



Credit Risk Management

1 SETTLEMENT RISK VS. PRESETTLEMENT RISK

1.1 交易的狀態可分為如下5類

- Revocable
- Irrevocable
- Uncertain
- Settled
- Failed

1.2 何謂SETTLEMENT RISK ?

- Settlement risk occurs during the periods of *irrevocable* and *uncertain* status, which can take from one to three days.
- Settlement Risk的特質
 - The risk happens due to the exchange of cash flow
 - This risk is made possible by counterparty default, liquidity constraints, or operational problems
 - Usually shorter-term, arising from the asymmetry of making/receiving payment
 - The transactions occur in several time zones, leading to the greatest risk
- How to reduce Settlement Risk?
 - Real-time gross settlement
 - Netting agreement, including bilateral netting, multilateral netting system (continuous-linked settlements) Solutions

1.3 何謂CREDIT RISK ?

- Economic loss from the failure of a counterparty to fulfill its contractual obligation during the life of the transaction, with examples including default on loans/bonds or failure to make the requirement on a derivative transactions
- Measured by the cost of replacing cash flows if that happens
- Tenor ranges from short to long, depending on the contract features

What can be said about the settlement risk of a Eurodollar future contract and a FRA with the same term? FRM 1998, 53

- A. The Eurodollar future contract and a FRA have the same settlement risk.
- B. The Eurodollar future contract has less settlement risk than a FRA.
- C. The Eurodollar future contract has more settlement risk than a FRA.
- D. The Eurodollar future contract may have more or less settlement risk dependent on.

2 CREDIT RISK VS. MARKET RISK

FACTORS	MARKET RISK	CREDIT RISK
Probability of Default	While default probabilities are specific to the counterparty, market risk are driven by market-wide common risk factors	Credit risk requires estimation of probability of default as well as identification of specific counterparties
Time Horizon	Market risk analysis is typically conducted over one, shorter, time horizon	Credit Risk analysis is usually focused on several longer time horizons
Distribution Assumptions	Mainly symmetric, perhaps fat tails	Does not assume returns are normally distributed. Probability of default is also not normally distributed but skewed to the left
Risk Control	Market risk is controlled with the help of position limits on divisions within an institution(Business/Trading unit)	When controlling credit risk, limits are imposed on the counterparty taken as a whole, (i.e., the firm's total exposure to the counterparty)
Legal issues	Not applicable because market risk tends to be more quantitative and clear cut	Very important. Questions as to the ownership of collateral, lack of strict adherence to seniority of claims by the courts, and questions about the legal status of netting arrangements usually render credit risk less quantifiable and subject to litigation

- Credit Risk is akin to short put positions: fixed spread (premium) & maximum loss of strike price (if default)

3 HOW TO MEASURE CREDIT RISK

Credit Loss = Default probability * Credit Exposure * Loss Given Default (or 1- recovery rate)



- **Default probability:** the discrete state of the counterparty, measured by probability of default (PD)
- **Credit exposure (CE):** or called exposure at default (EAD), is defined as the amount that the party with a claim will lose in case of default
 - *Bonds/Loans:* notional/face value, or the remaining outstanding amount, usually linear
 - *Derivatives:* replacement cost of the contracts (when you are “in the money”) and usually nonlinear
- **Loss given default (LGD):** Fractional loss due to default, opposite to fractional recovery rate(FRR), so $LGD + FRR$ should equal 1
- ***If the agreement has no market value, then there is no exposure, even if the counterparty is not creditworthy; on the other hand, an agreement with a very large market value may have significant credit risk even if the probability of counterparty default is small***

4 CREDIT EVENT

- A credit event is a discrete state. Either it happens or not. The issue is the definition of the event, which must be framed in legal terms
- The state of default is defined by S&P, as “ *The first occurrence of a payment default on any financial obligation, rated or unrated, other than a financial obligation subject to a bona fide commercial dispute; an exception occurs when an interest payment missed on the due date is made within the grace period*”

According to ISDA, events meet the definition of credit events include:

- Bankruptcy
- Failure to pay
- Obligation/cross default
- Obligation/cross acceleration
- Repudiation/moratorium
- Restructuring
- Downgrade
- Currency inconvertibility
- Governmental action

All of the following are considered events of default under the ISDA Master Agreement EXCEPT: 1998, 62

- A. An illegality, in which a party is unable to perform, based on changes in law or regulation
- B. A tax event that causes a party to make an additional payment (gross-up) or to have an amount withheld from a payment as a result of change in the tax law
- C. A credit event upon merger in which the credit worthiness of the merged entity becomes materially weaker than that of the original entity
- D. None of the above

5 DEFAULT PROBABILITY

5.1 HOW TO MEASURE DEFAULT RATE

- Altman: the domestic straight (nonconvertible) high-yield debt compilation of defaults divided by the market value of outstanding high-yield bonds.
- Moody's: the number of defaulting issuers (including foreign and convertible) having an observed bond rating divided by the total number of issuers with that rating

5.2 DEFAULT RATES (CUMULATIVE, & MARGINAL)

- Marginal default rate: the frequency of default in any given year, usually denoted as d_n , thus
 - d_1 = marginal default rate during year 1,
 - d_2 = marginal default rate during year 2,
 - .
 - .
 - .
 - d_n = marginal default rate during year N
 - Cumulative default **probability**: the probability that a borrower will default over a multiyear period. Usually denoted as c_n and,
 - $C_2 = d_1 + (1-d_1) \cdot d_2$
 - Sketch the path will help you understand the computation
 - $C_n = 1 - (1-d_1) \cdot (1-d_2) \cdot \dots \cdot (1-d_n)$
 - $1-C_n = (1-C_{n-1}) \cdot (1-d_n)$
- Page 421 is an example for exercise
- $(1-d_Y) = (1-d_M)^{12}$, given marginal default of each month is constant, very similar to that of mortality rates for mortgage-backed securities

What is the difference between the marginal default probability and the cumulative default probability? FRM 2000,34

- A. Marginal default probability is the probability that a borrower will default in any given year, whereas the cumulative default probability is over specified multi-year period.
- B. Marginal default probability is the probability that a borrower will default due to particular credit event, whereas the cumulative default probability is for all possible credit events
- C. Marginal default probability is the minimum probability that a borrower will default, whereas the cumulative default probability is the maximum probability
- D. Both a and c are correct

According to S&P, the 5-year cumulative probability default for AAA- rated is 15%. If the marginal probability of default for AAA debt from year 5 to year 6 is 10%, then what is the 6-year cumulative probability default for AAA-rated debt? FRM 2000, 31

- A. 25%
- B. 16.55%
- C. 15%
- D. 23.5%

What is the year-2 cumulative default probability if the marginal probability of default is 8% and 7% for the years 1 and 2, respectively?

- A. 4.94
- B. 7.44%
- C. 14.44%
- D. 85.56%

Assuming 1-year and 2-year Treasury rates of 11% and 12% and the 1-year and 2-year corporate bond rates are 16.5% and 17%, respectively, find the marginal probability of default for the corporate bond in its second year.

Answer:

Step1: compute 1-year forward Treasury rate

$$1+F_{12} = (1+i_2)^2 / (1+i_1), \text{ thus } F_{12} = 13\%$$

Step2: compute 1-year forward corporate bond rate

$$1+C_{12} = (1+k_2)^2 / (1+k_1), \text{ thus } C_{12} = 17.5\%$$

Step 3: compute repayment

$$C_{12} * (1 - \text{marginal default probability}) = F_{12}, \text{ thus marginal default probability equals } 3.83\%$$

Assume the cumulative probability of default over five years for a firm initially rated BBB, at time zero, would be 2.19%. The 6-year cumulative default rating for these firms was 2.91%, Use information supplied above for marginal and cumulative default rates to calculate the marginal default rate in the sixth year for a firm initially rated BBB?

5.3 TRANSITION PROBABILITIES

- Migration: a discrete process that consists of credit ratings changing from one period to the next
- Transition matrix: a table gives the probability of moving from one rating to another within a specific period
- Markov process: the assumption that says the migrations across states are independent from one period to the next
- The computation of default: using paths is easy and straightforward

State	Ending				Total
	A	B	C	D	
Starting					Prob.
A	0.97	0.03	0.00	0.00	1.00
B	0.02	0.93	0.02	0.03	1.00
C	0.01	0.12	0.64	0.23	1.00
D	0	0	0	1.00	1.00

- Consider a company in year 0 in the B category, how to compute the cumulative probability of default over two years? And the key is to use the table and sketch the path.
- The change in ratings over time is referred to as credit migration or credit drift. Using more than 20 years of historical rating changes, rating agencies assemble matrices than contain information on the historical behavior of credit migration.

5.4 OTHER ISSUES RELATED TO DEFAULT PROBABILITIES

- More default occurs even with a stable economic environment, because many issuers came to the market with a lower initial credit rating than in the past
- Speculative grade bonds are more subject to (volatile) economic activity

5.5 ACTUARIAL METHODS TO MEASURE DEFAULT PROBABILITY

- Actuarial methods provide “objective” (as opposed to risk-neutral) measures of default rates, usually based on historical default data
- This objective measures describe the “actual” or “natural” probability of default.
- Provided by external rating like credit rating agencies or internally, or derived from accounting variables models, discriminate analysis

5.6 MARKET-PRICE METHODS TO MEASURE DEFAULT PROBABILITY

- Market-price methods infer from traded prices that market's assessment of default risk, along with a possible risk premium. The market prices of debt, equity, or credit derivatives can be used to derive *risk-neutral measures of default risk*
- Risk-neutral measure provides a useful shortcut to price assets, such as options. For risk management purposes, however, they are contaminated by the effect of risk premiums and therefore do not exactly measure default probabilities
- Bond pricing/spread & Equity pricing are the most used methods

6 CREDIT RATINGS

Credit rating: an "evaluation of creditworthiness" issued by a rating agency, such as Moody's and Standard & Poor's, as an "opinion of the future **ability**, legal obligation, and **willingness** of a bond issuer or other obligor to make **full and timely** payments on **principal** and **interest** due to investors"

- Investment grade: BBB (Baa) above & included
- Speculative grade (below Investment grade): BB (Ba) below & included

Explanation	Standard & Poor's	Moody's
Investment grade:		
Highest grade	AAA	Aaa
High grade	AA	Aa
Upper medium grade	A	A
Medium grade	BBB	Baa
Speculative grade:		
Lower medium grade	BB	Ba
Speculative grade	B	B
Poor standing	CCC	Caa
Highly speculative	CC	Ca
Lowest equality, no interest	C	C
In default	D	

Modifiers: example A+, A, A-, A1, A2, A3, etc.

- Marginal default rate:
 - Increases for initial high credit high ratings (*mean reversion effect*)
 - Decreases for initial low credit ratings (*survival effect*)
- Default rate increases with the horizon, for a given initial credit rating, because credit risk increases with the horizon

7 KEY ISSUES ON CORPORATE RATING AND ITS PROCESS

- Issuer rating: an opinion on the obligor's general capacity to meet its financial obligations, not on a specific liability of the issuer
- Issue rating: an opinion to reflect the characteristics of the issues such as specific terms, the quality of the collateral, and the creditworthiness of guarantors
- Credit migration (credit drift): the change in rating over time. Rating agencies assemble matrices that contain information on the historical behavior for credit migration by using more than 20 years of historical rating changes. However, they are historic-oriented not forward-looking

7.1 FACTORS OF ISSUER RATING

7.1.1 Legal and Environment

It is important to know whether the firm complies with all relevant environmental requirements and whether there exist any contingent liabilities, such as lawsuits and warranty claims

- Industry rating summary: some industry is inherently riskier than others, making it a necessity to assess the risk of the borrower's industry. A scoring system is employed to specify key issues such as regulatory framework, technology change, long-term trends, vulnerability to macroeconomic environment, etc
- Tier assessment: lower-tiered borrowers in risky industries have been the leading contributors to credit losses. Thus, it is necessary to rate the relative risk of the firm within the industry. Think about Mosel 茂矽 and DRAM industry! It is also important to keep in mind that when assigning a firm to a risk tier, the assignment must be done relatively to other firms in the SAME industry, not relative to all firms in the market
- Industry/Tier position: the combined industry-risk rating and risk-tier position is used as a CAP for the initial obligor rating, meaning the overall obligor rating can be NO HIGHER than the combined risk rating of its industry and its tier position within the industry

7.1.2 Management and other Qualitative factors

- Day-to-Day account operations: smooth or not?
- Quality of management: the existence of a succession plan, effective risk-management, etc.

7.1.3 Financial Statement quality

- A thorough review of all aspects of the preparation and presentation of the borrower's financial statements, including audited or not, what level, ...

7.1.4 Financial Assessment

- Earnings and cash flows: EBITDA interest coverage, Free cash flow from operation, Operating results before Depreciation & Amortization
- Asset quality, liquidity, and leverage: debt/total capitalization
- Financial size, flexibility, and debt capacity: access to financial markets, alternative sources of financing, ability to assume additional debt

7.1.5 Country Risk

- Country risk acts to limit the obligor rating

7.2 FACTORS OF ISSUE/FACILITY RATING

7.2.1 Third-party support

- The validity of third-party's commitment to stand behind the obligations of the borrower
- Not 100% guarantee over the entire term of the facility
- Initial obligor(issuer) rating could be raised with this support

7.2.2 Term

- Shorter term, less risk

7.2.3 Structure

- The strength of the facility structure, especially applied to structured notes

7.2.4 Collateral

- The quality and depth of collateral/security could raise or lower that rating

If the probability of a counterparty defaulting over the next year is 1%, what would you expect the probability of the counterpart defaulting over the first month to be?
FRM 1999, 144

- A. 0%~0.07%
- B. 0.07%~0.09%
- C. 0.2%~0.3%
- D. None of the above

S&P has assigned a AAA-rating to Company X. What additional information should the risk manager consider when deciding what exposure limit to assign to Company

X? FRM 1998, 84

- A. The current financial condition of Company X
- B. The stability of Company X's sales, cash flows and financial ratios
- C. The outlook for Company X's industry
- D. The capital base of Company X

8 SOVEREIGN/COUNTRY RATINGS

*A sovereign credit is a debt security issued by a federal (i.e.) national government. Some examples are US Treasury Bonds, British Gilts, and others. Securities issued by a country need not be denominated in the country's currency. Debt issued in the **home currency** is called **local currency debt**, while debt issued in **another currency** is called **foreign currency debt**.*

The rating of foreign currency debt is lower than or equal to the rating of local currency debt !!!

8.1 QUANTITATIVE ASPECTS OF SOVEREIGN CREDIT ANALYSIS

- Political Risk
- Income and Economic Structures
- Economic Growth Prospects
- Fiscal Policy and Budgetary Flexibility
- Public Debt Burden
- Monetary Policy and Price Stability
- Balance of Payments Flexibility
- External Debt and Liquidity

8.2 QUALITATIVE ASPECTS OF SOVEREIGN CREDIT ANALYSIS

- Debt service ratio = interest plus amortization on debt/ exports, the higher the riskier
- Import ratio = total imports/total foreign exchange reserves, the higher the riskier
- Investment ratio = real investment/GDP, the higher the better (or riskier?)
- Variance of Exports Revenue = σ_{ER}^2 , the higher the riskier
- Domestic Money Supply Growth = $\Delta M/M$, the higher the riskier

8.3 LOCAL CURRENCY DEBT RATING VS. FOREIGN CURRENCY DEBT RATING

The government generally maintains control over the issuance of the local currency, willingness to pay and stability of the local currency are key issues in evaluating this type of debt. Key contributing factors include:

- The stability of political institutions
- Income and economic structure



- Fiscal policy and budgetary flexibility
- Monetary policy and inflationary pressures
- Public debt burden and debt service track record

For Foreign Currency Debt Rating, aside from the above, factors also include:

- The degree of integration into the international financial and economic system
- Potential security risks
- Balance of payments flexibility
- External financial position
- International liquidity

8.4 CORPORATE VS. SOVEREIGN CREDIT RISKS

The evaluation of sovereign credits is different from corporate debt, with focus on the following issues

- The financial ability of the country to pay interest and principal
- The willingness to pay interest and principal: countries can't be taken to court for nonpayment since there is no international bankruptcy court, there are limited legal remedies available to lenders
- Sovereign credit rating effectively caps the maximum rating for corporate within the country {e.g. Taiwan (AA-) and Chunghwa Telecom (AA-)}, based on the following justifications
 - The government has unique, wide-ranging powers not generally available to corporate concerns.
 - Also, the government has the first claim on available foreign exchange with which to repay its debts
 - Moreover, the government controls the ability of residents to obtain foreign currency
- **Availability of data:** Country data may be scarce and not the most-updated, GIGO (garbage in, garbage out) could be an issue
- **Due diligence:** Sovereign ratings are more difficult to conduct and costly
- **Subject factor:** More subject factors are taken into account while analyzing country risk

9 MARKET PRICES USED TO FIND DEFAULT PROBABILITY (BOND)

9.1 RISK-NEUTRAL VALUATION: BASED ON THE RATIONALE OF NO RISK PREMIUM

Assume one period, payment = 100, risk free rate = Y , corporate rate = Y^* , default rate = π , recovery rate = f , using the risk-neutral pricing, the current price must be the mathematical expectation of the values in the two (default and non-default) states, then

- Price (or Present Value) of Corporate Bond = PV of Risk-Free Bills, means



$100/(1+Y^*) = 100 \times (1-\pi)/(1+Y) + f \times 100 \times \pi/(1+Y)$, the price of a bond can be divided into two components including (1) the discounted future value of the bond assuming no default and (2) the discounted value if the contract defaults, scaled by the probability of default

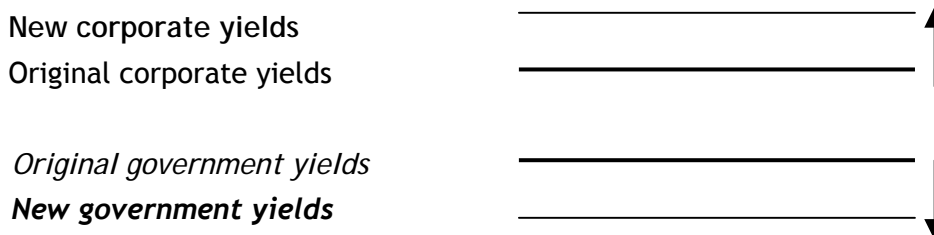
- Future Value of Corporate Bond = Future Value of Risk-Free Bills, means Initial amount $(1+Y) = \text{initial amount} \times \pi \times (1+Y^*) + \text{initial amount} \times 1 \times (1-\pi) \times (1+Y^*)$
- **From using the above formula, we can derive formula**
 $(1+Y) = (1+Y^*)[1-\pi(1-f)]$
 $Y^* = Y + \pi(1-f)$
 $Y^* - Y = \pi(1-f)$
 $Y^* - Y$ stands for credit spread, more specifically the probability of default, p , times the loss given default $(1-f)$
- **However, risk premium exists, and we redefine the above formula**
 $Y' = Y + \pi(1-f) + rp$, rp stands for risk premium which must be tied to some measure of bond risk as well as investor risk aversion (liquidity requirement also taken into account)

9.2 BOND YIELD SPREAD THEORIES

A bond yield spread is defined as the differential yield between various quality sectors (e.g. the yield spread between AAA- and BBB-rated corporate)

9.2.1 Quality Spread Theory

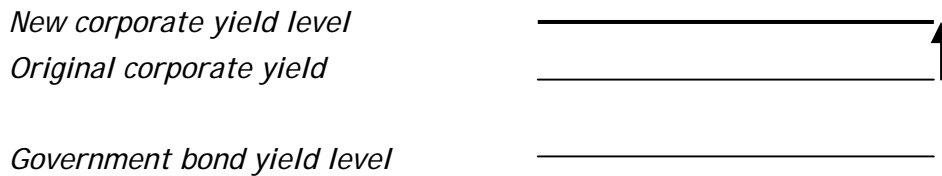
- Spreads are reduced during times of economic recovery. During economic recovery, the perceived quality of non-government issues is viewed as better or improved. Investors therefore will shift funds from government to corporate. As investors buy corporate, their prices rise and their yields fall. As investors sell governments, their prices fall and their yield rise. This phenomenon is called **a flight from quality**.
- The spread narrows as the economy turns bad



9.2.2 Interest Rate Volatility Theory

- Yield spreads widen in periods of high volatility (interest rate and price), due to the embedded option effect. Most non-government bonds have embedded options due to refunding, refinancing, and sinking fund call provisions. As volatility increases, the value of the call options increases, as the value of the

call option increases, the value of the callable bond must decrease (recall that callable bonds = noncallable bonds + call option?, bondholders are short the call option). As the value of the callable bond decreases, the bond's yield must increase. As the yield on the corporate bond increases, the yield spread between corporate and government increases.



The yield spread widens (narrows) as volatility increases (decreases)

9.3 RISK PREMIUM

- ***Bond prices are revised more frequently than credit ratings. As a result, movements in corporate bond prices tend to lead changes in credit ratings***
- ***Lower rating higher spread***
- ***Lead change in credit rating***
- ***Close + -***
- ***Volatile higher spread***
- ***Economy (expansion vs. recession)***

Assume the 3-month U.S. Treasury yield is 5.5% and the Eurodollar deposit rate is 6% (both on simple interest basis). What is the approximate probability of the Eurodollar deposit defaulting over its life (assuming a zero recovery rate)? FRM 1997, 23

A. 0.01%
 B. 0.1%
 C. 0.5%
 D. 1.0%

Assume the 1-year U.S. Treasury yield is 5.5% (on simple interest basis) and a default probability of 1% for 1-year CP. What should the yield of 1-year CP be (on simple basis) assuming 50% recovery rate? FRM 1997, 24

A. 6.0%
 B. 6.5%
 C. 7.0%
 D. 7.5%

What can be said about the spread (S1) between AA and A credits, and the spread between BBB and B credits (S2) in general? FRM 1998, 11

A. S1 is equal to S2
 B. S1 >= S2
 C. S2 >= S1

D. S1 may be less or more than S2

What can be said about the spread (S1) between AAA and BBB credits with 5 years to maturity, and the spread between AAA and BBB credits (S2) with 1 year to maturity, in general? FRM 1999, 137

- A. S1 is equal to S2
- B. S1 >= S2
- C. S2 >= S1
- D. S1 may be less or more than S2, according to market conditions

The yield on a zero-coupon Treasury bond with a one-year maturity is currently 6 percent p.a. The Treasury zero-coupon yield curve is assumed to be flat. The spread over Treasuries for an AA-rated corporate bond with a maturity of three years is 70 bps. What is the expected loss from default as a percentage of non-default value for the corporate bond? FRM 2000, 49

- A. 1.278
- B. 1.763
- C. 2.078
- D. 2.215

10 MARKET PRICES USED TO FIND DEFAULT PROBABILITY (EQUITY)

10.1 MERTON MODEL

- Value of Firm (V) = Bond (B) + Equity (S), according to Modern financial theory thinks
- The payoff of Bond/Loans: Similar to writing a put option on the value of its assets with an exercise price equal to the face value of the debt (K), the most that debt holders will ever receive is the face value of the debt, B.
- The payoff of Equity: Similar to owning a call option on the assets of the firm with a premium equal to S and an exercise price equal to the value of the firm's debt. If the firm's assets fall below the value of its debt, B, the shareholder's loss is limited to the amount of their initial equity invested in the firm.

- Recall Black-Scholes Pricing Formulas for pricing European calls and puts as follows,

Under the following assumptions:

- (1) The price of the underlying asset moves in a continuous fashion.
- (2) Interest rates are known and constant.
- (3) The variance of underlying asset return is constant.
- (4) Capital markets are perfect (short-sales are allowed, there are no transaction cost or taxes, and markets operate continuously)

$$C_t = S_t N(d_1) - X e^{-rT} N(d_2), \quad 0 \leq t < T$$

$$P_t = -S_t N(-d_1) + X e^{-rt} N(-d_2), \quad 0 \leq t < T$$

$$d_1 = \frac{\ln\left(\frac{S_t}{X}\right) + \left(r + \frac{1}{2}\sigma^2\right)T}{\sqrt{\sigma^2 T}}$$

$$d_2 = d_1 - \sqrt{\sigma^2 T} = \frac{\ln\left(\frac{S_t}{X}\right) + \left(r - \frac{1}{2}\sigma^2\right)T}{\sqrt{\sigma^2 T}}$$

- Re-writing B-S formula, here Call = Stock, Put = Debt, Exercise price (X) = Face Value of Debt (K), Stock price (S) = Value of the Firm (V)

$$S_t = V_t N(d_1) - K e^{-rt} N(d_2), \quad 0 \leq t < T$$

$$B_t = -V_t N(-d_1) + K e^{-rt} N(-d_2), \quad 0 \leq t < T$$

$$d_1 = \frac{\ln\left(\frac{V_t}{K}\right) + \left(r + \frac{1}{2}\sigma^2\right)T}{\sqrt{\sigma^2 T}}$$

$$d_2 = d_1 - \sqrt{\sigma^2 T} = \frac{\ln\left(\frac{V_t}{K}\right) + \left(r - \frac{1}{2}\sigma^2\right)T}{\sqrt{\sigma^2 T}}$$

$N(d_2)$ is the probability of exercising the call, or the bond will not default, therefore

$1 - N(d_2) = N(-d_2) = EDF$ (Estimated Default Frequency)

10.2 KMV MODEL - THE APPLICATION OF MERTON MODEL

- KMV refers to default probability as *expected default frequency (EDF)*, which is estimated by using Merton's option-pricing framework
- KMV methodology estimates default probability without relying on transition matrices
- EDF is a function of capital structure, asset return volatility, and current asset value
- EDF can be used to numerically rank firms relative to default risk because it is a firm-specific measure

10.3 THREE STAGES TO THE DERIVATION OF THE ACTUAL PROBABILITY OF DEFAULT

10.3.1 Estimate the market value and volatility of the firm's assets

$S = f(V, \sigma, LR, c, r)$ and $\sigma_s = g(V, \sigma, LR, c, r)$ where

S = market value of the firm's equity

V = market value of the firm's assets

LR = leverage ratio

σ = equity volatility



c = average coupon rate on the firm's debt
 r = risk-free rate, then get a combined result of
 $V = h(S, \dots, LR, c, r)$

Given that the capital structure of a firm is made up entirely of common stock, cash perpetual long-term debt, and convertible preferred stock.

10.3.2 Calculate the distance to default

- Default and bankruptcy are EQUIVALENT and default occurs when the value of a firm's assets falls below the value of its debt, based on Merton's Model
- KMV made some adjustments as follows - default usually occurs at asset values somewhere between the value of total debts and the value of short-term debt
- Distance to default (DD) is estimated for the probability of default and is the number of standard deviations between the mean of the firm's asset value distribution and a specified default threshold
- Threshold is set equal to the par value of current debts, which include short-term debt that must be service over the relevant time horizon, plus 50% of the book value of long-term debt
- $DD = \frac{E(V1) - DPT}{\sigma}$, where E(V1) = expected market value of the firm's assets in one year, DPT = default threshold, and σ = annualized asset returns volatility

10.3.3 Scale the distance to default to actual default probabilities using a default database

- DD is mapped into actual default probabilities
- A large sample of firms, including firms from the sample that has actually defaulted is plotted against the default distance
- EDF ranges from 0.02 to 20%

Calculate the distance to default using the following information:

Current market value of assets $V_0 = \$100$
 Net expected growth of assets per annum: 15%
 Annual asset volatility $\sigma = 5$
 Default point (DPT) = \$ 105

Answer

Expected asset value in one year = $E(V_1) = 1.15 * \$100 = \115

$$DD = \frac{E(V_1) - DPT}{\sigma} = \frac{115 - 105}{5} = 2$$

Assume that 10,000 firms in the sample population has a DD equal to 2 at point in time, and 60 of them defaulted over the next year, then EDF = number of defaults/number of firms = $60/10,000 = 60\text{bps} = 0.006$

Then translate 0.006 into grade scale very similar to that of rating agency (5+, AA,



etc.)

Suppose the expected future value of a firm's assets is \$200mn, the estimated default threshold is \$160mn, and the standard deviation of asset values is \$20mn. What would KMV calculate as the approximate distance to default (DD)? FRM 2001, 3 revised

- A. 1 standard deviation
- B. 2 standard deviations
- C. 2.5 standard deviations
- D. Cannot be determined from the information given

10.4 COMPARISON BETWEEN KMV MODEL AND RATING AGENCY

- EDFs tend to rise sharply in the period preceding default when the credit quality of an issuer deteriorates.
- EDFs start to increase about a year before the rating agencies downgrade the issuer
- DDs used by KMV and be adjusted to compensate for business and economic conditions - shortened during recessions and lengthened during expansion; Rating agencies usually conduct rating review annually
- Rating agencies estimate future default behavior base on historic values, meaning that the estimates will be dependent on the period used to derive marginal mortality rates
- KMV constructed transition materials matrices based on EDFs; S&P generates transition matrices based on historical rating, therefore KMV will report A higher rating migration probability and A lower default probability when making a comparison rating agency in the same rating category.

Example

Which of the following is used to estimate the probability of default for a firm in the KMV model? FRM 1999, 151

- I. An illegality, in which a party is unable to perform, based on changes in law or regulation
- II. A tax event that causes a party to make an additional payment (gross-up) or to have an amount withheld from a payment as a result of a change in the tax laws
- III. Failure by a party to make a payment of delivery
- IV. "Merger without assumption" in which the resulting entity of the CSP fails to assume the original obligations under which the agreement was negotiated
- V. A credit even upon merger in which the credit worthiness of the merged entity becomes materially weaker than that of the original entity

- A. I and II
- B. I, III, and IV



- C. II, III, and V
- D. All of the above

The KMV credit risk model generates an estimated default frequency (EDF) based on the distance between the current value of assets and the book value of liabilities. Suppose that the current value of a firm's assets and the book value of its liabilities are \$500 million and \$300 million, respectively. Assume that the standard deviation of returns on the assets is \$100 million, and that the returns on the asset are normally distributed. Assuming a standard Merton Model, what is the approximate default frequency (EDF) for this firm? FRM 2000, 60

- A. 0.010
- B. 0.015
- C. 0.020
- D. 0.030

Example

Which of the following is used to estimate the probability of default for a firm in the KMV model? FRM 1999, 140

- I. Historical probability of default based on the credit rating of the firm (KMV has a method to assign a rating to the firm if it un-rated).
 - II. Stock price volatility
 - III. The stock value of the firm's equity
 - IV. The market value of the firm's equity
 - V. The book value of the firm's debt
 - VI. The market value of the firm's debt
- A. I only
 - B. II, IV, and V
 - C. II, III, and VI
 - D. VI only

11 CREDIT EXPOSURE

Credit exposure is the amount at risk (the positive part of the value of the asset) when default occurs, also called exposure at default. For financial obligations such as bonds and/or loans, credit exposure is outstanding balance/face value; for derivatives, credit exposure is the value of the asset if POSITIVE, like an option. Replacement cost is determined by projecting the net cash flows to the party at risk on the basis of an interest rate forecast, often accomplished via simulation.

- Current exposure: credit exposure is readily observable
- Potential/Future exposure: credit exposure is random, usually the function of (several) variables
- Expected credit exposure: the expected market of replacement value of a contract or asset on a specific date
- Worse credit exposure: the greatest loss amount at a specified confidence level, also commonly referred to as credit at risk (CAR)



- Expected credit loss: the normal and expected losses as the result of contracting, defined over a certain time interval, usually one year, and can be expressed by the following formula as
$$ECL_t = ECE_t \times \text{probability of default} \times (1-f)$$
- Unexpected credit loss: the worst-case loss at a particular confidence level and is also called CAR scaled by the probability of default and one minus the recovery rate
$$UCL_t = CAR_t \times \text{probability of default} \times (1-f)$$

Contracts such as IRS that are privately arrangements between two parties entail credit risks. Consider a financial institution that has entered into offsetting IRS contracts with two manufacturing companies, GE and UT. In which one of the following situations is the financial institution exposed to credit risk from the swap position? The most likely possibility is: FRM 2000,34

- A. A default by GE when the value of the swap to the financial institution is positive
- B. A default by GE when the value of the swap to the financial institution is negative
- C. That the interest rate will move so that the value of the swap to UT becomes negative
- D. That the interest rate will move so that the value of the swap to GE becomes positive

12 VALUE AT RISK & CAR

Credit at risk (CAR) is the worst-case credit exposure at a specified confidence level. If we assume a normal distribution, then for a 95 percent confidence level, $CAR = 1.65 \times$. Therefore, UCL (unexpected credit loss) = CAR x probability of default x (1-f). UCL also called default VAR.

**** Be sure to remember 1.645 (or 1.65) standard deviation and 2.33 deviation under 95% and 99% confidence level !!!**

- CAR and default VAR are harder to estimate than traditional VAR due to estimates of variables (e.g. recovery rates, collateral value, financial guarantee payment) required in the process
- The dynamic nature of CAR and default VAR must be taken into account since, at any given moment, credit exposure will usually be different for different time horizons
- CAR and default VAR require that in addition to every position type being considered separately, each counterparty must also be considered separately.
- Default losses can be expected to display fat tails, which violate the normality assumptions. This is a caution when working with CAR and default VAR
- Stress testing should be used to measure the potential impact of severe and extreme value events

Derivative credit risk is more difficult to assess because

- A. When it comes to derivatives, assumptions of normality are often violated.
- B. Recovery rates fluctuate often, depending on the legal status of a claim; and the courts do not adhere to strict priority rules
- C. Notional amount and value of a contract cannot be used to estimate credit at risk (CAR) due to hidden risks present in derivative positions

Which of the following statements is INCORRECT?

- A. CAR is measure at a given confidence level
- B. Market risk and credit risk differ in that the former is measured over a shorter period
- C. Replacement cost of a derivatives contract increases as the estimate of recovery increases
- D. When assessing credit risk for derivatives, portfolio risk cannot be calculated by adding up individual exposures without regard to their interactions with each other

Which of the following statements is CORRECT?

- A. Requiring margin increases liquidity risk for both parties to a contract since money is needed up front.
- B. The same multiple of standard deviation can be used for all positions to estimate the worst-case impact on portfolios
- C. As a risk management technique, credit derivatives can be used to transfer credit risk due to a third party as well as to speculate on credit risk
- D. Netting arrangement are usually applies only to long-term derivatives, since credit risk increases over time for contracts such as forwards

Which of the following does NOT represent a credit risk management technique for derivatives that will reduce credit exposure?

- A. Firm A has a positive value contract on a bond index with Firm B, which will be netted out with another contract written on S&P 500 between these two
- B. Firms A and B have an over-the-counter forward contract on natural gas between them, which will be settled every month instead of daily settlement as in the case of futures
- C. Firms A and B require that when either firm's credit rating falls below investment grade, all outstanding contracts will be settled immediately, and the firm whose rating is intact will be released of any future obligations
- D. Firm A has a poor credit rating, and it approached a third party to issue a financial guarantee on its behalf favoring the counterparty. Firm B, with whom it has entered into a commodities contract, The third party's credit rating is the same as that of Firm A, and the two are very highly correlated

Credit provisions should be taken to cover all of the following EXCEPT: FRM 1998, 85

- A. non-performing loans
- B. the expected loss of a loan portfolio
- C. an amount equal to the VAR of the credit portfolio
- D. excess credit profits earned during below average loss years

Assume that the DV01 of an IRS is equal to 4,000 times its time left to maturity in years. At initiation, the swap tenor is three years and the swap is at par. Assume that the interest rate curve moves are parallel, stochastic with constant volatility and normally distributed and independent with 1 day standard deviation of 5bps. Assume 250 business days per year. The swap's max potential exposure at the 99% confidence level is approximately: FRM 1999, 143

- A. 700,000
- B. 1,000,000
- C. 1,500,000
- D. 2,000,000

13 CREDIT EXPOSURE OF CASH INSTRUMENTS

- Loans/Bonds
- Guarantees
- Commitments
- Swaps/Forwards
- Long Options
- Short Options

14 CREDIT EXPOSURE OF DERIVATIVES

Derivatives related credit risks may be hidden and may lead to an UNANTICIPATED loss. There are three reasons why such risks are more difficult to assess compared with traditional (cash) credit risks

14.1 LACK OF A CLEAR RELATIONSHIP BETWEEN CONTRACT VALUE

Payments on most derivatives are based on a notional amount, which does not give the correct idea of the risk associated with the derivative. Furthermore, the contract value lacks a direct relationship with the credit exposure, even if one were to estimate the default probabilities and recovery amounts. Although the initial value for forwards and swaps contracts is zero, contract values can fluctuate wildly with the passage of time due to the nature of derivatives pricing. Therefore, at any given time, it would be hard to use the current value of such a contract to project future credit related losses

14.2 ADDITIONAL RISK DUE TO THE LEVERAGE CHARACTERISTICS OF DERIVATIVES

Many derivatives are highly leverages contracts, therefore their risk can vary greatly for small changes in the underlying variables. Further, while it is true that the most severe losses usually in the tails of the distribution, some positions (e.g. straddle) have maximum losses when the underlying price does not change at all.

14.3 DIFFICULT IN ASSESSING TOTLA PORTFOLIO RISK DUE TO COMPLICATED RELATIONSHIP

From portfolio theory, we know that changes in prices of securities (e.g. stocks and bonds) interact with each other; these interactions are captured with the help of covariance and correlation, which allow us to assess total portfolio risk. With



derivatives, capturing similar interaction effects between different derivative positions is necessary to properly assess portfolio credit risk. However, due to the complicated pricing structures of most derivatives, assessing such risk is much more challenging.

- What is the primary difference between the default implications of loans versus those of swaps? FRM 1999, 105
- A. The principal in a swap is not at risk
 - B. The cash flows in the loans are determined by the level of rates, not the difference in rates
 - C. Default on a loan requires only that the firms be in financial distress, a swap also requires that the remaining value be negative
 - D. All of the above

14.4 INTEREST-RATE SWAPS

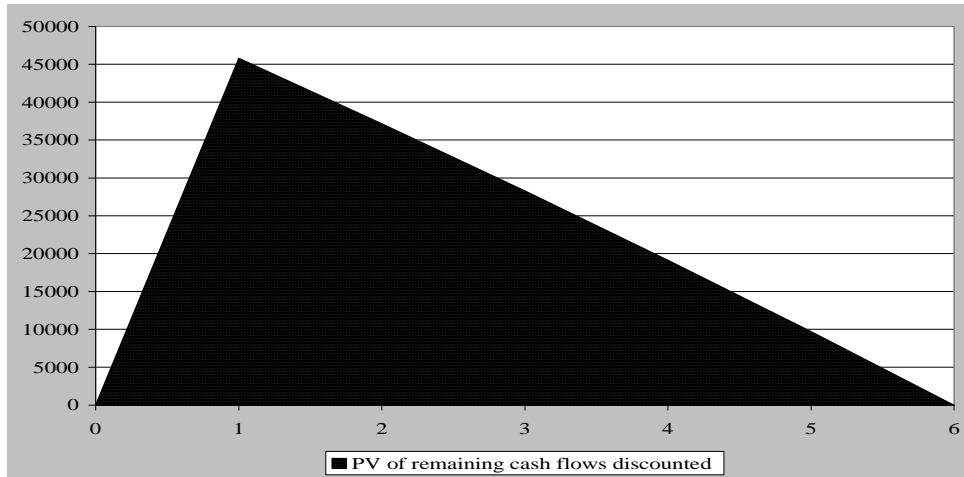
The amount of the intermediary's exposure is either **the replacement cost of the swap** or **the loss that will result from selling the remainder of the unmatched swap in the secondary market**. It is important to note the exposure value is a function of **the passage of time** and **changes in interest rates**.

Bank X enters into an interest rate swap with company Y. It receives semiannual payments at an interest rate of 8 percent against payment of six month LIBOR for a period of three years. Assuming a notional principal amount of \$1,000,000, please calculate the credit risk exposure if (1) the swap rate goes down to 6% and (2) the swap rate goes up to 10%.

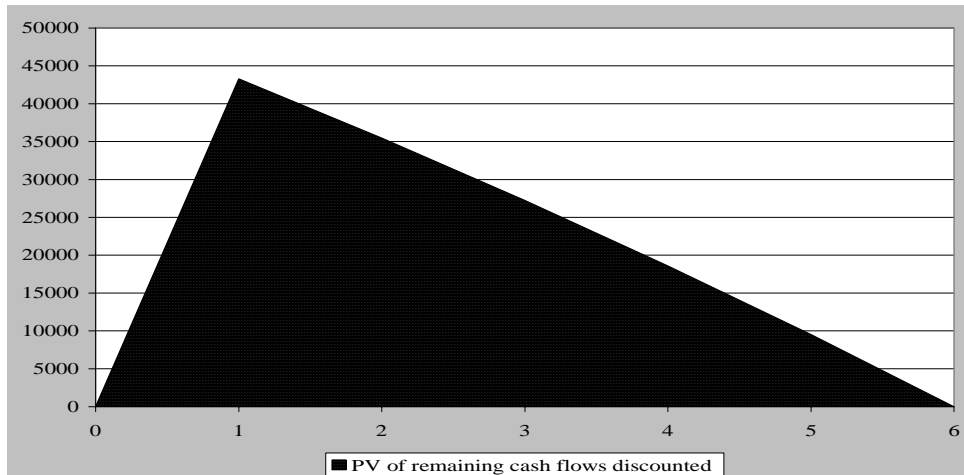
We use BA II Plus and get the following table

Interest Period	Fixed rate payment @ 8%	Fixed rate payment @ 6%	Fixed rate payment @ 10%	Cash flow differential @ 6% to X	Cash flow differential @ 10% to X	PV of remaining cash flows discounted at 6%	PV of remaining cash flows discounted at 8%
1	40,000	30,000	50,000	(10,000)	20,000	(45,797)	43,295
2	40,000	30,000	50,000	(10,000)	20,000	(37,171)	35,460
3	40,000	30,000	50,000	(10,000)	20,000	(28,286)	27,232
4	40,000	30,000	50,000	(10,000)	20,000	(19,135)	18,594
5	40,000	30,000	50,000	(10,000)	20,000	(9,709)	9,524
6	40,000	30,000	50,000	(10,000)	20,000	0	0

For Bank X, if rate goes to 6% counterparty, risk exposure is as follows



For Company Y, if rate goes to 10%, risk exposure is as follows



- The diffusion effect: the dispersion of interest rates can be expected to increase with time
 - The amortization effect: the overall market value will tend toward zero of the amount of the final payment, with the shrinking of time to maturity
- For example, a 2-year swap contract with semiannual payments may increase in value as interest rates diverge following issuance; but as time progresses, the number of semiannual payments will decrease from four to zero*
- *Monte Carlo simulation is often used to calculate risk exposure in practice. The distributions of future credit exposures are estimated at many discrete points over the life of the instrument portfolio.*

Mean reversion or Non mean reversion decides the peak risk exposure of IRS.

Be sure to remember the following formula for computing the timing of peak exposure for IRS instrument without mean-reversion effect taken into account, i.e.

$$(V) = [K(T-t)] \times \sqrt{t}$$

A 10-year fixed-floating swap, with monthly settlements, reached its maximum credit exposure at time closest to which stage into its life (assume evaluation at inception) FRM 1997, 151

- A. 1 year
- B. 3.33 years
- C. 5.00 years
- D. 7.50 years

Example:

The amount of potential exposure arising from being long an OTC USD/EUR forward contract will be a function of the :

- I. Credit quality of the counterparty
- II. Tenor of the contract
- III. Volatility of the spot USD/EUR exchange rate
- IV. Volatility of the USD interest rate
- V. Volatility of the EUR interest rate
- VI. Nominal amount of the contract FRM 1999, 147

- A. All of the above
- B. All except I
- C. I, II, III, and VI
- D. III, IV, and V

Assume that swap rates are identical for all swap tenors. A swap dealer entered into a plain vanilla swap one year ago as the receive-fixed party, when the price of the swap was 7 percent. Today this swap dealer will face credit risk exposure from this swap only if the value of the swap for the dealer is: FRM 1999, 112

- A. negative, which will occur if new swaps are being priced at 6%
- B. negative, which will occur if new swaps are being priced at 8%
- C. positive, which will occur if new swaps are being priced at 6%
- D. positive, which will occur if new swaps are being priced at 8%

Bank One enters into a 5-year swap contract with Mervin Co. to pay LIBOR in return for a fixed 8% on a nominal principal of \$100mn. Two years from now, the market rate on three-year swaps at LIBOR is 7%; at this time Mervin Co. declares bankruptcy and defaults on its swap obligation. Assume that the net payment is made only at the end of each year for the swap contract period. What is the market value of the loss incurred by Bank One as result of the default? FRM 2000, 56

- A. \$1.927mn
- A. \$2.245mn
- B. 2.624mn
- C. 3.011mn

Determine at what point in the future that a derivatives' portfolio will reach its maximum potential exposure. All derivatives are on one underlying, which is assumed to move in a stochastic fashion (variance in the underlying's value increased linearly with time passage). The derivatives' portfolio sensitivity to the

underlying is expected to drop off as $(T-t)^2$ (square to the time left to maturity), where T is the time from today to last contract in the portfolio rolls of hand, t is the item from today. FRM 2000, 29

- A. T/5
- B. T/3
- C. T/2
- D. None of the above

Determine at what point in the future that a derivatives' portfolio will reach its maximum potential exposure. All derivatives are on one underlying, which is assumed to move in a stochastic fashion (variance in the underlying's value increased linearly with time passage). The derivatives' portfolio sensitivity to the underlying is expected to drop off as $(T-t)$ (square to the time left to maturity), where T is the time from today to last contract in the portfolio rolls of hand, t is the item from today. FRM 2000, 40

- A. T
- B. T/2
- C. T/3
- D. T/5

14.5 CURRENCY SWAPS

CCS differs from IRS with two respects:

- (1) In addition to exchange rate, interest rates may affect cash flow projections for currency swaps.
- (2) An exchange of principal takes place with a currency swap.
- (3) Peak exposure vs. Potential exposure

The degree of potential credit exposure of being long a DEM IRS with counterparty will be a function of: (FRM 1997, 129)

- A. the swap tenor and credit quality of the counterparty
- B. the credit quality of the counterparty only
- C. the volatility of DEM interest rates and swap tenor
- D. the volatility of DEM interest rates only

A trader purchases a six month OTC straddle on Stock A for a 1 million premium from counterparty. The maximum credit exposure over the life of the trade is: (FRM 1997, 131)

- A. less than 1 million
- B. between .5 million to 1 million
- C. exactly 1 million
- D. greater than 1 million

Which of the following conditions result in a higher probability of default? FRM 1999, 106

- A. The maturity of the transaction is longer
- B. The counterparty is more creditworthy
- C. The price of the bond, or underlying price in the case of a derivative is less volatile
- D. Both A & C



Example

Which of the following will NOT create a credit risk to the bank?

- I. Bank receive fixed on single currency IRS
- II. Bank sells a digital option with a contingent layout equal to USD 1mn
- III. Bank buys an interest rate collar
- IV. Bank sells a 10mn US/Yen at the money straddle(FRM 1999, 123)

- A. I only
- B. II and IV
- C. I and III
- D. I, II, and III

For a 10-year, \$100 million notional amount, which one of the following swap positions has the highest potential future credit exposure at the time specified?
FRM 2000, 45

- A. Currency swap (USD vs. YEN) three years after inception
- B. Currency swap (USD vs. YEN) five years after inception
- C. Interest-rate swap (USD, fixed vs. floating) three years after inception
- D. Interest-rate swap (USD, fixed vs. floating) five years after inception

What is the primary difference between the default implication of loans versus those swaps? FRM 1999, 105

- A. The principal in a swap is not at risks
- B. The cash flows in the loans are determined by the level of rates, not the difference in rates
- C. Default on a loan requires only that the firm be in financial distress, a swap also requires that the remaining value be negative
- D. All of the above

Which of the following 10-year swaps has the highest potential credit exposure?
FRM 2001, 8

- A. A CCS after 2 years
- B. A CCS after 9 years
- C. An IRS after 2 years
- D. An IRS after 9 years

15 CREDIT VAR - CVAR

- Measurement of unexpected loss
- Deviation away from ECL (expected credit loss)
- CVaR = WCL - ECL, here, WCL stands for Worst Credit Loss (up to certain confidenc level)

Consider for instance a portfolio of \$ 100 mn with 3 bonds A, B, and C, with various probabilities of default. To siimply, we assume

- (1) that the exposures are constant
- (2) the the recovery in case of default is zero



(3) that default events are independent across issuers

Please compute credit VAR under 95% confidence level

Issuer	Exposure (mio)	Prob.
A	25	0.05
B	30	0.1
C	45	0.2

Default	Loss(mio)	Prob.	Cum. Prob.	E(Li)	Variance
(i)	Li	p(Li)		Li*p(Li)	(Li-E(Li))^2*p(Li)
None	\$0	0.684	0.684	\$0.0000	120.08
A	25	0.036	0.72	\$0.9000	4.97
B	30	0.076	0.796	\$2.2800	21.32
C	45	0.171	0.967	\$7.6950	172.38
A,B	55	0.004	0.971	\$0.2200	6.97
A,C	70	0.009	0.98	\$0.6300	28.99
B,C	75	0.019	0.999	\$1.4250	72.45
A,B,C	100	0.001	1	\$0.1000	7.53
			Sum	\$13.2500	434.69

FRM Handbook, 2nd edition pp.401-402

Expected Loss = \$13.25

Standard deviation of $(CL) = (434.69)^{0.5} = 20.85$

Credit VAR = $13.25 + 1.645 * 20.85 = 47.55$ (c.f. 45) = expected loss + unexpected loss

Unexpected loss = Credit VAR - Expected loss = $47.55 - 13.25 = 34.30$ or $45 - 13.25 = 31.75$

A portfolio consists of two (long) assets \$100 mn each. The probability of default over the next year is 10% for the first asset, 20% for the second asset, and the joint probability of default is 3%. Estimate the expected loss on this portfolio due to credit defaults over the next year assuming 40% recovery rate for both assets. FRM 2000, 51

- A. \$ 18 mn
- B. \$ 22 mn
- C. \$ 30 mn
- D. None of the above

16 RECOVERY RATES

- The bankruptcy process creates a *pecking order* for a company's creditors. This spells out the order in which creditors are paid, thereby creating



differences in the recovery rate across creditors. Within each class, however, creditors should be treated equally.

- Firms are unable to make required payments can file for the following two procedures
 - Chapter 7 bankruptcy: the liquidation of the firm's assets; the proceeds should be distributed to creditors based on their priority to claim assets
 - Chapter 11 bankruptcy: a reorganization of the firm during which the firm continues to operate under court supervision; different from Chapter 7, Junior creditors/shareholders often receive some proceeds
- The priority to claim (the pecking order)
 - Secured vs. Unsecured
 - Senior vs. Junior

Seniority	Type of Creditor
Highest (paid first)	Secured creditors: Up to the extent secured collateral Priority creditors: Firms that lend money during bankruptcy period; Providers of goods, and services during bankruptcy period; Taxes General creditors: Unsecured creditors before bankruptcy
Lowest (paid last)	Shareholders

Which of the following statements about the seniority of preferred stocks is true? FRM 1998, 56

- A. It should be between senior secured debt and senior unsecured debt
- B. It should be between subordinated debt and unsubordinated debt
- C. It should be between unsubordinated and common stock
- D. It should be the same as that of common stock

When a company defaults, recovery rates (as expected) are lower for junior debt than for senior debt. However, if you invested at the start of the bankruptcy period (i.e., after default has been announced when bonds are trading at a deep discount), which of the following statements is TRUE? FRM 1999, 135

- A. During the bankruptcy reorganization period, senior debt gives a better return than junior debt
- B. During the bankruptcy reorganization period, junior debt gives a better return than senior debt
- C. During the bankruptcy reorganization period, senior debt usually gives a similar return to junior debt
- D. Studies comparing returns on senior and junior debt during a bankruptcy reorganization period have, in general, given inconclusive or conflicting results.



Which one of the following deals would have the largest credit exposure for a \$1mn deal size (assume the counterparty in each deal is a AAA-rated bank and has no settlement risk)? FRM 2000,47

- A. Pay fixed in an AUD IRS for 1 year
- B. Sell USD against AUD in a 1-year forward foreign exchange contract
- C. Sell a 1-year AUD Cap
- D. Purchase a 1-year CD

17 EXPOSURE MODIFIERS

17.1 MARKING TO MARKET/REQUIRING MARGIN AND COLLATERAL

- Margin and collateral can be liquidated in the case of default reducing credit exposure.
- Two-way MTM vs. One-way MTM

17.2 REQUIRING CREDIT GUARANTEE

Credit guarantees from firms with high(er) credit ratings increases the recovery rate in case of default as the guarantor will step in to make up the shortfall'

17.3 COLLATERAL

- Against current/potential exposure
- The amount of the collateral will exceed the fund owed by an amount known as the haircut, particularly if the collateral has less satisfactory liquidity - a combination of credit risk and market risk

17.4 INCLUDING CREDIT TRIGGERS

Trigger clauses automatically force a settlement of contract in case the credit rating of one of the parties drops below a threshold and are used more frequently in long-term derivative contracts

17.5 EXPOSURE LIMITS

- Credit exposure can be controlled by setting limits of exposure to a party on the basis of notional amounts and credit at risk
- The function of middle office

17.6 RECOUPONING

Requiring contracts to be settled on a periodic basis, the party can reduce their credit exposure at the risk of imposing a liquidity crunch on the counterparty

17.7 NETTING ARRANGEMENTS

Netting of exposures acts to reduce credit exposures by allowing the offsetting for amounts due between two counterparties. Contracts often require that transactions are settled only by transfer of the net amount due to or from a party. Netting out payments to be paid to a party against those to be received from the same party reduces the impact of default since the defaulting party cannot demand



payments on positive value contracts and default on negative value contracts

17.8 USING CREDIT DERIVATIVES

Credit derivatives have become increasingly popular as a way of transferring credit risk to a third party, alter a firm's credit risk profile, enhancing yields, and diversifying existing credit exposure

Which of the following mechanisms is not a vehicle a derivative participant used to reduce credit exposure on a set of transactions? (FRM 1997, 150)

- A. Payment and close-out netting agreements
- B. Collateral or other credit enhancements
- C. Early termination agreements
- D. Periodic mark-to-market

All of the following could help to reduce the credit exposure on a set of derivative transactions EXCEPT: FRM 1998 75

- A. Daily MTM of transactions
- B. Netting agreements with the counterparty
- C. Collateral and other credit enhancements
- D. Early termination agreement

Which one of the following statements about credit risk from derivatives instruments is NOT correct? FRM 2000, 82

- A. If credit limits are exceeded, exceptions should be resolved according to the institution's policies and procedure
- B. Credit exposures should always be computed net of risk-reducing features such as master netting agreement and collateral or third party guarantees
- C. Credit limits that consider both settlement and pre-settlement exposures should be established for all counterparties with whom the institution conducts business
- D. Prior to settlement, credit risk is measured as the sum of the replacement cost of the position plus an estimate of the institution's potential future exposure from the instrument as a result of market changes

A diversified portfolio of OTC derivative An equity repo is a repo in which common stock is used as collateral in place of the more usual fixed-income instrument. The mechanics of equity repos are effectively the same as fixed-income repos, except that the haircut FRM 1999, 123

- A. Is smaller because equities are more liquid than fixed-income instruments
- B. Is larger because equities are more volatile than those of fixed-income instruments
- C. About the same for both because the counterparty credit risk is the same

Cannot be determined in advance because equity prices, in contrast to fixed-income instrument prices, are not martingales

An equity repo is a repo in which common stock is used as collateral in place of the more usual fixed-income instrument. The mechanics of equity repos are effectively the same as fixed-income repos, except that the haircut FRM 1999, 123

- D. Is smaller because equities are more liquid than fixed-income instruments

- E. Is larger because equities are more volatile than those of fixed-income instruments
- F. About the same for both because the counterparty credit risk is the same
- G. Cannot be determined in advance because equity prices, in contrast to fixed-income instrument prices, are not martingales

18 CLO & CBO

- Collateralized loan obligations (CLOs): Securities are backed by pools of high-yield corporate bonds
- Collateralized bond/debt obligations (CBOs/CDOs): Securities are backed by pools of high-yield corporate bonds with the following features: ratings below investment grade (i.e. below BB+/Ba1), bond issues in emerging markets, corporate loans advanced by commercial banks
- A special-purpose vehicle (SPV) is set up.
- Cash flows from underlying assets (collateral) are separated into tranches (classes) with different characteristics (basically, the priority of payments in order),
- Same (in and out) cash flows, same total market value, same risk profile
- Tranches are rated from investment grade to non-investment grade
- Tranches are structured that at least one of the other tranches, and its securities, is more risky than the original assets
- The riskiest tranche is referred to as the equity tranche, often held by a bank
- CLOs have better recovery values (smaller single amount & more numbers?) and shorter average lives (amortization), therefore it is easier to create high-quality CLO-based notes than to do so for CBO-based notes.

In a typical CBO, a pool of high yield bonds are posted as collateral and the cash flows from the collateral are structured as several classes of securities (the offered securities) with different credit ratings and a residual piece (the equity) which absorbs most of the default risk. When comparing the market value weighted average rating of the collateral and that of the offered securities, which of the following is true? FRM 1998, 55

- A. The market value weighted average rating of the collateral is about the same as the offered securities
- B. The market value weighted average rating of the collateral is higher than the same as the offered securities
- C. The market value weighted average rating of the collateral is lower than the same as the offered securities
- D. The market value weighted average rating of the collateral may be lower or higher than the same as the offered securities

Structured finance makes it possible to finance credits which are:

- A. strong
- B. average
- C. risky
- D. all of the above

19 BASICS OF CREDIT DERIVATIVES

- Credit derivatives are used to mitigate (hedge) three types of credit risk: **default risk**, **credit spread risk**, and **downgrade risk**
- Credit derivatives, which are individually negotiated contracts, exist in the form of **options**, **forwards**, or **swaps**
- The payoffs of the contract are dependent upon the credit characteristics of the underlying asset or borrower
- Credit derivatives are customized over-the-counter (OTC) contracts that are typically settled in cash
- Credit derivatives are usually more efficient (taking into consideration transactions costs, taxes, and other costs) than buying or selling the underlying security
- Traded on stand-alone basis or embedded in other instruments
- Buyers seek protection by paying premiums and receive partial compensation from sellers if some credit event occurs

20 TYPES OF CREDIT RISK

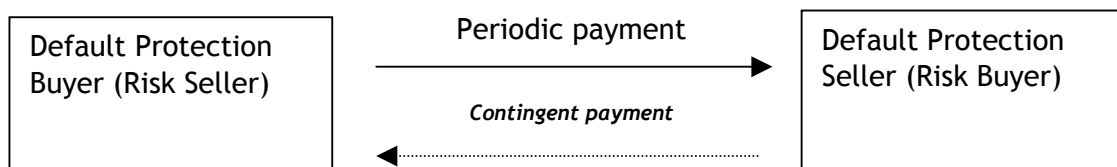
- **Default Risk:** the issuer will not pay interest and/or principal when due. Default risk is a huge concern for managers and can be effectively hedged by transferring credit risk through the use of credit options, forwards, and swaps
- **Credit Spread Risk:** the risk comes from the spread on an asset (i.e., its yield premium over the relevant risk free benchmark) will increase. Credit spread changes are often associated with macroeconomic events in either the domestic or global financial markets. An increase in the spread would cause the asset to under perform the risk free benchmark on a relative basis. Options and forwards are often used here
- **Downgrade Risk:** the risk reflects the possibility that the credit rating of an asset/issuer is downgraded by rating agencies. Downgrade risk is an absolute measure of credit risk; Credit Spread risk is a relative measure of credit risk. Options, forwards, swaps are utilized here

21 TYPES OF CREDIT DERIVATIVES

21.1 CLASSIFIED CRITERIA INCLUDE

- The underlying credit: a single entity or a basket/group of entities
- The exercise conditions: credit event (rating downgrade, or an increase in credit spreads)
- The payoff function (fixed or variable amount)

21.2 CREDIT DEFAULT SWAPS (信用違約風險交換)





*condition: credit event on reference asset (specific bonds)

A credit derivative that requires the risk seller to pay a fixed periodic fee in exchange for a payment contingent upon some future credit event. If the event occurs, the risk buyer pays the risk seller a specified amount, often based on the loss

- Investing in a risky bonds = Investing in a risky-free bond + buying a CDS (you are taking the credit risk *since the premium received makes the risky bond comparatively cheaper*)
- CDS decreases exposure to the reference credit but assumes new credit risk derived from counter-party - the higher rating of counterparty and the lower correlation with the underlying asset (reference credit), the larger CDS spreads you have to pay because of higher protection received! (Table 22-2)
- Payment forms include: Cash settlement, Physical delivery, and Lump sum.
- First of basket to default swap: the protection buyer has the right to deliver one, and only one, defaulted security out of a basket of selected securities.
- Settlement

The Rose Foundation enters into a 1-year credit default swap on a notional amount of \$10 million of 5-year bonds issued by the Crescent Corporation. The swap entails an annual premium of 55bps. Assume that the Crescent Corporation defaults at the end of the first year, trading at 60 cents to the dollar. Describe the cash flows associated with the credit default swap. Key issues: pay attention to the cash flows at the very beginning and if the credit event occurs!

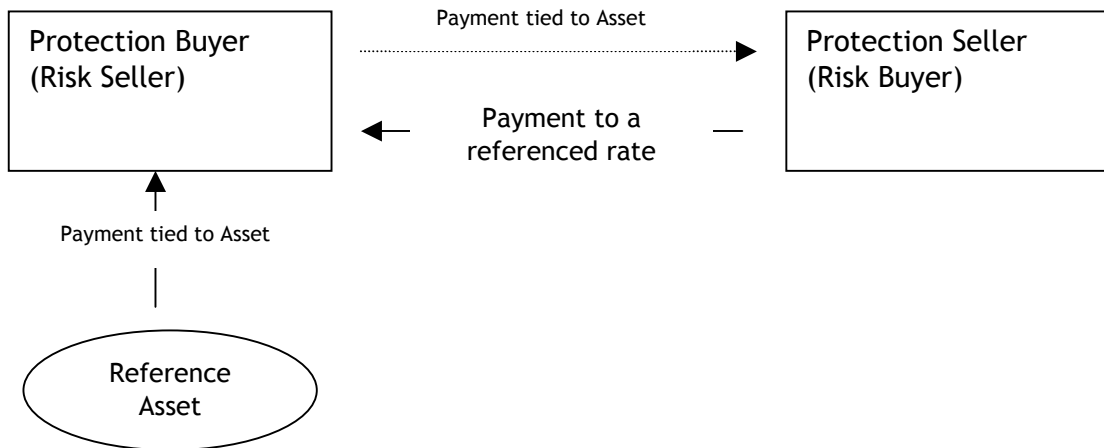
A CDS has been created with a 5-year term, \$50 million notional, and 125 bps spread. Two years after the initiation of the CDS, the reference entity defaults on the reference obligation. A polling of dealers has determined a mid-market price of 42. What would the cash settlement value be in this situation? SCH p.185

- A. \$50 million
- B. \$625,000
- C. \$29 million
- D. \$21 million

Compared with an asset swap, a similar credit swap will pay: FRM 1999, 109

- A. more
- B. less
- C. the same
- D. both A & B

21.3 TOTAL RETURN SWAPS (ONE TYPE OF ASSET SWAP) PART I



A total return swap is a two-party agreement in which the total rate of return from one asset is exchanged for another cash flow

- If the pricing of reference asset is down, the buyer receives compensation
- If the pricing of reference asset is up, the buyer receives nothing (remember: premium is paid in advance to buy this derivative)
- Cash flows are exchanged regardless of whether or not a credit event takes place
- The holder of an asset to eliminate economic risk without having to sell the asset
-

Bank A has made a \$100 million loan to company xyz at a fixed rate of 10%. The bank can hedge its exposure by entering a TRS with counterparty B, whereby it promise to pay the interest on the loan plus the change in the market value of the loan in exchange for LIBOR plus 50bps. If the market value of the loan increases, the bank has to make a greater payment. Otherwise, its payment will decrease, possibly becoming negative. Say that LIBOR is currently at 9% and that after one year, the value of the loan drops from \$100 to \$95 million. Then the net obligation from Bank A is ?

Fixed rate of Reference asset: 10%

Asset Value: down to USD 95 from USD 100

The buyer makes payment from reference assets: $100 \times 10\% = 10$

The buyer receives payment based on reference rate: $100 \times 9.5\% = 9.5$

The buyer makes payment to reflect the change of market value of reference asset: $(95 - 100) / 100 \times 100 = -5$, equivalent to receiving payment 5

Total cash flow = $-10 + 9.5 + 5 = 4.5$

Company A and Company B enter into a trade agreement in which Company A will periodically pay all cash flows and capital gains arising from Bond X to Company B. On the same dates Company B will pay Company A LIBOR + 50 bps plus any decrease in the market value of BOND X. What type of trade is this? FRM 1998, 90

- A. A total return swap
- B. A fixed income linked swap
- C. An inverse floater
- D. An interest rate swap

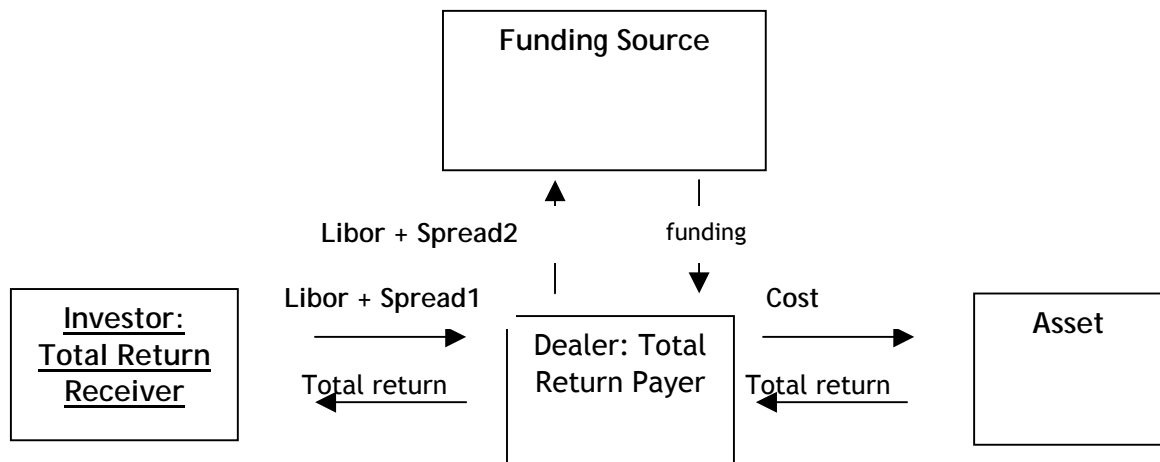
Bank One has made a \$200 million loan to a software company at a fixed rate of 12%. The bank wants to hedge its exposure by entering into a Total Return Swap with counterparty, Interloan Co., in which Bank One promised to pay the interest on the loan plus the change in the market value of the loan in exchange for LIBOR plus 40 bps. If after one year the market value of the loan has decreased by 3% and LIBOR is 11%, what will be the net obligation of BANK One? FRM 2000, 62

- A. Net receipt of \$4.8 million
- B. Net payment of \$4.8 million
- C. Net receipt of \$5.2 million
- D. Net payment of \$5.2 million

A portfolio manager holds a default swap to hedge an AA corporate bond positions. If the counterparty of the default swap is acquired by the bond issuer, then the default swap: FRM 1999, 116

- A. increases in value
- B. decreases in value
- C. decrease in value only if the corporate bond is downgraded
- D. is unchanged in value

21.4 TOTAL RETURN CREDIT SWAPS (PART II)



- The total return payer owns the risky asset, while the total return receiver agrees to receive the asset's total return in exchange for a fixed-or floating-rate payment stream
- For payer: can transfer asset's risk to the total return receiver in exchange for a fixed margin. Hence, the main benefit to the bank is the elimination of credit risk. If the asset is already on the payer's balance sheet, he can reduce risk and receive a fee
- For receiver: the recipient of the total return swap does not have to finance the purchase of underlying assets (borrowing other's B/S?); the number of swap transactions can be significantly less than the individual transactions; the receiver may not have a great deal of expertise in this area. Hence, the

receiver benefits the credit analysis the bank has already performed;
additional leverage can be built into the terms of the swap agreement

- Downside risk, however, may be limited (page 499)

21.5 CREDIT SPREAD FORWARD AND OPTIONS

Payoff is tied to an underlying credit spread between a risky and risky-free bond (relative basis)

21.5.1 For Credit Spread Forward Contract (page 498)

- $\text{Payoff} = \{\text{Credit Spread}_{\text{maturity}} - \text{Credit Spread}_{\text{strike}}\} * \text{Modified Duration} * \text{Notional Amount}$
- $\text{Payoff} = \text{Pricing Differential} * \text{Notional Amount} = \{\text{Pricing}_{\text{strike}} - \text{Pricing}_{\text{maturity}}\} * \text{Notional Amount}$
- Cash flow in/out is **always there** for protection buyer

Suppose that the LIBOR is 7 1/8 percent, and a hypothetical firm is able to offer 5-year 9 1/8 percent annual coupon notes at a spread of 200 bps over LIBOR. The bonds are issued with a credit spread forward with a strike price, which is determined by a 300 bps spread over LIBOR. Now suppose (1) that one year later the actual spread is 350 bps, please calculate the payoff and direction of the credit forward, (2) Alternatively, if the spread remains 200 bps. Here, we assume notional amount is \$ 25mn and modified duration is 3.

21.5.2 For Credit Spread Option Contract

- $\text{Payoff} = \text{Max}(\text{Spread} - K, 0) * \text{Modified Duration} * \text{Notional Amount}$
- $\text{Payoff} = \text{Max}(\text{Pricing}_{\text{strike}} - \text{Pricing}_{\text{maturity}}, 0) * \text{Notional Amount}$
- Cash flow could be **zero or positive** for protection buyer

Cont'd from the previous example. Suppose that the LIBOR is 7 1/8 percent, and a hypothetical firm is able to offer 5-year 9 1/8 percent annual coupon notes at a spread of 200 bps over LIBOR. The bonds are issued with a credit spread put with a strike price, which is determined by a 300 bps spread over LIBOR? Now suppose that one year later (technically, the day after the first coupon payment for computational simplicity) LIBOR is 6 3/4 percent and the yield on the bond is 10 1/4 percent. Please compute the value of the put at these two times (t=0 and t=1).

A credit spread option has a notional of \$100mn with a maturity of one year. The underlying security is an 8% 10-year bond issued by the corporation XYZ. The current spread is 150bps against 10-year Treasuries. The option is European type with a strike of 160bps. Assume that, at expiration, Treasury yields have moved from 6.5% to 6% and the credit spread has widened to 180bps. The payoff at time = 1? FRM Handbook 2nd edition, p.498

Reference asset: coupon=8%, tenor=10 years
Time=0, Yield=150bp+10-year Treasury yield (6.5%)
Time=1, Yield=180bp+10-year Treasury yield (6.0%)
Strike Benchmark=160bp+10-year Treasury yield



Step1: compute the pricing of current yield by using BA II Plus

$$N=9*2=18$$

$$I/Y=7.8\%*2=3.9\%$$

$$PMT=100*8\%*0.5=4$$

$$FV=100$$

And we get $PV=101.276$

Step2: compute the pricing based on the strike option

$$N=18$$

$$I/Y=7.6\%*2=3.8\%$$

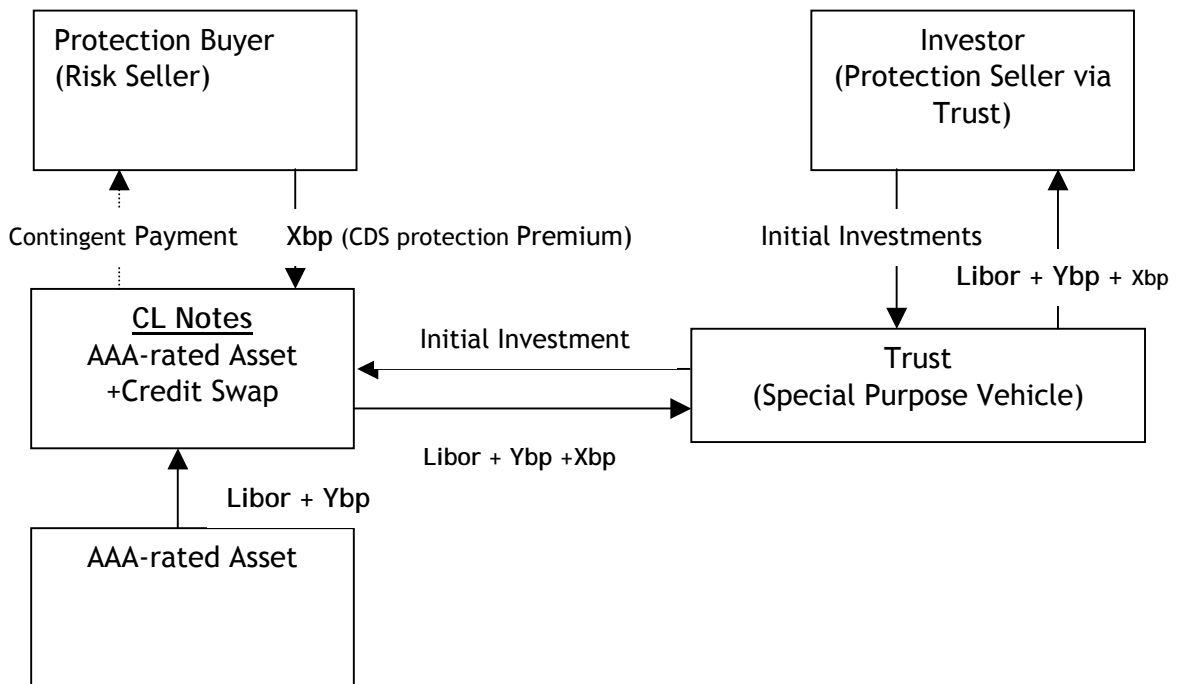
$$PMT=4$$

$$FV=100$$

And we get $PV=102.574$

Step3: Sketch the graph and then compare pricing differential, since the current pricing is below the pricing based on the strike option, meaning the derivative is ***IN THE MONEY***, and the payoff is $(102.574-101.276)/100*100,000,000=1.297237MN$

21.6 CREDIT LINKED NOTES (信用連結債券)



A credit-linked note is a structure where the cash flows to both parties depend on the credit performance of a reference credit.

- Trust is set up to issue notes/certificates for which the proceeds (collected from Investor) are invested to acquire cash collateral (e.g. T-bills or AAA-rated notes) plus to take a short position in CDS (receive premium from protection buyer).
- The fee paid by the protection buyer + cash collateral yield is passed through Trust to the investor (protection seller)
- If the reference credit defaults, the collateral is liquidated to compensate the loss the Protection Buyer and the remains are to distributed to the Investors
- In return of this higher yield (above 100bp, e.g. p. 495), the investor must be willing to lose some of the principal (initial Investment) should a default event occur

22 USEFUL FEATURE OF CREDIT DERIVATIVES

- **Portfolio exposure:** alter portfolio exposure to improve the ratio of expected return to unexpected loss
- **Arbitrage opportunities:** enable banks to capitalize on arbitrage opportunities such as price discrepancies and bond rating disparities
- **Confidentiality:** provide banks with confidentiality (credit protection can be purchased without the obligor's knowledge)
- **Timeliness:** only takes a few hours to set up a credit derivative
- **Access to exposure:** gain exposure to an asset without having to make a loan

23 PROS AND CONS OF CREDIT DERIVATIVES

- The transfer of risks
- Price discovery
- Transactional efficiency
- Various valuation methods
- Legal risk
- Regulatory arbitrage

Which of the following is a type of credit derivative? FRM 1997, 66

- A. A put option on a corporate bond
- B. A total return swap on a loan portfolio
- C. A note that pays an enhanced yield in the case of a bond downgrade
- D. All of the above

CFA Level reading book 2 pp.87

Which of the following is NOT a typical form for a credit derivatives security?

- A. Option contract
- B. Futures contract
- C. Swap agreement
- D. Forward contract

Which of the following is NOT a type of credit risk?

- A. Default risk
- B. Maturity risk
- C. Downgrade risk
- D. Credit spread risk

In many cases, the motivation for assuming credit risk is to speculate on an improving in credit quality. Which of the following represents another possible motivation for assuming credit risk?

- A. Hedging
- B. Receive income
- C. Reduce leverage
- D. Offset foreign exchange exposure

An investor owns a \$15 million bond position upon which he has purchased a credit spread put option. The current price of the bonds is 94.155, and the current strike price of the put is 97.450. Which of the following represents the value of the put option?

- A. \$0
- B. \$329,500
- C. \$494,250
- D. 14,123,250

Which of the following most correctly describes how the strike price on a credit spread put option is determined? The strike price:

- A. following a specific time-decay schedule
- B. is fixed when the option is written by the seller

- C. is calculated by discounting bond cash flows with a benchmark rate plus a strike spread
- D. is calculated by discounting bond cash flows with a benchmark rate plus the initial spread over the benchmark when the bonds were issues

Which of the following explains why a total return credit swap may be used in portfolio management? CFA Level III reading

- A. To increase credit exposure
- B. To decrease credit exposure
- C. To transfer the credit risk of a specific asset to another party
- D. All of the above

Bank of America makes a \$10 million, 4%, 4-year loan (with semiannual payments) to Final Markup, Inc., at a spread of 110 bps to the 4-year Treasury. In order to hedge the credit risk, B of America enters into a 1-year credit spread option contract with TER Inc., with a \$10 million notional on corporate bonds with a spread strike of 120 bps. At maturity of the option contract, the Treasury yield is still 2.9 percent, but credit spread on the bonds is 140 bps. What amount will TER owe to B of A?

- A. \$55,638
- B. \$60,000
- C. \$102,887
- D. \$300,000

All of the following can be accomplished with the use of a credit derivative EXCEPT: FRM 1998, 88

- A. reducing credit concentration risk
- B. allowing a fund to invest in corporate loans
- C. preventing the bankruptcy of loan counterparty
- D. leveraging credit risk

Which of the following statements is/are ALWAYS true? FRM 1999, 107

- A. Payment in a credit swap is contingent upon a future credit event
- B. Payment in a total rate of return swap is not contingent upon a future credit event
- C. Both A & B
- D. None of the above

Example:

Which of the following are needed to value a credit swap? FRM 1999, 141

- I. Correlation structure for the default and recovery rates of the swap counterparty and reference credit
 - II. The swap or treasury yield curve
 - III. Reference credit spread over swap or treasury rates
 - IV. Swap counterparty credit spread curve over swap or treasury rates
- A. II, III, and IV
 - B. I, III, and IV
 - C. II and III



D. All of the above

24 SUMMARY OF RISK CONTROL MECHANISM

Exposure Reduction	Exposure Diversification
Buy Credit Protection	Sell Credit Protection
Sell Loans	Buy Loans (assignments and participations)
Buy CDS Indexes	Sell CDS Indexes
Sell CLOs,CBOs, CDOs, CLNs	Buy CLOs,CBOs, CDOs, CLNs
Buy options to sell Bonds and Stocks	Buy Bonds, FRNs, and Asset Swap
Buy option on credit	Buy option on credit