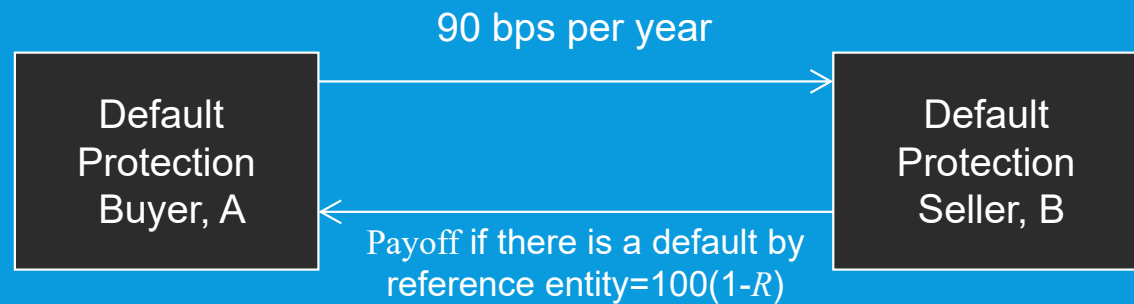# CREDIT DERIVATIVES

# CREDIT DERIVATIVES

- Derivatives where the payoff depends on the credit quality of a company or sovereign entity

- The market started to grow fast in the late 1990s but has declined somewhat since the 2007-2009 crisis

# CREDIT DEFAULT SWAPS

- 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 may be deliverable)

# CDS STRUCTURE



90 bps per year

Default Protection Buyer, A

Default Protection Seller, B

$\text{Payoff}$ if there is a default by reference entity=$100(1-R)$

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 (more usually) a cash equivalent amount

- An auction process usually determines a cash payout

- 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%?

# MOODY'S STATISTICS ON RECOVERY RATES (1982-2014)

| Class | Average recovery rate (%) |
|---|---|
| Senior secured | 52.8 |
| Senior unsecured | 37.4 |
| Senior subordinated | 31.1 |
| Subordinated | 31.4 |
| Junior subordinated | 24.7 |

# CDSS AND BONDS

- A 5-year bond plus a 5-year CDS produces a portfolio that is (approximately) risk-free

- This shows that bond yield spreads should be close to CDS spreads

- The CDS-bond basis is the excess of CDS spreads over the corresponding bond yield spreads. (Negative during the credit crisis)

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# THE PAYOFF

- Usually there are a number of bonds that can be delivered in the event of a default
- The protection buyer can choose to deliver the bond with the lowest price
- But in practice an auction process is usually used to determine a cash payoff

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# 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

# HAZARD RATES

- A hazard rate of $h(t)$ at time $t$ means that there is a probability of $h(t)\Delta t$ of a default between times $t$ and $t+\Delta t$ conditional on no earlier default

- The survival probability to time $t$ is $e^{-\bar{h}t}$ where $\bar{h}$ is the average hazard rate up to time $t$

# CDS VALUATION

- Hazard rate for reference entity is 2%.

- Assume payments are made annually in arrears, that defaults always happen halfway through a year, and that the expected recovery rate is 40%.

- The risk-free rate is 5% per annum continuously compounded.

- Let the breakeven CDS rate be $s$ per dollar of notional principal

# UNCONDITIONAL DEFAULT AND SURVIVAL PROBABILITIES

| Time (years) | Survival Probability | Default Probability |
|---|---|---|
| 1 | 0.9802 | 0.0198 |
| 2 | 0.9608 | 0.0194 |
| 3 | 0.9418 | 0.0190 |
| 4 | 0.9231 | 0.0186 |
| 5 | 0.9048 | 0.0183 |

# CALCULATION OF PV OF PAYMENTS

| Time (yrs) | Survival Probability | Expected Payment | Discount Factor | PV of Expected Payment |
|---|---|---|---|---|
| 1 | 0.9802 | $0.9802s$ | 0.9512 | $0.9324s$ |
| 2 | 0.9608 | $0.9608s$ | 0.9048 | $0.8694s$ |
| 3 | 0.9418 | $0.9418s$ | 0.8607 | $0.8106s$ |
| 4 | 0.9231 | $0.9231s$ | 0.8187 | $0.7558s$ |
| 5 | 0.9048 | $0.9048s$ | 0.7788 | $0.7047s$ |
| Total | | | | $4.0728s$ |

# PRESENT VALUE OF EXPECTED PAYOFF (PRINCIPAL = $1)

| Time (yrs) | Default Probability | Recovery Rate | Expected Payoff | Discount Factor | PV of Expected Payoff |
|---|---|---|---|---|---|
| 0.5 | 0.0198 | 0.4 | 0.0119 | 0.9753 | 0.0116 |
| 1.5 | 0.0194 | 0.4 | 0.0116 | 0.9277 | 0.0108 |
| 2.5 | 0.0190 | 0.4 | 0.0114 | 0.8825 | 0.0101 |
| 3.5 | 0.0186 | 0.4 | 0.0112 | 0.8395 | 0.0094 |
| 4.5 | 0.0183 | 0.4 | 0.0110 | 0.7985 | 0.0088 |
| Total | | | | | 0.0506 |

# PV OF ACCRUAL PAYMENT MADE IN EVENT OF A DEFAULT (PRINCIPAL = $1)

| Time | Default Probability | Expected Accrued Payment | Discount Factor | PV of Payment |
|------|---------------------|--------------------------|-----------------|---------------|
| 0.5 | 0.0198 | $0.0099s$ | 0.9753 | $0.0097s$ |
| 1.5 | 0.0194 | $0.0097s$ | 0.9277 | $0.0090s$ |
| 2.5 | 0.0190 | $0.0095s$ | 0.8825 | $0.0084s$ |
| 3.5 | 0.0186 | $0.0093s$ | 0.8395 | $0.0078s$ |
| 4.5 | 0.0183 | $0.0091s$ | 0.7985 | $0.0073s$ |
| Total | | | | $0.0422s$ |

# PUTTING IT ALL TOGETHER

- PV of expected payments is $4.0728s + 0.0422s = 4.1150s$

- The breakeven CDS spread is given by

  $4.1150s = 0.0506$ or $s = 0.0123$ (123 bps)

- The value of a swap negotiated some time ago with a CDS spread of 150bps would be $4.1150 \times 0.0150 - 0.0506 = 0.0111$ per dollar of 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 hazard is 1.63% 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

# OTHER CREDIT DERIVATIVES

- Binary CDS

- First-to-default Basket CDS

- Total return swap

- Credit default option

- Collateralized debt obligation

# BINARY CDS

- 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 0.0844 and the breakeven binary CDS spread is 205 bps

# FIRST TO DEFAULT BASKET CDS

- Similar to a regular CDS except that several reference entities are specified and there is a payoff when the first one defaults

- The valuation depends on "default correlation"

- Second, third, and $n$th to default deals are defined similarly

# TOTAL RETURN SWAP

- Agreement to exchange total return on a corporate bond for LIBOR plus a spread

- At the end there is a payment reflecting the change in value of the bond

- Usually used as financing tools by companies that want an investment in the corporate bond

Total Return on Bond →

| Total Return Payer | | Total Return Receiver |

← LIBOR plus 25bps
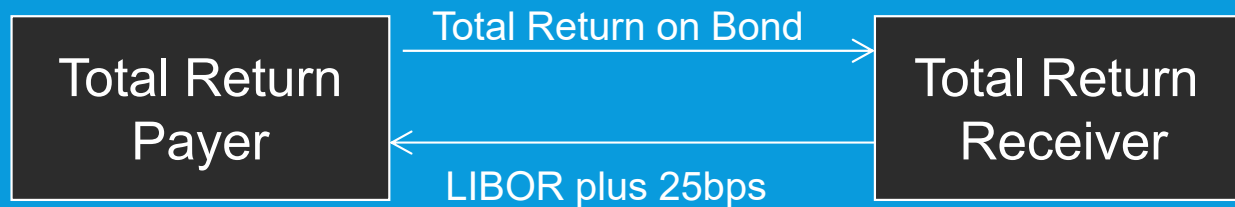
# CDS FORWARDS AND OPTIONS

- Example: Forward contract to buy 5-year protection on Ford for 280 bps in one year. If Ford defaults during the one-year life the forward contract ceases to exist

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

# CREDIT INDICES

- CDX NA IG tracks the average CDS spread for a portfolio of 125 investment-grade (rated BBB or above) North American companies

- iTraxx Europe tracks the average CDS sppread for a portfolio of 125 investment-grade European companies

# THE USE OF FIXED COUPONS

- Increasingly CDSs and CDS indices trade like bonds to facilitate trading

- A coupon is specified

- If spread is greater than coupon, the buyer of protection pays Notional Principal × Duration × (Spread–Coupon)

- Otherwise the seller of protection pays

    Notional Principal × Duration × (Coupon–Spread)

- Duration is the amount the spread has to be multiplied by to  get the PV of spread payments. (In our example, it was 4.1150.)

# ASSET BACKED SECURITIES (ABS)

- Securities 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 tranched

- 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.

# COLLATERALIZED DEBT OBLIGATIONS

- A cash CDO is an ABS where the underlying assets are debt obligations

- A synthetic CDO involves forming a similar structure with short CDS contracts

- 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
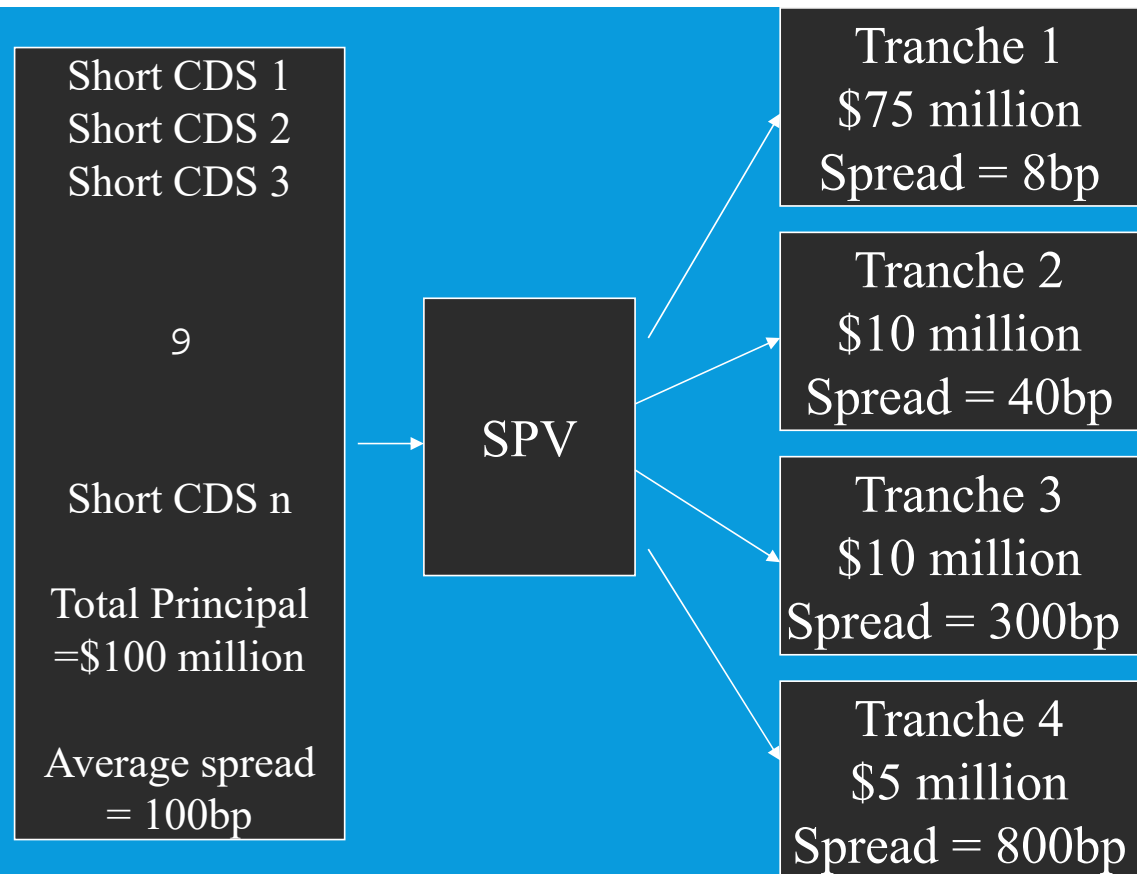
# STANDARD TRANCHES ARE CREATED FROM STANDARD PORTFOLIOS

- CDX NA IG:
  - Tranches: 0-3%, 3-7%, 7-10%, 10-15%, 15-30%, 30-100%

- iTraxx Europe:
  - Tranches: 0-3%, 3-6%, 6-9%, 9-12%, 12-22%, 22-100%

# SINGLE TRANCHE TRADING

- Where one tranche is traded without the other tranches being created

- The synthetic CDO structure is used as a reference for defining the cash flows (but it is never actually created)

# MID-MARKET QUOTES FOR ITRAXX EUROPE

| | Tranche | | | | | |
|---|---|---|---|---|---|---|
| | 0-3% | 3-6% | 6-9% | 9-12% | 12-22% | Index |
| Jan 31, 2007 | 10.34% | 41.59 | 11.95 | 5.60 | 2.00 | 23 |
| Jan 31, 2008 | 30.98% | 316.90 | 212.40 | 140.00 | 73.60 | 77 |
| Jan 31, 2009 | 64.28% | 1185.63 | 606.69 | 315.63 | 97.13 | 165 |