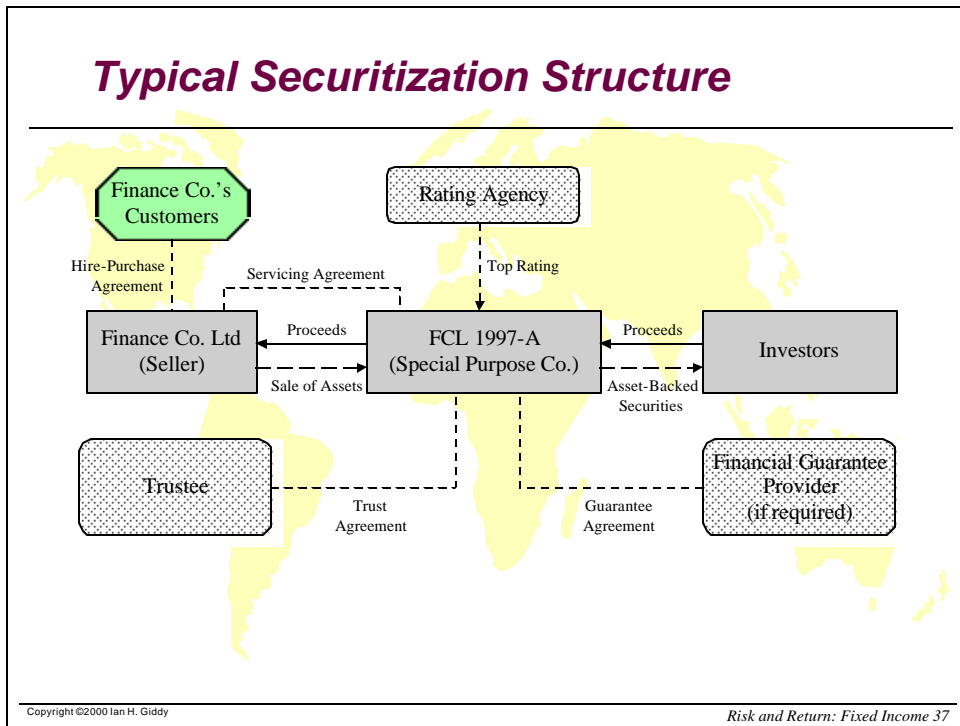
Debt Instruments: Three Special Cases

- High yield bonds
- Country debt and Brady Bonds
- Asset-Backed Securities

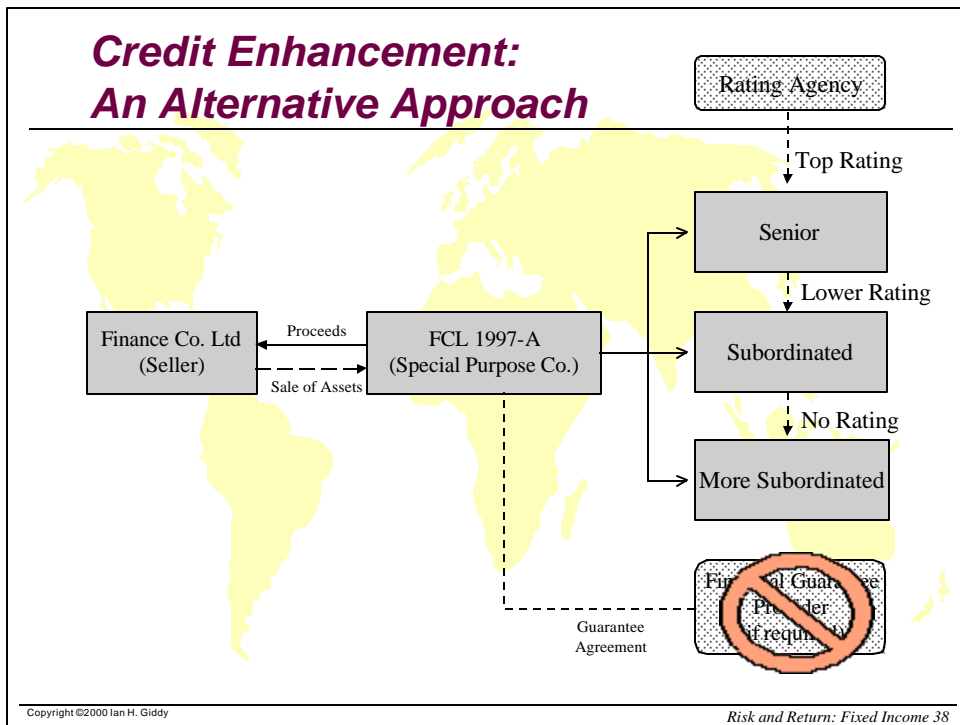
Securitization: The Structure

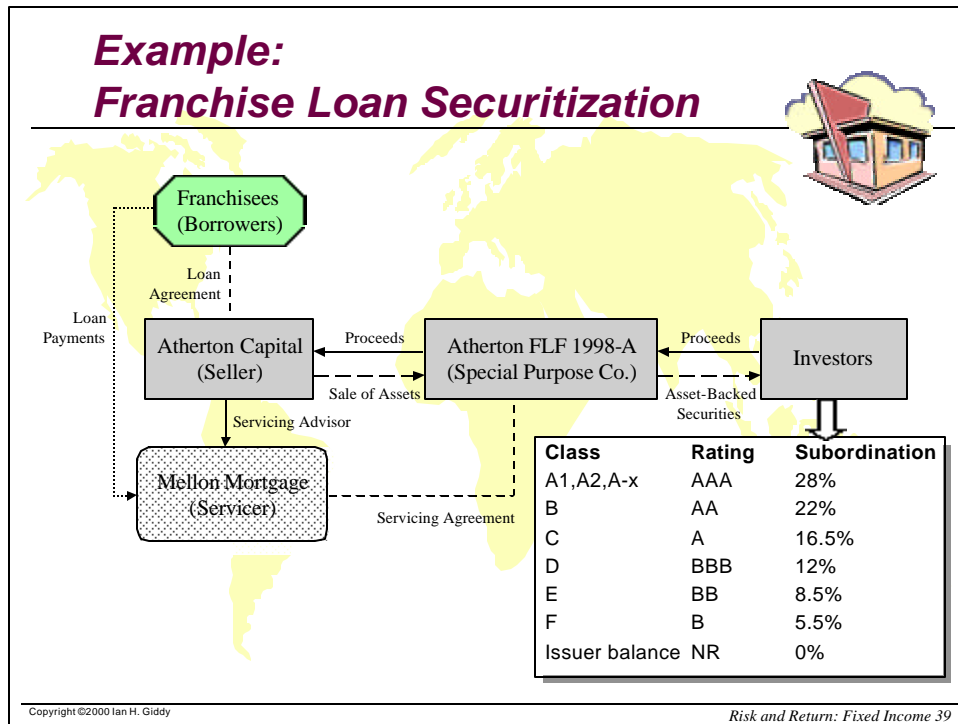


Typical Securitization Structure



Credit Enhancement: An Alternative Approach





Rating Reports

- General reports on a sector, like CLOs
- Pre-sale report on an individual CLO, once risks have been evaluated but final terms and credit enhancement have not yet been finalized
- Final deal report
- Periodic updates

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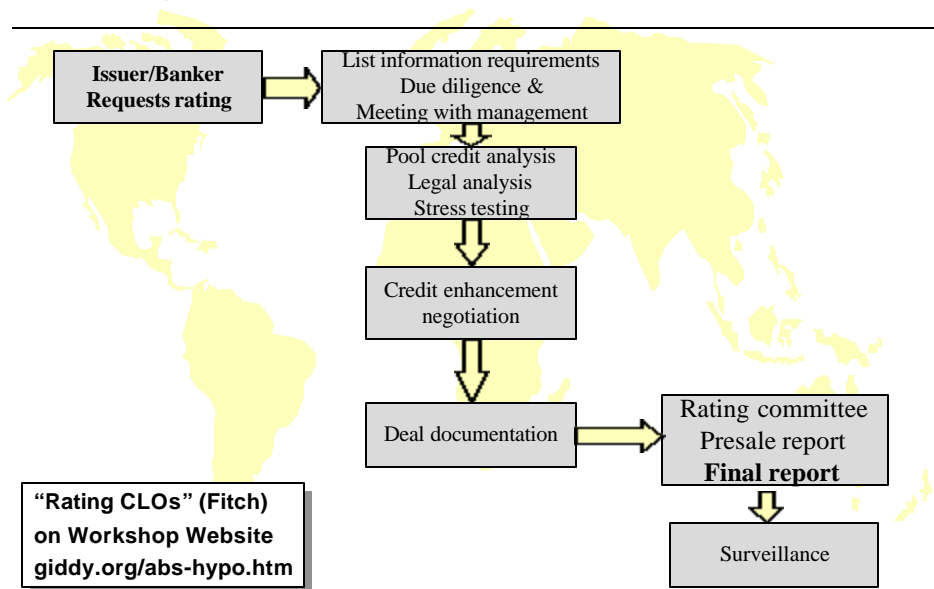
Key Factors Agencies Examine

- the quality of the pool of assets, evaluated as a portfolio
- the credit quality of all the parties to the deal.
- operational support for servicing, transfer, recording, follow-up, etc;
- credit enhancement
- legal structure
- sovereign risks
- market price risks
- payment timing risks

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Rating Process



“Rating CLOs” (Fitch)
on Workshop Website
giddy.org/abs-hypo.htm

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CLO Rating Process (Fitch)

- Information request
- Initial review
 - ◆ Bank’s internal credit standards, history
 - ◆ Credit scoring correlation
 - ◆ Chargeoffs and nonaccruals
- Due diligence
- Legal
- SPV
- Participations vs assignments vs CLNs
- Determining credit enhancement

Stress Testing & Credit Enhancement

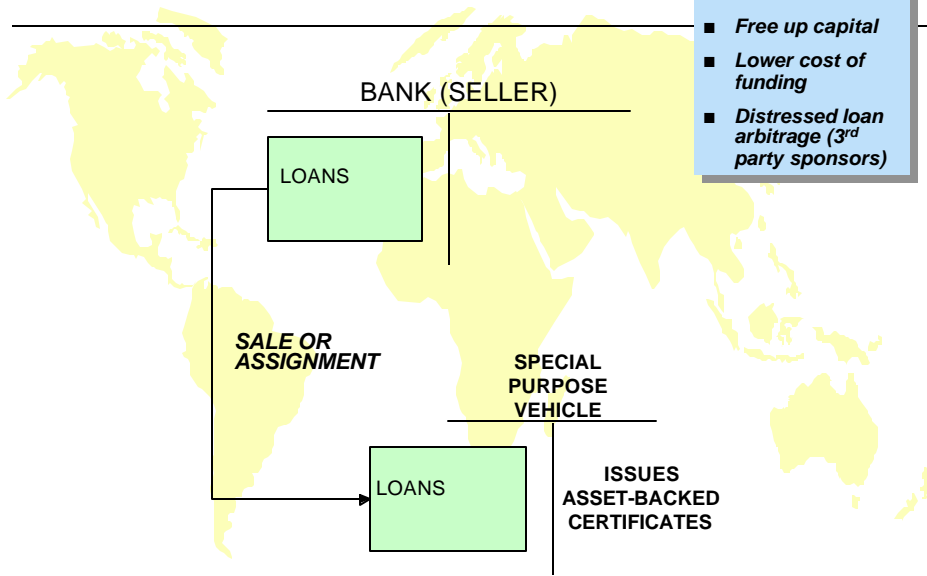
Collateral	Default probability 10yr	Note rating	
		BBB	AAA
AAA	1%	0.5	1.3
BBB	4%	5.0	14.0
B-	34.5%	39.7	70.8

Source: Fitch/BCA Bank CLOs

Collateralized Debt Obligations

- Cash flow backed CLOs and CBOs
- Market value backed CBOs
- Synthetic CLOs

Cash Flow Backed CLOs

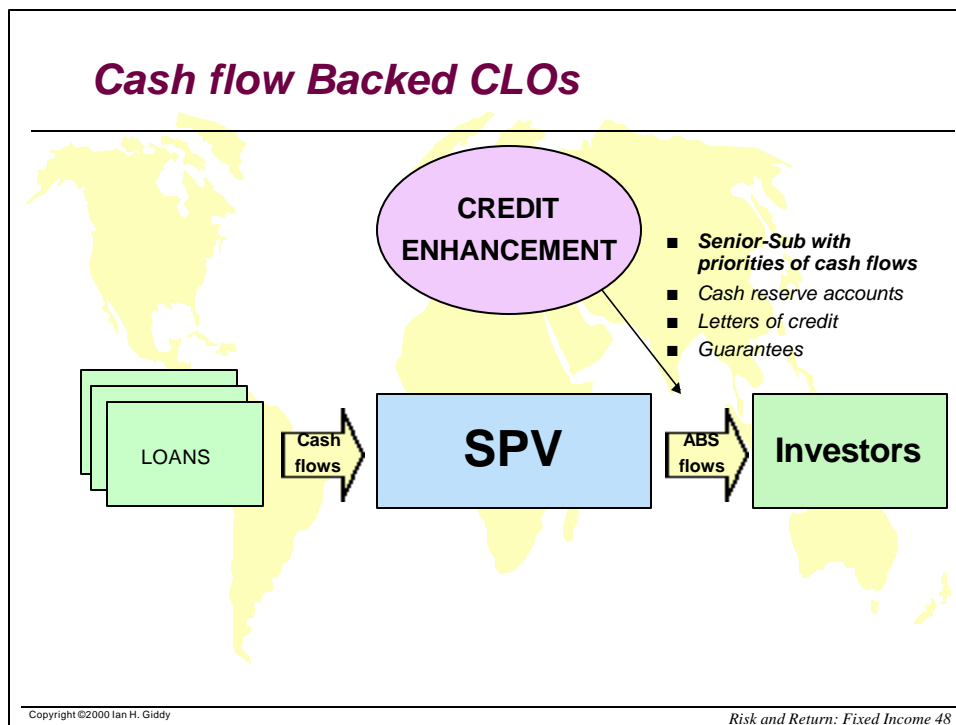


Sample Information Request

<p>General/Organization</p> <ul style="list-style-type: none"> ☐ Functional Areas and Staffing Levels ☐ Key Officers and Responsibilities ☐ Team Biographies ☐ Related Experience and Performance ☐ Credit Approval Process <p>Market Risk Management</p> <ul style="list-style-type: none"> ☐ Hedging Strategy ☐ Interest Rate Risk Limits ☐ Counterparty Approval <p>Portfolio Risk Management</p> <ul style="list-style-type: none"> ☐ Investment Strategy ☐ Risk Management Philosophy ☐ Pricing Systems ☐ Portfolio Monitoring <p>Portfolio Level</p> <ul style="list-style-type: none"> ☐ Distributions by: <ul style="list-style-type: none"> > Country > Industry > Credit Rating > Asset Class > Loan Size > Maturity > Payment Frequency > Margin > Loan Type > Base Rate — LIBOR, Prime, and Federal Funds, Among Others > Currency > Collateral > Position of Loan in Borrower's Capital Structure > Drawn and Undrawn Amounts > Swap Rate > Swap Counterparty > Facility Rating > Amortization Schedule 	<p>Credit Risk Management</p> <ul style="list-style-type: none"> ☐ Performance Benchmarks ☐ Use of External Ratings ☐ Internal Credit Evaluation System <ul style="list-style-type: none"> > Basis of Credit-Scoring System > Adjustments for Industry > Influence of Collateral > Treatment of Guarantees > Relationships/Parent Companies/Subsidiaries ☐ Default Levels (by Internal Credit Score and Year) ☐ Recovery Levels (by Internal Credit Score and Year) ☐ Loan Provisions <p>Actual Loss History</p> <ul style="list-style-type: none"> ☐ Specific Credit Information by Borrower <ul style="list-style-type: none"> > Name > Guarantor > Parent Company > Country > Industry <p>Operations</p> <ul style="list-style-type: none"> ☐ Risk Management Tracking and Reporting ☐ Procedures to Assure Consistent Use of Credit Scoring (Previous Changes to the Credit-Scoring System) ☐ Monitoring of Upgrades and Downgrades ☐ System Contingency Plans <p>Transaction</p> <ul style="list-style-type: none"> ☐ Cash Flow Model <p>Legal Opinions*</p> <ul style="list-style-type: none"> ☐ First Perfected Security Interest Opinion ☐ FIRREA Opinion ☐ True Sale Opinion ☐ Nonconsolidation Opinion
--	---

*U.S. issuers. Requirements for other jurisdictions will vary.
LIBOR — London Interbank Offered Rate; FIRREA — Financial Institutions Reform, Recovery, and Enforcement Act of 1989.

Source: Fitch, "Bank CLOs: an Overview"



Senior-Sub CLO Structure

Sample CLO Balance Sheet
(\$ Mil.)

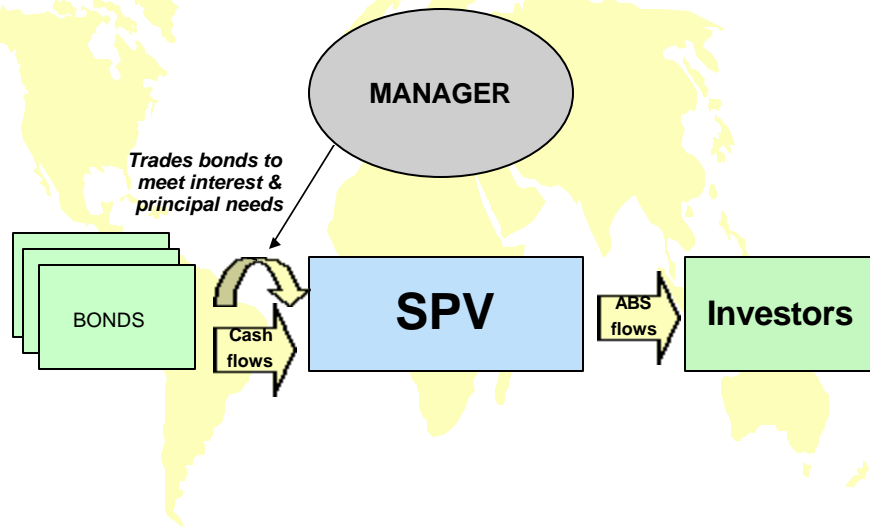
Assets (Loans)	Liabilities (Notes)	Rating	%
5,000	4,650	'AAA/AA'	93
—	100	'A'	2
—	100	'BBB'	2
—	150*	—	3
5,000	5,000		

*Equity, not rated. CLO – Collateralized loan obligation.

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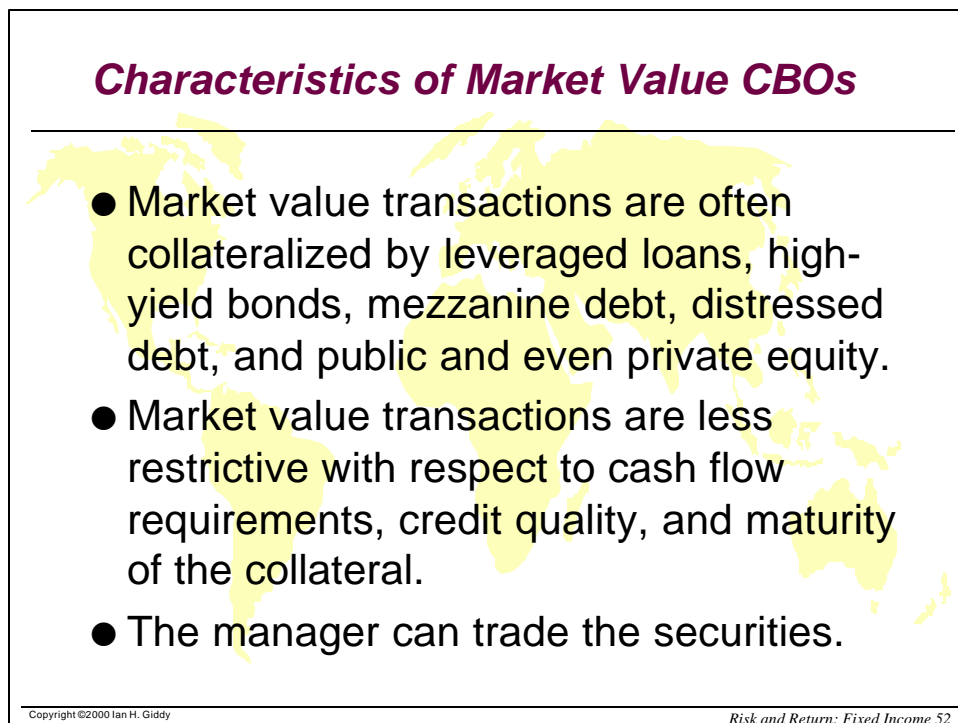
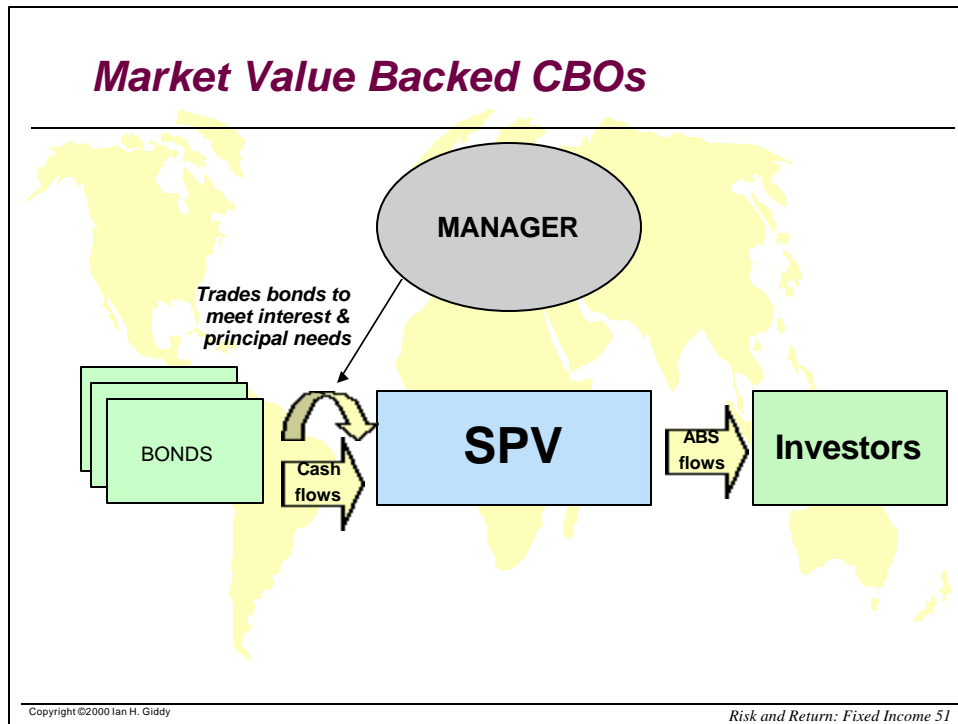
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Market Value Backed CBOs

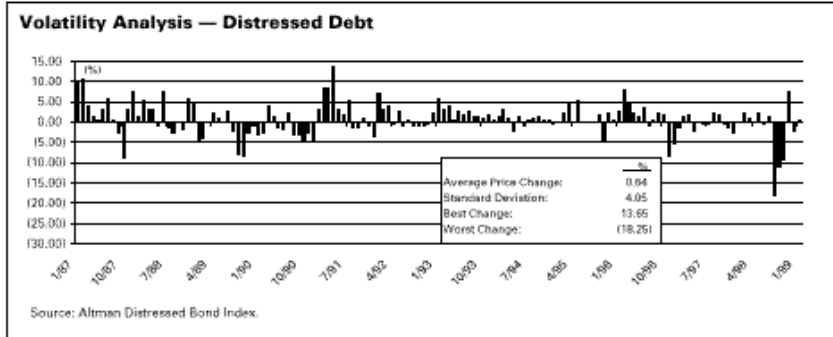


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Rating Agencies Analyze Price Volatility to Determine CE Requirements

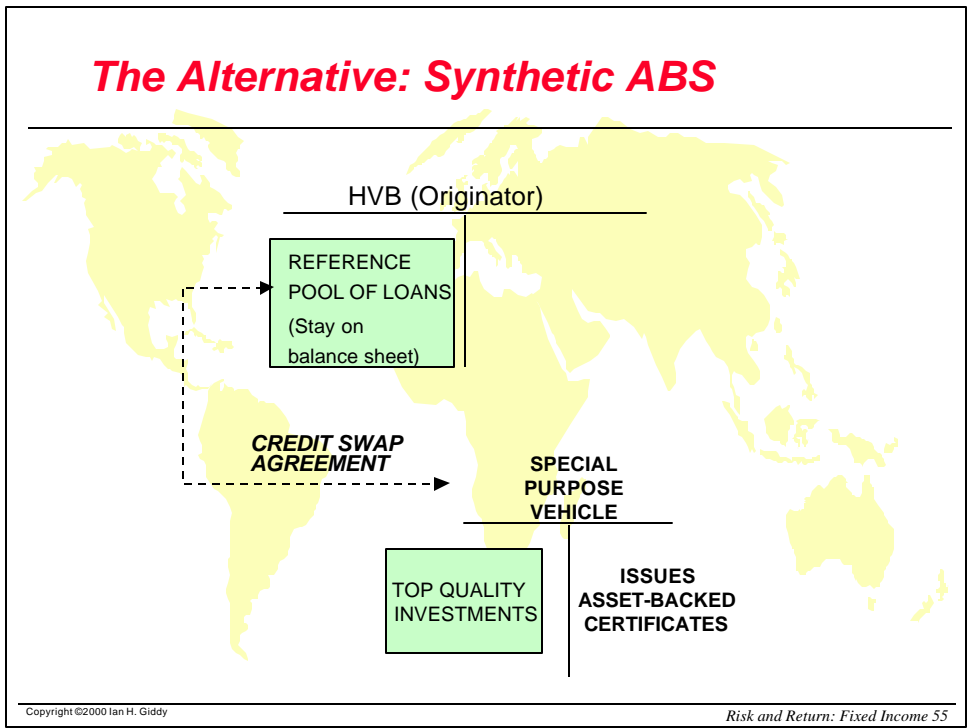


Advance rates determine how much rated debt can be issued against the market value of an asset.

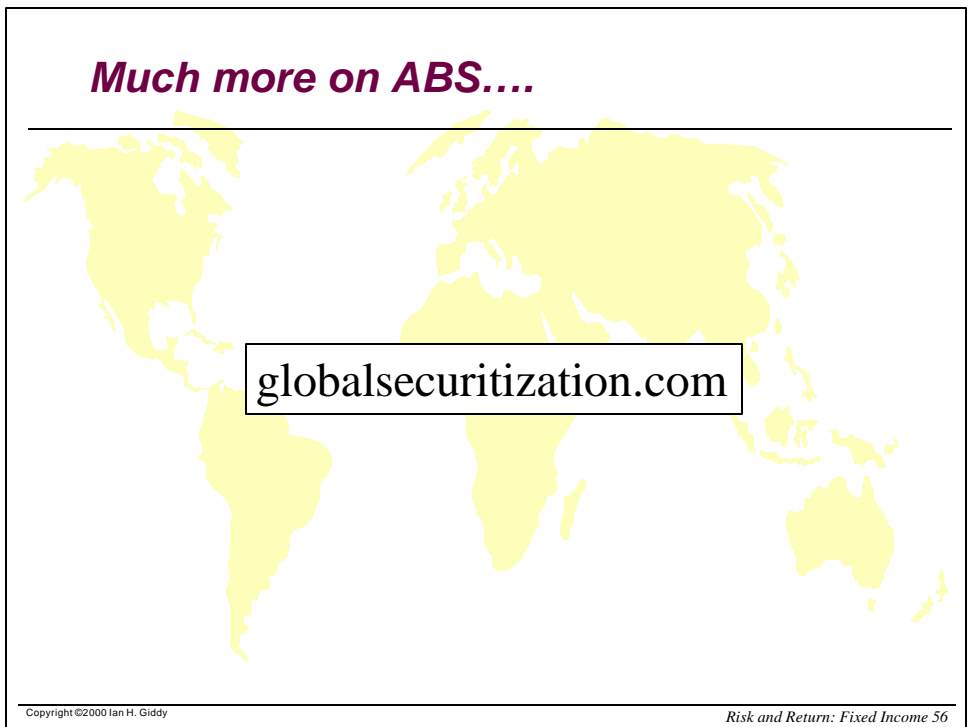
Asset Category	'B'	'BB'	'BBB'	'A'	'AA'	'AAA'
Cash and Equivalents	100	100	100	100	100	100
Certificate of Deposit, Commercial Paper	100	100	99	99	99	99
Senior Secured Bank Loans	96	95	93	91	89	87
'AAA' Corporate Bonds	96	95	93	91	89	87
'AA' Corporate Bonds	96	95	93	91	88	86
'A' Corporate Bonds	96	94	92	89	87	84
'BBB' Corporate Bonds	96	94	91	88	85	82
'BB-' High-Yield Debt	94	92	90	86	82	77
< 'BB-' High-Yield Debt	93	89	85	80	73	66
Investment-Grade Convertibles	90	85	80	70	60	50
High-Yield Convertibles, PIK, Zero, Step-Up	88	81	76	63	52	40
Mezzanine, Distressed Debt	85	80	73	60	55	27
Emerging Market	85	78	71	50	40	27
Equity, Illiquid Debt	85	78	71	50	40	27

Note: Advance rates may vary for more or less diversified pools.

The Alternative: Synthetic ABS



Much more on ABS....



Default Risk and Ratings

- Rating companies
 - ◆ Moody's Investor Service
 - ◆ Standard & Poor's
 - ◆ Duff and Phelps
 - ◆ Fitch
- Rating Categories
 - ◆ Investment grade
 - ◆ Speculative grade

Bond Credit Ratings

Moody's	Standard & Poor's	Interpretation
Aaa	AAA	High-quality debt instruments
Aa	AA	
A	A	Strong to adequate ability to pay principal and interest
Baa	BBB	
Ba	BB	Ability to pay interest and principal speculative
B	B	
Caa	CCC	
Ca	CC	
C	C	
	D	In default

Factors Used by Rating Companies

- Coverage ratios
- Leverage ratios
- Liquidity ratios
- Profitability ratios
- Cash flow to debt

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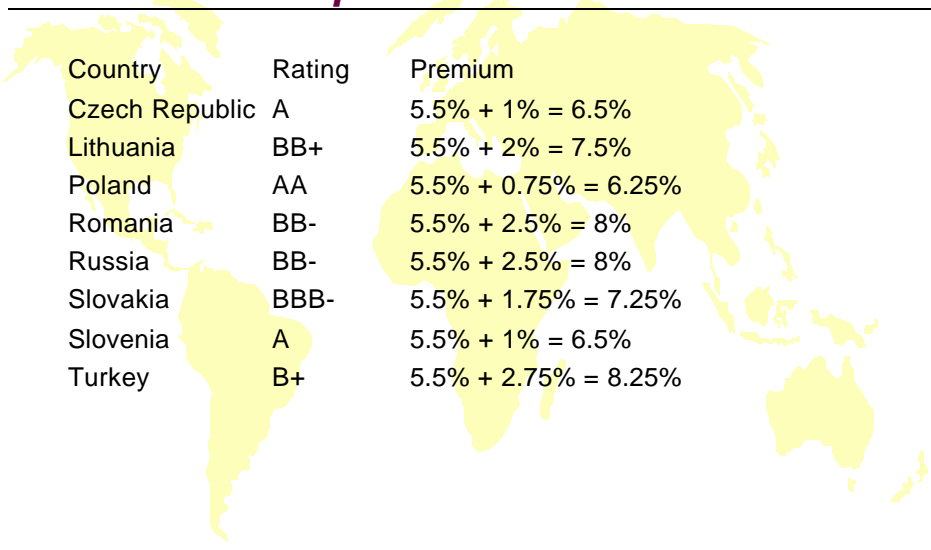
Country Risk Premiums: Latin America

<i>Country</i>	<i>Rating</i>	<i>Risk Premium</i>
Argentina	BBB	5.5% + 1.75% = 7.25%
Brazil	BB	5.5% + 2% = 7.5%
Chile	AA	5.5% + 0.75% = 6.25%
Columbia	A+	5.5% + 1.25% = 6.75%
Mexico	BBB+	5.5% + 1.5% = 7%
Paraguay	BBB-	5.5% + 1.75% = 7.25%
Peru	B	5.5% + 2.5% = 8%
Uruguay	BBB	5.5% + 1.75% = 7.25%

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Country Risk Premiums: Eastern Europe

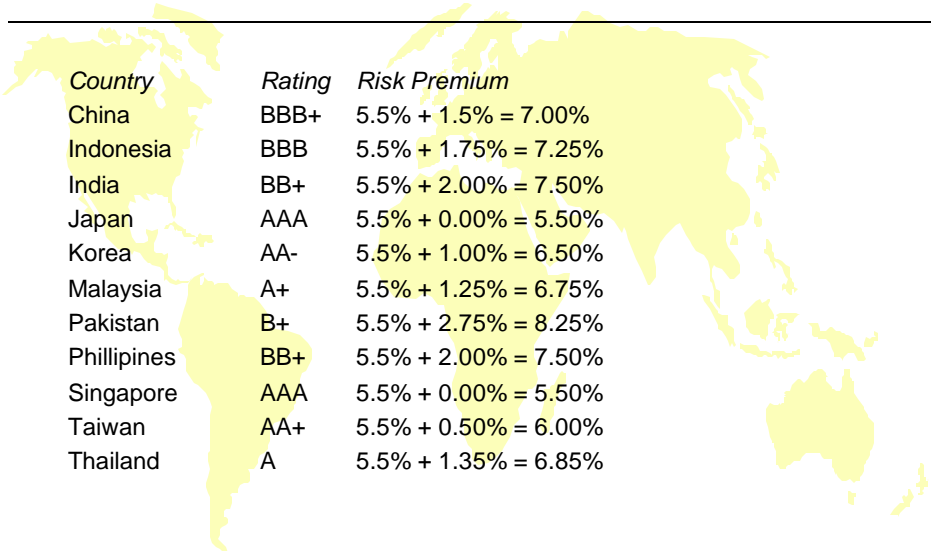


Country	Rating	Premium
Czech Republic	A	$5.5\% + 1\% = 6.5\%$
Lithuania	BB+	$5.5\% + 2\% = 7.5\%$
Poland	AA	$5.5\% + 0.75\% = 6.25\%$
Romania	BB-	$5.5\% + 2.5\% = 8\%$
Russia	BB-	$5.5\% + 2.5\% = 8\%$
Slovakia	BBB-	$5.5\% + 1.75\% = 7.25\%$
Slovenia	A	$5.5\% + 1\% = 6.5\%$
Turkey	B+	$5.5\% + 2.75\% = 8.25\%$

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Country Risk Premiums: Asia

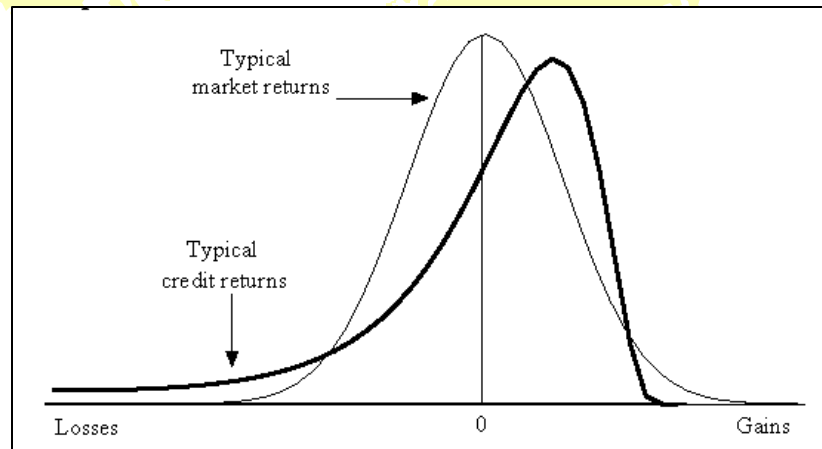


Country	Rating	Risk Premium
China	BBB+	$5.5\% + 1.5\% = 7.00\%$
Indonesia	BBB	$5.5\% + 1.75\% = 7.25\%$
India	BB+	$5.5\% + 2.00\% = 7.50\%$
Japan	AAA	$5.5\% + 0.00\% = 5.50\%$
Korea	AA-	$5.5\% + 1.00\% = 6.50\%$
Malaysia	A+	$5.5\% + 1.25\% = 6.75\%$
Pakistan	B+	$5.5\% + 2.75\% = 8.25\%$
Philippines	BB+	$5.5\% + 2.00\% = 7.50\%$
Singapore	AAA	$5.5\% + 0.00\% = 5.50\%$
Taiwan	AA+	$5.5\% + 0.50\% = 6.00\%$
Thailand	A	$5.5\% + 1.35\% = 6.85\%$

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Credit Risk versus Market Risk



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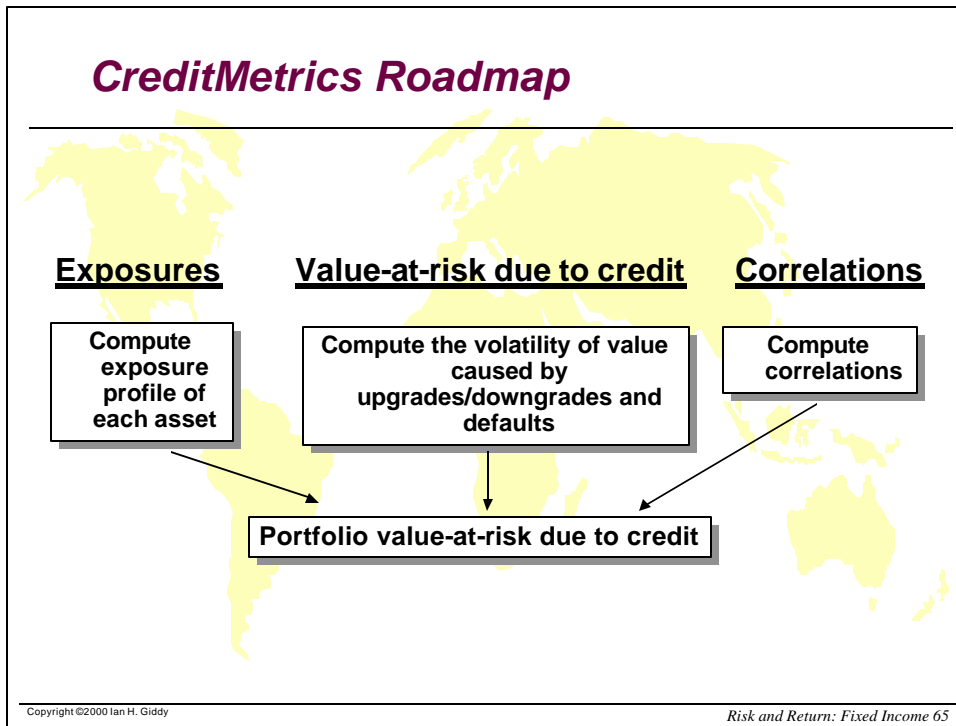
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CreditMetrics Methodology

- Establishes the *exposure* profile of each obligor in a portfolio.
- Computes the *volatility* in value of each instrument caused by possible upgrades, downgrades, and defaults.
- Taking into account *correlations* between each of these events, it combines the volatility of the individual instruments to give an **aggregate portfolio volatility**.

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Volatilities from “Transition Matrix”

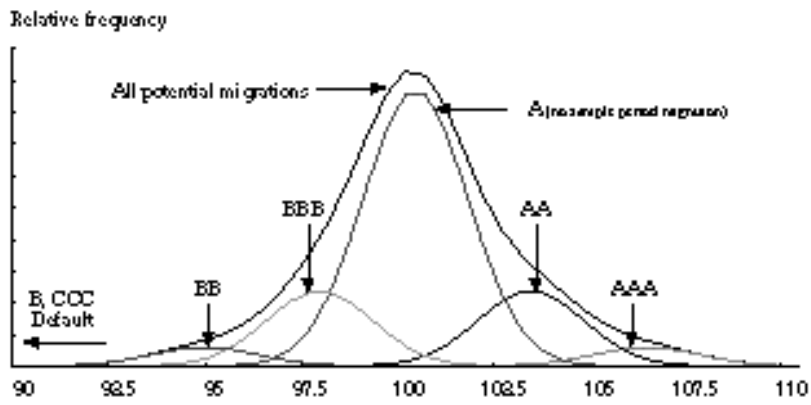
One-year transition matrix (%)

Initial Rating	Rating at year-end (%)							
	AAA	AA	A	BBB	BB	B	CCC	Default
AAA	90.81	8.33	0.68	0.06	0.12	0	0	0
AA	0.70	90.65	7.79	0.64	0.06	0.14	0.02	0
A	0.09	2.27	91.05	5.52	0.74	0.26	0.01	0.06
BBB	0.02	0.33	5.95	86.93	5.30	1.17	0.12	0.18
BB	0.03	0.14	0.67	7.73	80.53	8.84	1.00	1.06
B	0	0.11	0.24	0.43	6.48	83.46	4.07	5.20
CCC	0.22	0	0.22	1.30	2.38	11.24	64.86	19.79

Source: Standard & Poor's CreditWeek (15 April 96)

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Construction of Volatility Across Credit Horizons



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Defaults and Recovery Rates

Recovery rates by seniority class (% of face value, i.e., "par")

Seniority Class	Mean (%)	Standard Deviation (%)
Senior Secured	53.80	26.86
Senior Unsecured	51.13	25.45
Senior Subordinated	38.52	23.81
Subordinated	32.74	20.18
Junior Subordinated	17.09	10.90

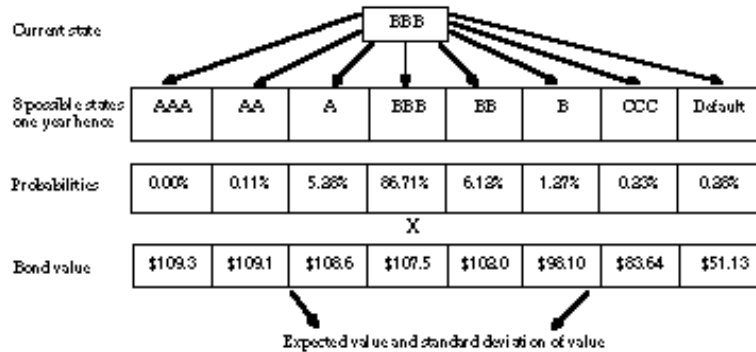
Source: Carty & Lieberman [1996] - Moody's Investors Service

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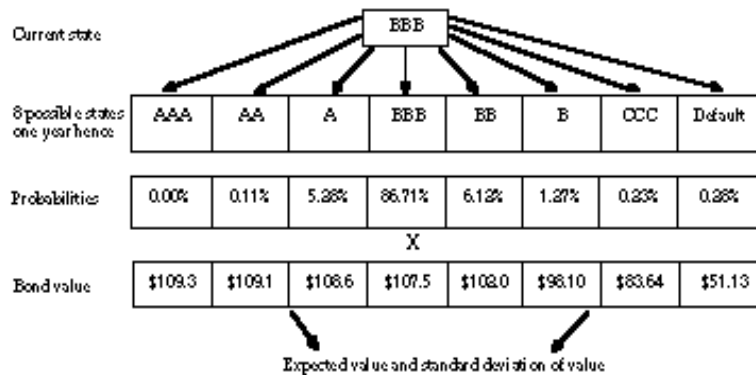
The Distribution of Returns

Constructing the distribution of value for a BBB bond



A Picture of a BBB Bond's Value Distribution

Constructing the distribution of value for a BBB bond



Calculating Mean and Standard Deviation

Calculating volatility in value due to credit quality changes for a single exposure

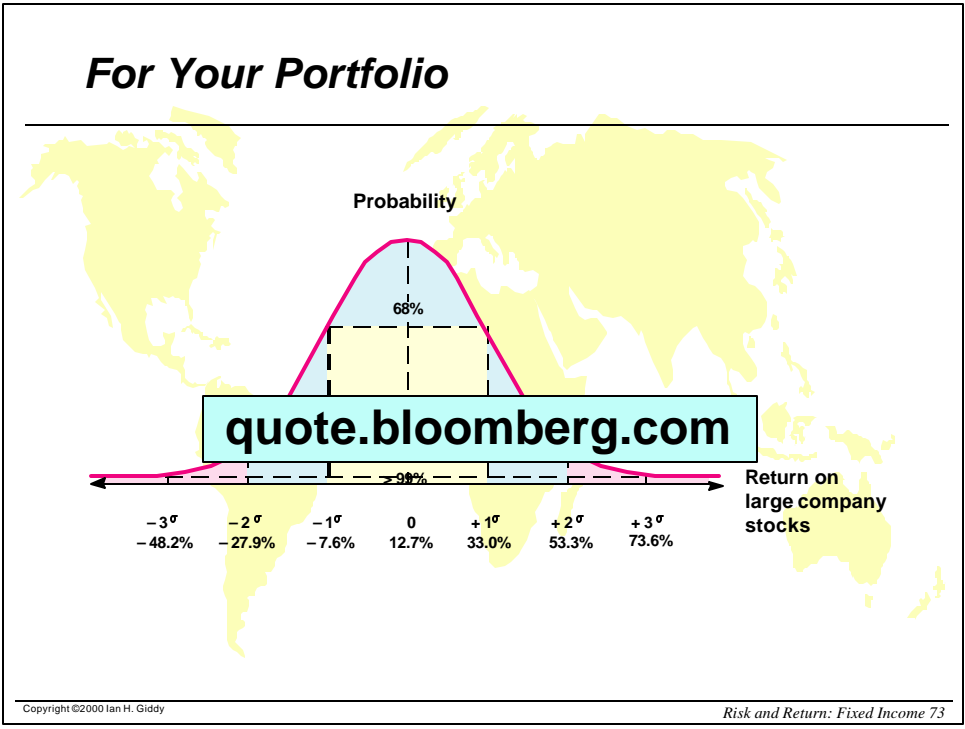
Year-end rating	Probability of state (%)	New bond value plus coupon (\$)	Probability weighted value (\$)	Difference of value from mean (\$)	Probability weighted difference squared
AAA	0.02	109.37	0.02	2.28	0.0010
AA	0.33	109.19	0.36	2.10	0.0146
A	5.95	108.66	6.47	1.57	0.1474
BBB	26.93	107.55	28.49	0.46	0.1853
BB	5.30	102.02	5.41	(5.06)	1.3592
B	1.17	98.10	1.15	(8.99)	0.9446
CCC	0.12	83.64	1.10	(23.45)	0.6598
Default	0.18	51.13	0.09	(55.96)	5.6358
		Mean -	\$107.09	Variance -	8.9477
				Standard deviation -	\$2.99

CreditMetrics

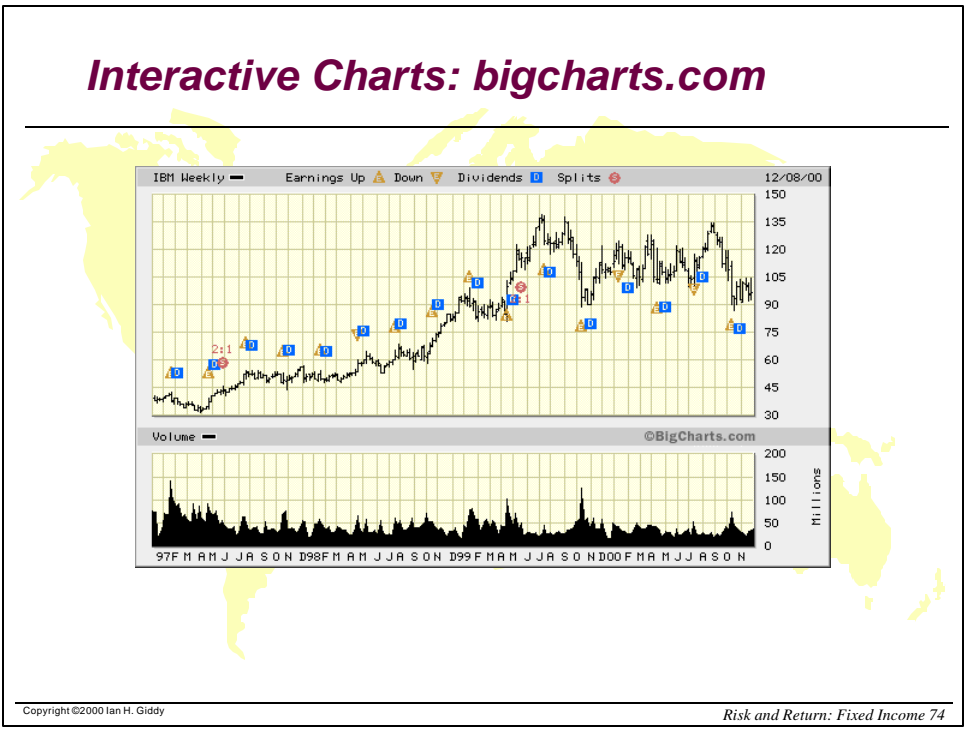
Simulating the distribution of credit returns

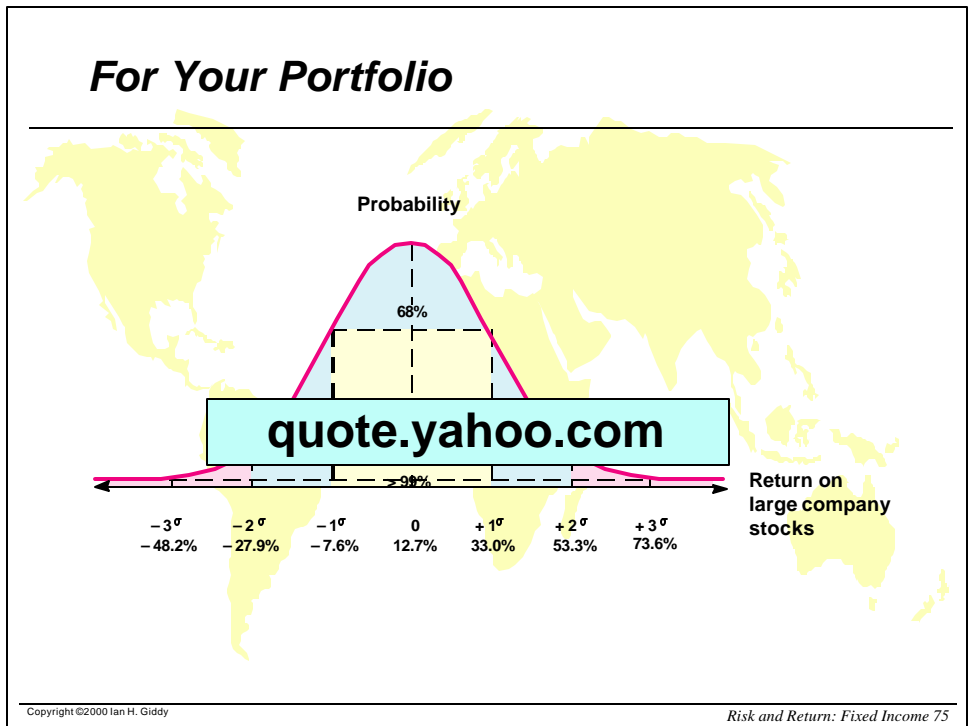


For Your Portfolio



Interactive Charts: bigcharts.com





- ### Summary
- Measuring Return & Risk
 - Risk of Fixed-Income Securities
 - Quantifying Credit Risk
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- Risk and Return: Fixed Income 76

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