

CREDIT DERIVATIVES



WHAT ARE CREDIT DERIVATIVES?

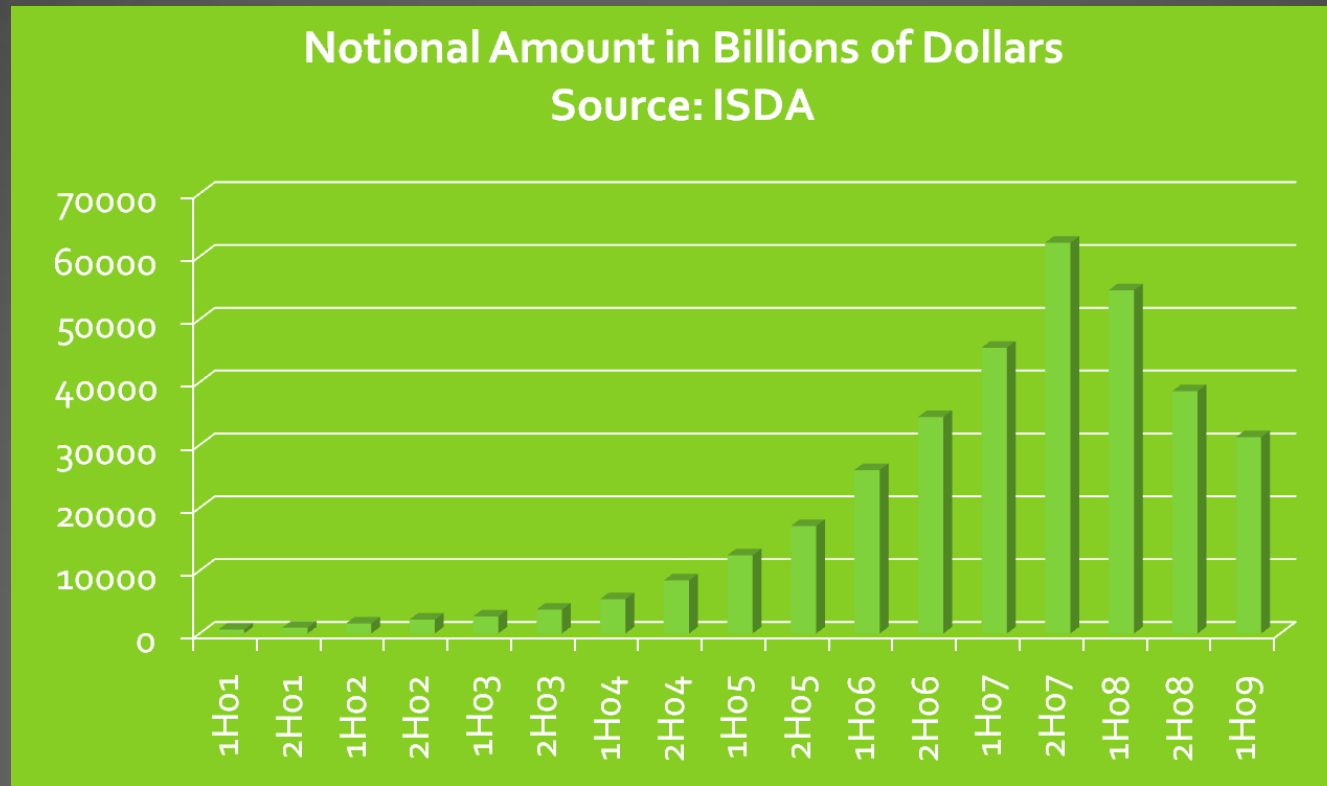
“Credit derivatives are derivative instruments that seek to trade in credit risks.”

Credit Risk: The risk that a counterparty to a financial transaction will fail to fulfill their obligation.

CREDIT DERIVATIVES

- A way for banks and other lenders to hedge against the credit risks of particular borrowers (corporations or sovereigns).
- First credit derivatives traded in mid to late 1990s
- Most common type is credit default swap (CDS)

CREDIT DEFAULT SWAP GROWTH AND DECLINE



COMPARISONS TO CORPORATE DEBT

- ▶ In June 2007, the total amount of corporate bonds issued in the US was only \$11 trillion.
- ▶ Some credit derivatives written on collateralized debt obligations (CDO) or foreign firms. CDO market size was estimated at \$2 trillion in 2006.
- ▶ CDOs are a form of mortgage backed security or other asset backed security.

USERS OF CREDIT DERIVATIVES

- Banks buy credit derivatives to hedge the risk of their borrowers defaulting.
- Insurance companies are among the major sellers of credit derivatives.
- Hedge funds and pension funds also use credit derivatives.

SOME TERMS

- **Credit Event:** A bankruptcy, default or other event that triggers a payoff in a credit derivative as defined in the contract.
- **Credit Rating:** A rating issued by a rating agency such as Moody's, S&P, or Fitch of the creditworthiness of a company or a security such as a CDO.
- **Reference Asset:** The loan or debt security underlying a credit derivative.

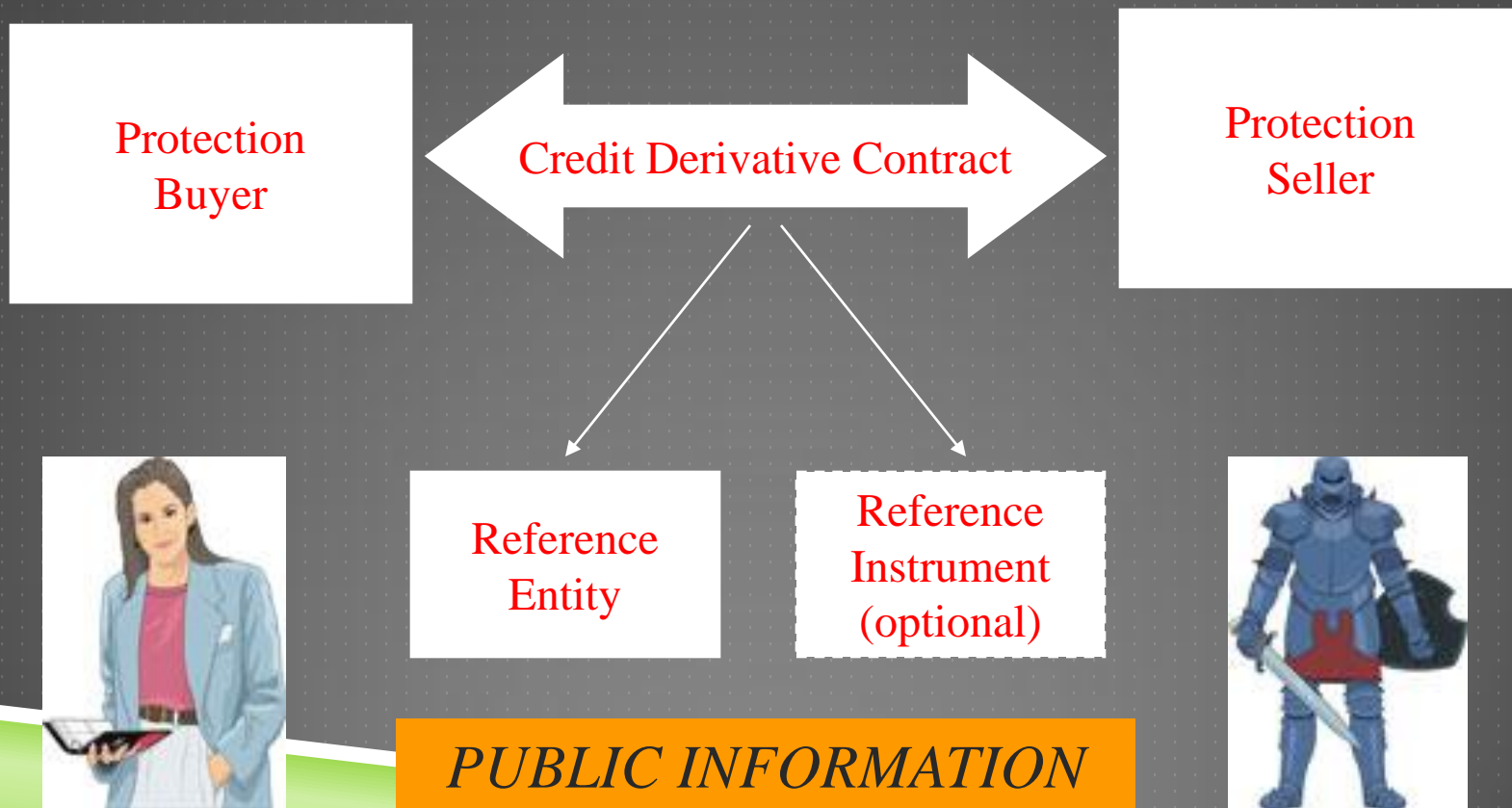
CREDIT RATINGS

- ▶ In the S&P rating system, AAA is the best rating. After that comes AA, A, BBB, BB, B, CCC, CC, and C
- ▶ The corresponding Moody's ratings are Aaa, Aa, A, Baa, Ba, B, Caa, Ca, and C
- ▶ Bonds with ratings of BBB (or Baa) and above are considered to be “investment grade”

REFERENCE ASSET

A reference asset can be a bank loan or it can be a debt instrument from a corporation (corporate bond) or a country (sovereign debt). Or, as noted, a CDO.

HOW DOES A CREDIT DERIVATIVE CONTRACT WORK



CREDIT DERIVATIVES SELLER AND BUYER



- ▶ The seller promises to protect the buyer against an economic loss in a “reference asset” (a credit asset such as a bond, a loan or equivalent) due to a “credit event” (e.g. bankruptcy or default).
- ▶ The buyer pays the seller an annual premium for the protection. In the case of an OTC credit event (e.g. bankruptcy or default), the protection seller compensates the protection buyer for the economic loss experienced (e.g. drop in the value of a bond).



TYPES OF CREDIT DERIVATIVES

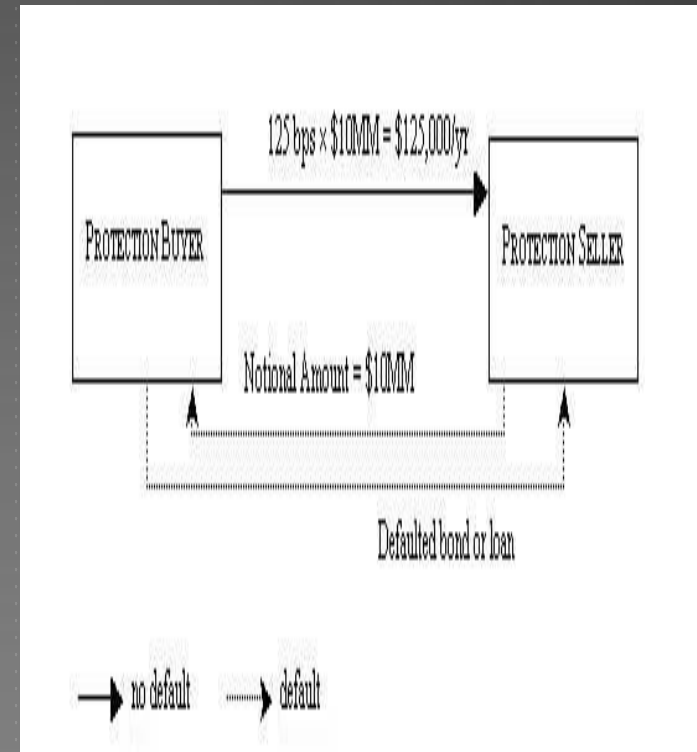
- Credit Default Swap
- Total Return Swap
- Credit Spread Option
- Downgrade Option

CREDIT DEFAULT SWAP

- A bilateral contract in which the seller agrees to make a payment to the buyer in the event of a specified credit event in exchange for a fixed payment or series of fixed payments; the most common type of credit derivative.
- Think of a credit default as an insurance policy against a credit event.

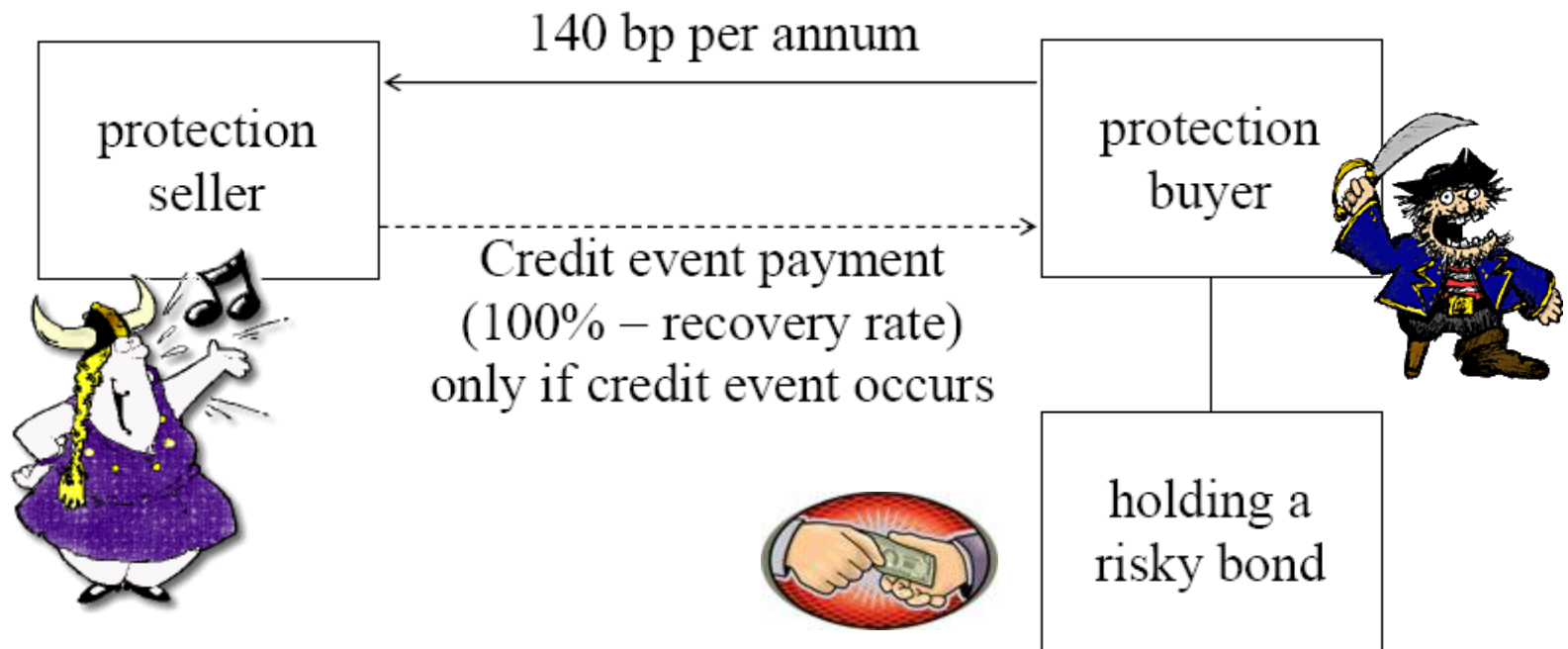
CREDIT DEFAULT SWAPS

- ▶ A credit default swap (CDS) is a credit derivative, that is priced as a yield spread and quoted in basis points, typically for a minimum notional value of \$10 million.
- ▶ CDS pricing is based on the probability that the reference entity will experience a credit event and the expected recovery rate, which is often defined as a percentage of the face value of the reference asset.



Credit default swaps

The protection seller receives fixed periodic payments from the protection buyer in return for making a single contingent payment covering losses on a reference asset following a default.



CREDIT DEFAULT SWAP EXAMPLE

- Suppose GalaxiBank makes a \$10 million loan to General Starships at 7% interest payable in installments over 5 years. GalaxiBank then buys a credit default swap from insurance company Planetary Interstellar Group (PIG).
- Insurance companies are big users of credit derivatives in the US.



CREDIT DEFAULT SWAP EXAMPLE

In this example, GalaxiBank pays a premium to PIG of \$50,000 per year to PIG. In the event of a specified credit event, PIG will pay GalaxiBank the notional amount (\$10 million) less any recovery value (what GalaxiBank can get from selling the loan).



CREDIT EVENT

- A credit event must be defined in the swap contract. The definition may include a default, missed payment, bankruptcy, or credit downgrade.
- The International Swaps and Derivatives Association (ISDA) has published master agreements with standard definitions of a credit event.

CREDIT DEFAULT SWAP EXAMPLE

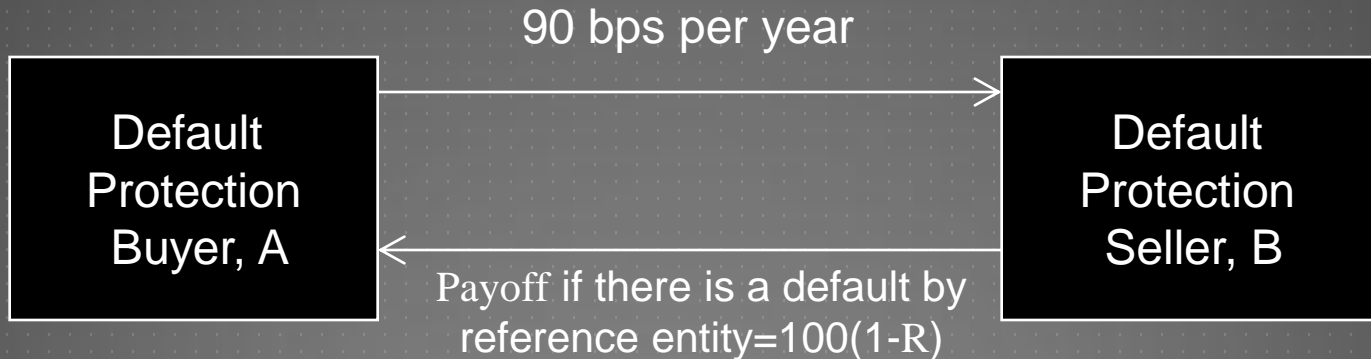
- In our example, suppose, GS's credit rating is downgraded, reducing the market value of the loan from \$10,000,000 to \$9,000,000. PIG will then pay GalaxiBank \$1,000,000.
- A credit default swap looks a lot like an insurance policy on credit and is subject to the problems with moral hazard and adverse selection that typically apply to insurance policies. We'll discuss these issues a little later.



CREDIT DEFAULT SWAPS

- ▶ A huge market with over \$40 trillion of notional principal
- ▶ Buyer of the instrument acquires protection from the seller against a default by a particular company or country (the reference entity)
- ▶ Example: Buyer pays a premium of 90 bps per year for \$100 million of 5-year protection against company X
- ▶ Premium is known as the *credit default spread*. It is paid for life of contract or until default
- ▶ If there is a default, the buyer has the right to sell bonds with a face value of \$100 million issued by company X for \$100 million (Several bonds are typically deliverable)

CDS STRUCTURE (FIGURE 23.1, PAGE 527)



Recovery rate, R , is the ratio of the value of the bond issued by reference entity immediately after default to the face value of the bond

OTHER DETAILS

- ▶ Payments are usually made quarterly in arrears
- ▶ In the event of default there is a final accrual payment by the buyer
- ▶ Settlement can be specified as delivery of the bonds or in cash
- ▶ Suppose payments are made quarterly in the example just considered. What are the cash flows if there is a default after 3 years and 1 month and recovery rate is 40%?

ATTRACTIONS OF THE CDS MARKET

- ▶ Allows credit risks to be traded in the same way as market risks
- ▶ Can be used to transfer credit risks to a third party
- ▶ Can be used to diversify credit risks

USING A CDS TO HEDGE A BOND

Portfolio consisting of a 5-year par yield corporate bond that provides a yield of 6% and a long position in a 5-year CDS costing 100 basis points per year is (approximately) a long position in a riskless instrument paying 5% per year

VALUATION EXAMPLE (PAGE 528-530)

- ▶ Conditional on no earlier default a reference entity has a (risk-neutral) probability of default of 2% in each of the next 5 years. (This is a default intensity)
- ▶ Assume payments are made annually in arrears, that defaults always happen half way through a year, and that the expected recovery rate is 40%
- ▶ Suppose that the breakeven CDS rate is s per dollar of notional principal

UNCONDITIONAL DEFAULT AND SURVIVAL PROBABILITIES

(TABLE 23.1)

Time (years)	Default Probability	Survival Probability
1	0.0200	0.9800
2	0.0196	0.9604
3	0.0192	0.9412
4	0.0188	0.9224
5	0.0184	0.9039

CALCULATION OF PV OF PAYMENTS

TABLE 23.2 (PRINCIPAL=\$1)

Time (yrs)	Survival Prob	Expected Paymt	Discount Factor	PV of Exp Pmt
1	0.9800	0.9800 _s	0.9512	0.9322 _s
2	0.9604	0.9604 _s	0.9048	0.8690 _s
3	0.9412	0.9412 _s	0.8607	0.8101 _s
4	0.9224	0.9224 _s	0.8187	0.7552 _s
5	0.9039	0.9039 _s	0.7788	0.7040 _s
Total				4.0704 _s

PRESENT VALUE OF EXPECTED PAYOFF (TABLE 23.3; PRINCIPAL = \$1)

Time (yrs)	Default Probab.	Rec. Rate	Expected Payoff	Discount Factor	PV of Exp. Payoff
0.5	0.0200	0.4	0.0120	0.9753	0.0117
1.5	0.0196	0.4	0.0118	0.9277	0.0109
2.5	0.0192	0.4	0.0115	0.8825	0.0102
3.5	0.0188	0.4	0.0113	0.8395	0.0095
4.5	0.0184	0.4	0.0111	0.7985	0.0088
Total					0.0511

PV OF ACCRUAL PAYMENT MADE IN EVENT OF A DEFAULT. (TABLE 23.4; PRINCIPAL = \$1)

Time	Default Prob	Expected Accr Pmt	Disc Factor	PV of Pmt
0.5	0.0200	0.0100 _s	0.9753	0.0097 _s
1.5	0.0196	0.0098 _s	0.9277	0.0091 _s
2.5	0.0192	0.0096 _s	0.8825	0.0085 _s
3.5	0.0188	0.0094 _s	0.8395	0.0079 _s
4.5	0.0184	0.0092 _s	0.7985	0.0074 _s
Total				0.0426 _s

PUTTING IT ALL TOGETHER

- ▶ PV of expected payments is $4.0704s + 0.0426s = 4.1130s$
- ▶ The breakeven CDS spread is given by
 $4.1130s = 0.0511$ or $s = 0.0124$ (124 bps)
- ▶ The value of a swap negotiated some time ago with a CDS spread of 150bps would be $4.1130 \times 0.0150 - 0.0511$ or 0.0106 times the principal.

IMPLYING DEFAULT PROBABILITIES FROM CDS SPREADS

- ▶ Suppose that the mid market spread for a 5 year newly issued CDS is 100bps per year
- ▶ We can reverse engineer our calculations to conclude that the default intensity is 1.61% per year.
- ▶ If probabilities are implied from CDS spreads and then used to value another CDS the result is not sensitive to the recovery rate providing the same recovery rate is used throughout

TOTAL RETURN SWAP

A type of credit derivative in which one counterparty receives the total return (interest payments and any capital gains or losses) from a specified reference asset and the other counterparty receives a specified fixed or floating cash flow that is not related to the creditworthiness of the reference asset.

TOTAL RETURN SWAP

With a total return swap, the lender or bond holder transfers both the risk and the return from a reference asset to the swap buyer. In contrast, a credit default swap transfers the risk, but not the return.

TOTAL RETURN SWAP EXAMPLE

Let us return to the loan in the previous example: A GalaxiBank 5-year \$10,000,000 loan at 7% interest to General Starships. In a total return swap, GalaxiBank transfers the GS 7% interest payment to PIG in exchange for a fixed rate: for example, 5%, the current interest rate on a US Treasury 5-year note. If GS defaults, PIG does not get paid, but GalaxiBank does.

TOTAL RETURN SWAP EXAMPLE

The rate that PIG pays GalaxiBank could be fixed or floating (e.g., related to LIBOR), as long as it is not related to the creditworthiness of GS.

After GalaxiBank enters into the total return swap, GS still owes the money to GalaxiBank, but economically, it is almost as if GalaxiBank sold the loan to PIG (as discussed below, GalaxiBank is subject to risk related to PIG's creditworthiness).

OTHER CREDIT DERIVATIVES

- ▶ **Downgrade options:** options that pay off if the credit rating of a reference entity is downgraded.
- ▶ **Credit Spread Options:** options on the difference between the yield on a reference asset such as a corporate bond and the risk free yield (T-bills).

OTHER CREDIT DERIVATIVES

- ▶ Binary CDS
- ▶ First-to-default Basket CDS
- ▶ Credit default option
- ▶ Collateralized debt obligation

BINARY CDS (PAGE 531-32)

- ▶ The payoff in the event of default is a fixed cash amount
- ▶ In our example the PV of the expected payoff for a binary swap is 0.0852 and the breakeven binary CDS spread is 207 bps

CREDIT INDICES

- ▶ CDX NA IG is a portfolio of 125 investment grade companies in North America
- ▶ itraxx Europe is a portfolio of 125 European investment grade names
- ▶ The portfolios are updated on March 20 and Sept 20 each year
- ▶ The index can be thought of as the cost per name of buying protection against all 125 names
- ▶ The way the index is traded is more complicated (See Example 23.1, page 534)

CDS FORWARDS AND OPTIONS (PAGE 534-535)

- ▶ Example: European option to buy 5 year protection on Ford for 280 bps starting in one year. If Ford defaults during the one-year life of the option, the option is knocked out
- ▶ Depends on the volatility of CDS spreads

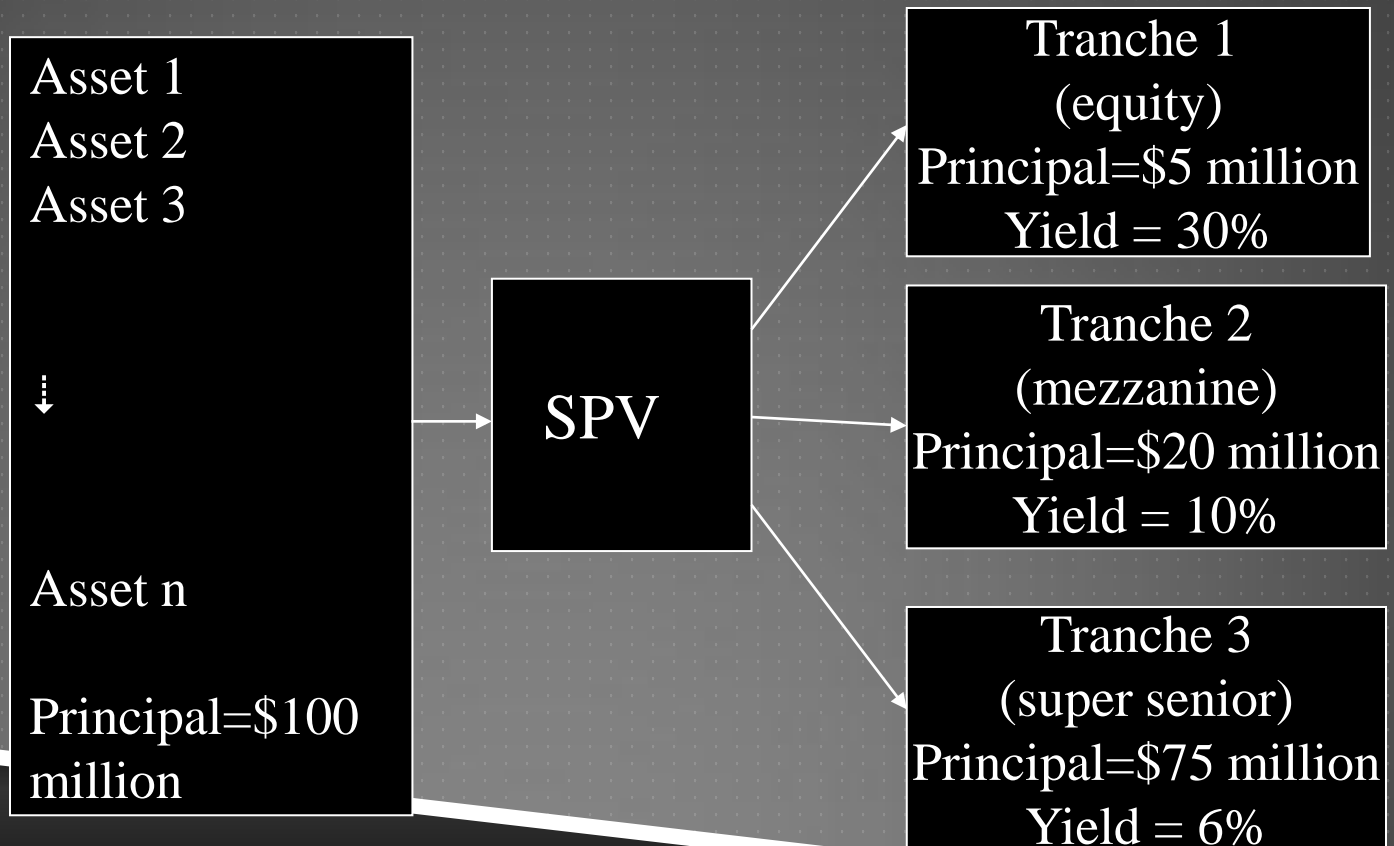
BASKET CDS (PAGE 535)

- ▶ Similar to a regular CDS except that several reference entities are specified
- ▶ In a first to default swap there is a payoff when the first entity defaults
- ▶ Second, third, and n th to default deals are defined similarly
- ▶ Why does pricing depends on default correlation?

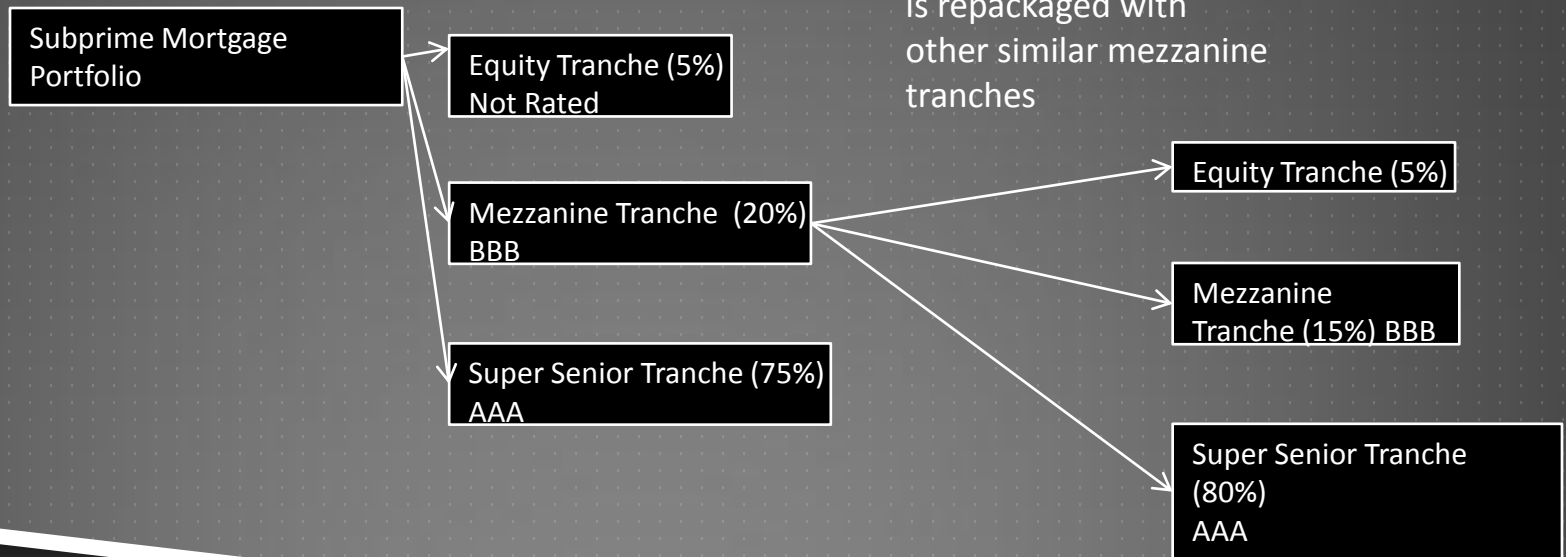
ASSET BACKED SECURITIES

- ▶ Security created from a portfolio of loans, bonds, credit card receivables, mortgages, auto loans, aircraft leases, music royalties, etc
- ▶ Usually the income from the assets is tranching
- ▶ A “waterfall” defines how income is first used to pay the promised return to the senior tranche, then to the next most senior tranche, and so on.

POSSIBLE STRUCTURE (FIGURE 23.3)



THE MEZZANINE TRANCHE IS MOST DIFFICULT TO SELL...



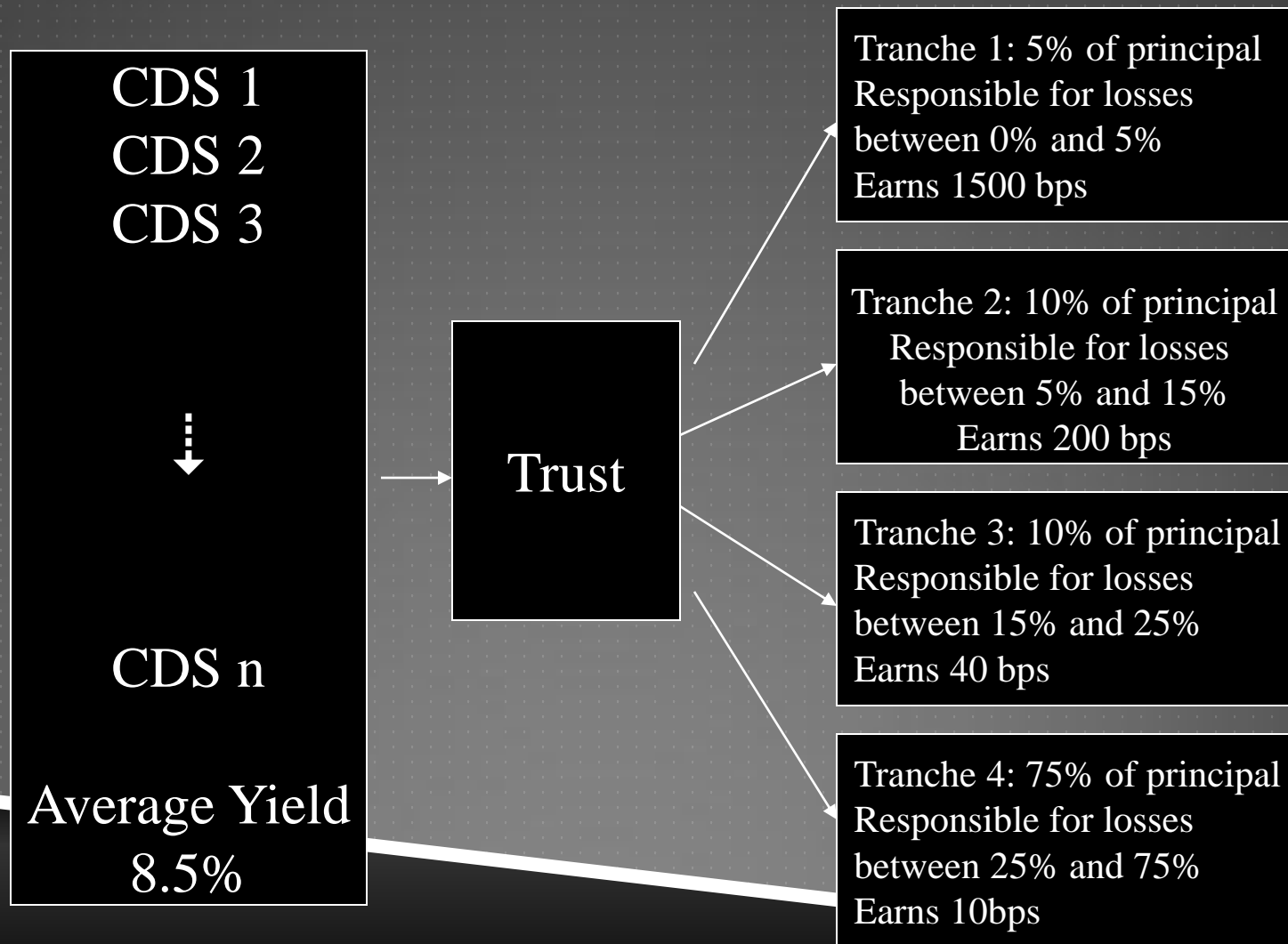
THE CREDIT CRUNCH (SEE BUSINESS SNAPSHOT 23.3, PAGE 539)

- ▶ Between 2000 and 2006 mortgage lenders in the U.S. relaxed standards (liar loans, NINJAs, ARMs)
- ▶ Interest rates were low
- ▶ Demand for mortgages increased fast
- ▶ Mortgages were securitized using ABSs and ABS CDOs
- ▶ In 2007 the bubble burst
- ▶ House prices started decreasing. Defaults and foreclosures, increased fast.

COLLATERALIZED DEBT OBLIGATIONS (PAGE 538-40)

- ▶ A cash CDO is an ABS where the underlying assets are corporate debt issues
- ▶ A synthetic CDO involves forming a similar structure with short CDS contracts on the companies
- ▶ In a synthetic CDO most junior tranche bears losses first. After it has been wiped out, the second most junior tranche bears losses, and so on

SYNTHETIC CDO STRUCTURE



SYNTHETIC CDO DETAILS

- ▶ The bps of income is paid on the remaining tranche principal.
- ▶ Example: when losses have reached 7% of the principal underlying the CDSs, tranche 1 has been wiped out, tranche 2 earns the promised spread (200 basis points) on 80% of its principal

SINGLE TRANCHE TRADING

- ▶ This involves trading tranches of portfolios that are unfunded
- ▶ Cash flows are calculated as though the tranche were funded

QUOTES FOR STANDARD TRANCHEs OF CDX AND ITRAXX (TABLE 23.6)

Quotes are 30/360 in basis points per year except for the 0-3% tranche where the quote equals the percent of the tranche principal that must be paid upfront in addition to 500 bps per year.

CDX NA IG (Mar 28, 2007):

Tranche	0-3%	3-7%	7-10%	10-15%	15-30%	30-100%
Quote	26.85%	103.8	20.3	10.3	4.3	2

iTraxx Europe (Mar 28, 2007)

Tranche	0-3%	3-6%	6-9%	9-12%	12-22%	22-100%
Quote	11.25%	57.7	14.4	6.4	2.6	1.2

VALUATION OF SYNTHETIC CDOS AND BASKET CDSS (PAGE 542-547)

- ▶ A popular approach is to use a factor-based Gaussian copula model to define correlations between times to default
- ▶ Often all pairwise correlations and all the unconditional default distributions are assumed to be the same
- ▶ Market likes to imply a pairwise correlations from market quotes.

VALUATION OF SYNTHETIC CDOS AND BASKET CDOS

$$Q(t|F) = N\left(\frac{N^{-1}[Q(t)] - \sqrt{\rho}F}{\sqrt{1-\rho}}\right)$$

- The probability of k defaults from n names by time t conditional on F is

$$\frac{n!}{(n-k)!k!} Q(t|F)^k [1 - Q(t|F)]^{n-k}$$

- This enables cash flows conditional on F to be calculated. By integrating over F the unconditional distributions are obtained

IMPLIED CORRELATIONS

- ▶ A compound correlation is the correlation that is implied from the price of an individual tranche using the one-factor Gaussian copula model
- ▶ A base correlation is correlation that prices the 0 to $X\%$ tranche consistently with the market where $X\%$ is a detachment point (the end point of a standard tranche)

PROCEDURE FOR CALCULATING BASE CORRELATION (PAGE 547)

- ▶ Calculate compound correlation for each tranche
- ▶ Calculate PV of expected loss for each tranche
- ▶ Sum these to get PV of expected loss for base correlation tranches
- ▶ Calculate correlation parameter in one-factor gaussian copula model that is consistent with this expected loss

IMPLIED CORRELATIONS FOR ITRAXX ON MARCH 28, 2007 (TABLE 23.8)

Tranche	0-3%	3-6%	6-9%	9-12%	12-22%
Compound Correlation	18.3%	9.3%	14.3%	18.2%	24.1%

Tranche	0-3%	0-6%	0-9%	0-12%	0-22%
Base Correlation	18.3%	27.3%	34.9%	41.4%	58.1%

INSURANCE COMPANY USE

As noted, insurance companies often are sellers of credit derivatives. To them, it is like another line of insurance. Insurance companies may also buy credit derivatives to hedge their own credit risk.

SOME CONCERNS ABOUT CREDIT DERIVATIVES

- Moral Hazard
- Adverse Selection
- Counterparty Credit Risk

MORAL HAZARD

Moral Hazard: Lenders may make riskier loans than they would otherwise because they can reduce the risk with credit derivatives. This makes it easier for risky borrowers to obtain loans, but may increase the frequency of defaults and bankruptcy.

ADVERSE SELECTION

The lender will generally have much better information about a borrower's creditworthiness than the credit derivative seller.

COUNTERPARTY CREDIT RISK

When you enter into a credit derivative you are taking on credit risk related to your counterparty. For example, if a large company went bankrupt and an insurance company had sold too many credit derivatives on that company, it too could default. This concern can be addressed with collateral requirements.

BENEFITS OF CREDIT DERIVATIVES

- May improve soundness of banking system by enabling banks to hedge credit risk.
- May make it easier for borrowers to obtain loans and at lower rates.

AMERICAN INTERNATIONAL GROUP

- AIG issued \$500 billion notional amount of CDS by 2007, got \$250 million in annual income.
- Many of these were on CDOs rather than corporate debt.
- With AA credit rating, AIG had to post little or no collateral.

AIG IN CRISIS

- Credit events became more frequent in 2007 and 2008 especially involving CDOs because of the foreclosure crisis.
- AIG's credit rating was downgraded after Lehman Brothers declared bankruptcy in Sept. 2008, causing a massive "margin call" (more collateral required).
- AIG received an \$85 billion bailout in the form of a term loan facility from the NY Fed. AIG received \$97 billion more since Sept. 2008.