Options and Risk Models

FRM一级培训讲义-强化班

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Topic Weightings in FRM Part Ⅰ

Session NO.	Contents	Weightings
Study Session 1	Foundations of Risk Management	20
Study Session 2	Quantitative Analysis	20
Study Session 3	Financial Markets and Products	30
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Framework

- Option Markets
- Financial Institutions
- Market Risk Models
- Credit Risk Models
- Operational Risk Models

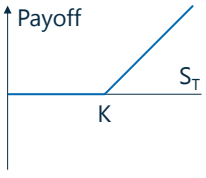
Options Market

Properties of Stock Options

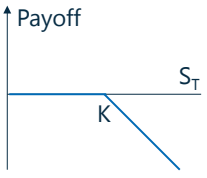
- **Basics**
  - Call and Put Options
  - European and American Option
- **Moneyness**
  - **In the money:** Immediate exercise would generate a positive payoff
  - **At the money:** Immediate exercise would generate no payoff
  - **Out of the money:** Immediate exercise would result in a loss
- **Intrinsic Value and Time Value**
  - **Intrinsic Value:** The amount that it is in the money, and zero otherwise
    - ✓ Intrinsic value of call option: C=max [S – X, 0]
    - ✓ Intrinsic value of put option: P=max [X – S, 0]
  - **Time Value:** The difference between the price of an option (called its premium) and its intrinsic value is due to its time value.

Calls and Puts

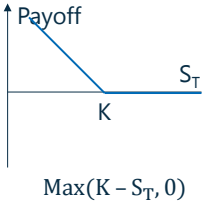
- **Payoffs of Options**



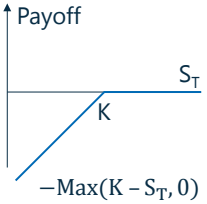
$\text{Max}(S_T - K, 0)$



$-\text{Max}(S_T - K, 0)$



$\text{Max}(K - S_T, 0)$



$-\text{Max}(K - S_T, 0)$

Properties of Options

- **Call Options**

Call Option	Upper Bounds	Lower Bounds
European (No Dividend)	S_0	$\max(S_0 - PV(K), 0)$
European (Dividend)	S_0	$\max(S_0 - PV(K) - PV(Divs), 0)$
American (No Dividend)	S_0	$\max(S_0 - PV(K), 0)$
American (Dividend)	S_0	视红利情况而定

- **Put Options**

Put Option	Upper Bounds	Lower Bounds
European (No Dividend)	$PV(K)$	$\max(PV(K) - S_0, 0)$
European (Dividend)	$PV(K)$	$\max(PV(K) + PV(Divs) - S_0, 0)$
American (No Dividend)	K	$\max(K - S_0, 0)$
American (Dividend)	K	视红利情况而定

- **Put-Call Parity** $\text{European Call Price} + PV(K) + PV(Divs) = \text{European Put Price} + S$

Properties of Options

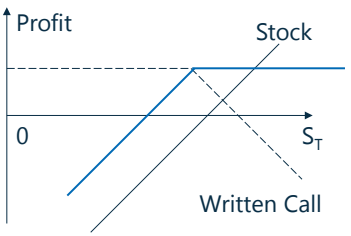
- What will be the lower bound for the price of a three-month European put option on a non-dividend-paying stock if the current stock price is USD 22, the strike price is USD 25, and the risk-free rate is 6% per year (annually compounded)?
  - The lower bound (USD) is

$$\max(PV(K) - S_0, 0) = \frac{25}{(1+0.06)^{0.25}} - 22 = 2.64$$

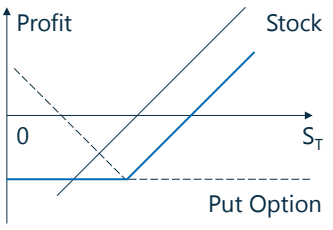
- The current price of a non-dividend-paying stock is USD 29 and the price of a four-month call option on the stock with a strike price of USD 30 is USD 2. The risk-free rate is 4% per annum (annually compounded). What is the price of a four-month put option on the stock with a strike price of USD 30? Assume no arbitrage opportunities exist.
  - By put-call parity : Put= Call +PV(K)-S
  - The put price(USD)is thus given by: $2 + \frac{30}{1.04^{1/3}} - 29 = 2.61$

Simple Strategies

- **Covered Call and Protective Put**



Covered Call = -C + S

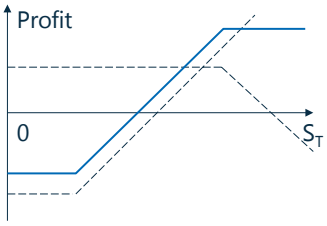


Protective Put = S + P

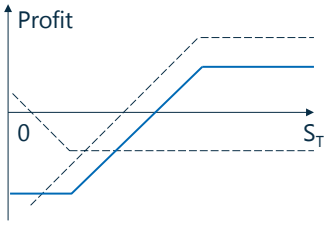
- **Principal Protected Notes(PPN)**
  - A PPN is structured as a zero-coupon bond and an option with a payoff that is linked to an underlying asset, index, or benchmark.
  - It guarantees a minimum return equal to the investor's initial investment (the principal amount), regardless of the performance of the underlying assets.

Spread Strategies

- **Bull Spread**
  - Vertical spread, outlook is bullish



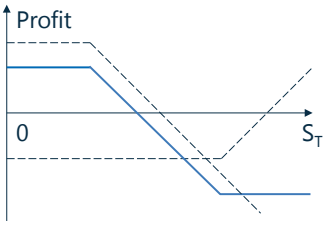
Bull Call Spread



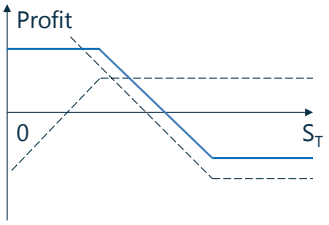
Bull Put Spread

Spread Strategies

- **Bear Spread**
  - Vertical spread, outlook is bearish



Bear Call Spread

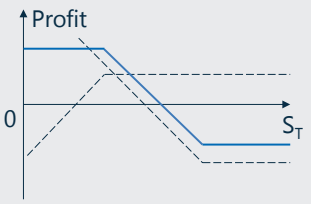


Bear Put Spread

- **Box Spread**
  - A box spread is a combination of a bull call spread with strike prices K_1 and K_2 and a bear put spread with the same two strike prices.
  - The payoff from a box spread is always $K_2 - K_1$.

Spread Strategies

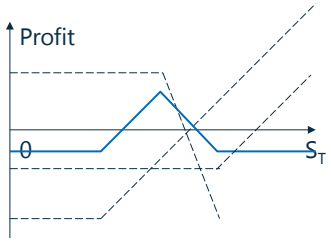
- A trader creates a bear spread using put options with strike prices of USD 25 and USD 30 and the same time to maturity. The options cost USD 2 and USD 4.50(respectively). Under what circumstances will the trade be profitable?



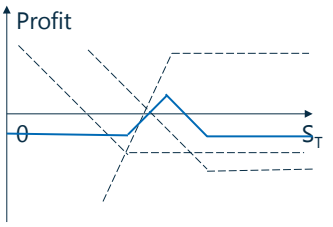
  - It costs USD 2.50 to set up the bear spread.
  - The trade will be profitable if the price of the asset at maturity is less than USD 27.50

Spread Strategies

➢ **Butterfly Spread**



Butterfly Spread



Butterfly Spread

- Expects low volatility
- Capped risk

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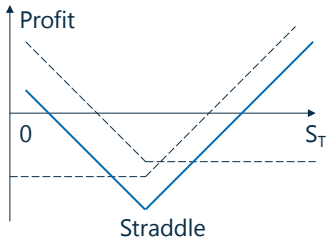
Combination Strategies

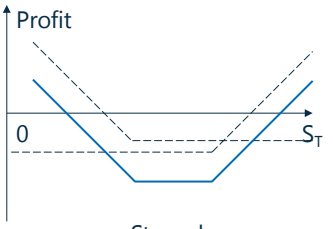
➢ **Straddle and Strangle**

- A Combination is an option trading strategy that involves taking a position in both calls and puts on the same stock.



Straddle

- A call and a put
- Same strike price
- Direction neutral
- Wants volatility



Strangle

- A call and a put
- Different strike price
- Like straddle, but cheaper
- Wants volatility

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Trading Strategies involving Options

➢ **Conclusion**

Simple Strategy	**A share and an option**
Spread Strategy	**Both are call, or both are put**
Bull	2 different K
Bear	2 different K
butterfly	3 different K
Calendar	2 different T
Combination Strategy	**Call and put**
Straddle & Strangle	Wants volatility

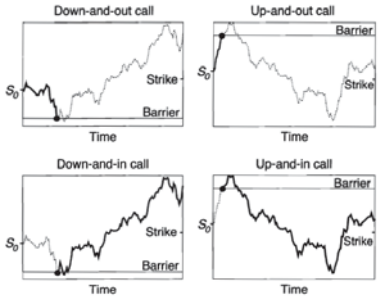
Exotic Options

- **Gap Options**
  - The payoff from a call option is $S_T - K_1$, if $S_T \geq K_2$
  - The payoff from a put option is $K_1 - S_T$, if $S_T \leq K_2$
- **Forward Start Options**
  - A forward start option is an advance purchase of a put or call option that will become active at some specified future time. It is essentially a forward on an option.
- **Compound Options**
  - Options on options
  - A call on a call, a put on a call, a call on a put, and a put on a put
  - If both options are exercised, the total premium will be more than the premium on a single option
- **Chooser Option**
  - After a specified period of time, the holder can choose whether the option is a call or a put.

max(c, p)

Exotic Options

- **Barrier Options**
  - Payoffs and existence depend on whether the underlying's asset price reaches a certain barrier level over the life of the option.
  - A **knock-out** option ceases to exist when the underlying asset price reaches a certain barrier while a **knock-in** option comes into existence only when the underlying asset price reaches a barrier.



Exotic Options

- **Binary Options/Digital Options**
  - **Cash-or-Nothing**
  - ✓ Pays some fixed amount of cash if the option expires in-the-money.
  - **Asset-or-Nothing**
  - ✓ Pays the value of the underlying security.
  - A regular European call option is equivalent to a long position in an asset-or-nothing call and a short position in a cash-or-nothing call.
  - A regular European put option is equivalent to a long position in a cash-or-nothing put and a short position in an asset-or-nothing put.

Exotic Options

- **Lookback Options**
  - Payoffs depend on maximum or minimum price of the underlying asset
  - With **floating strike** and with **fixed strike**.

$$\text{Call}_{\text{floating strike}} = \text{Max}(S_T - S_{\min}, 0) \quad \text{Put}_{\text{floating strike}} = \text{Max}(S_{\max} - S_T, 0)$$
$$\text{Call}_{\text{fixed strike}} = \text{Max}(S_{\max} - k, 0) \quad \text{Put}_{\text{fixed strike}} = \text{Max}(K - S_{\min}, 0)$$

- **Asian Options**
  - Payoff depends on arithmetic average of the underlying asset price
  - **Average price option** and **average strike option**.

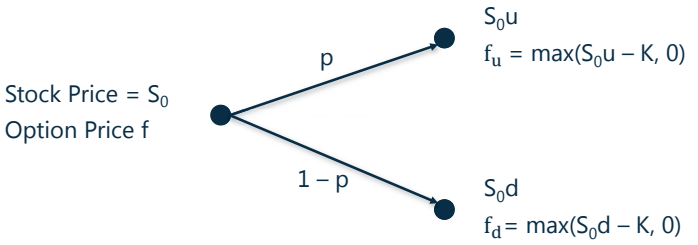
$$\text{Call}_{\text{average price}} = \text{Max}(S_{\text{avg}} - K, 0) \quad \text{Put}_{\text{average price}} = \text{Max}(K - S_{\text{avg}}, 0)$$
$$\text{Call}_{\text{average strike}} = \text{Max}(S_T - S_{\text{avg}}, 0) \quad \text{Put}_{\text{average strike}} = (S_{\text{avg}} - S_T, 0)$$

Exotic Options

- **Volatility and Variance Swap**
  - **Volatility Swap**
    - ✓ Exchanging of volatility based on a national principal
    - ✓ Payments base on pre-specified volatility and realized volatility.
  - **Variance Swap**
    - ✓ Exchanging pre-specified fixed variance rate for realized variance rate
- **Static Options Replication**
  - This technique involves searching for a portfolio of actively traded options (regular options) that approximately replicates the exotic option. Shorting this position provides the hedge.

Binomial Trees

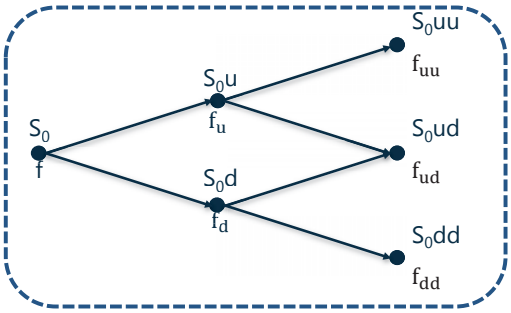
- **Risk-Neutral Valuation**
  - investors do not adjust their expected return based on risk, so the expected return on all assets is risk-free interest rate.
- **One-Step Binomial Model**



$$p = \frac{e^{r\Delta t} - d}{u - d} \qquad f = [pf_u + (1-p)f_d]e^{-r\Delta t} \qquad u = e^{\sigma\sqrt{\Delta t}}; \quad d = e^{-\sigma\sqrt{\Delta t}}$$

Multi-Step Trees

- **European Options**

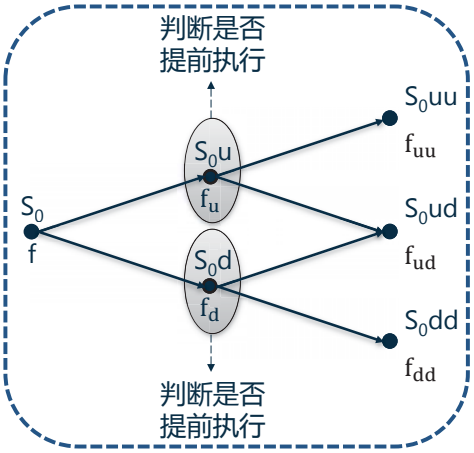


$$p = \frac{e^{r\Delta t} - d}{u - d}$$

$$f = e^{-2r\Delta t}(p^2 f_{uu} + 2p(1-p)f_{ud} + (1-p)^2 f_{dd})$$

Multi-Step Trees

- **American Options**



- Make sure that the option value at each node is no less than the intrinsic value.

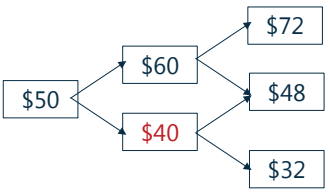
Multi-Step Trees

- **Example: Put Option with price jump of +/- 20%**

Asset	Strike	Time	Riskless	Div. Yield
$50	$52	2	5%	0%

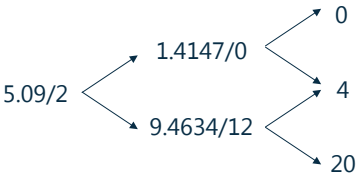
⇩

u	d	p
1.2	0.8	0.6282



Multi-Step Trees

- **Example: Put Option with price jump of +/- 20%**



- **European put**

$$(2 \times 4 \times 0.6282 \times (1 - 0.6282) + 20 \times (1 - 0.6282)^2)e^{-0.05\times 2} = 4.1923$$

- **American put**

$$\left(0 \times 0.6282 + 4 \times (1 - 0.6282)\right)e^{-0.05\times 1} = 1.4147$$

$$\left(4 \times 0.6282 + 20 \times (1 - 0.6282)\right)e^{-0.05\times 1} = 9.4634$$

$$\left(1.4147 \times 0.6282 + 12 \times (1 - 0.6282)\right)e^{-0.05\times 1} = 5.09$$

Other Assets

- **Options on Stocks with Dividends**

$$pSu + (1 - p)Sd = Se^{(r-q)\Delta t} \qquad p = \frac{e^{(r-q)\Delta t} - d}{u - d}$$

  - Everything else about the tree is the same as before.
- **Options on Stock Indices**
  - Usually, index provides a dividend yield. Therefore, the valuation should involve the modification as above.
- **Options on Currencies**
  - Currency can be considered as an asset providing a yield.
- **Options on Futures**
  - It costs noting to enter into a futures contract and we can treat a futures contract like a stock paying a dividend yield of r. Therefore, we get:

$$p = \frac{1 - d}{u - d}$$

Black-Scholes-Merton Model

- **Assumptions**
  - The stock price follows the process with μ and σ constant.
  - There are no transaction costs or taxes. All securities are perfectly divisible.
  - There are no dividends during the life of the derivative.
  - There are no riskless arbitrage opportunities.
  - Security trading is continuous.
  - The risk-free rate of interest, r, is constant and the same for all maturities.
  - The options being considered cannot be exercised early.
- **Valuation**

$$call = S_0N(d_1) - Ke^{-rT}N(d_2)$$

$$put = Ke^{-rT}N(-d_2) - S_0N(-d_1)$$

$$d_{1,2} = \frac{\ln(S_0/K) + \left(r \pm \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

Black-Scholes-Merton Model

- A stock price is USD 50 with a volatility of 22%. The risk free rate is 3%. Use the Black- Scholes-Merton formula to value
  - A European call option and
  - A European put option

  when the strike price is USD 50, and the time to maturity is nine months

$$d_1 = \frac{\ln\left(\frac{S_0}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} = 0.2134$$

$$d_2 = \frac{\ln(S_0/K) + \left(r - \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} 0.0228$$

$$\text{call} = S_0 N(d_1) - Ke^{-rT}N(d_2) = 4.3$$

$$\text{put} = Ke^{-rT}N(-d_2) - S_0 N(-d_1) = 3.2$$

Black-Scholes-Merton Model

- **The early exercise of American options**

$$\text{AC: } D_n \geq K\left(1 - e^{-r(T-t_n)}\right) \quad \text{AP: } D_n \leq K(1 - e^{-r(T-t_n)})$$

- **Options on Stocks with Dividends**

$$c = S_0 e^{-qT}N(d_1) - Ke^{-rT}N(d_2) \quad p = Ke^{-rT}N(-d_2) - S_0 e^{-qT}N(-d_1)$$

$$d_{1,2} = \frac{\ln(S_0/K) + (r - q \pm \sigma^2/2)T}{\sigma\sqrt{T}}$$

- **Options on Currencies**
  - Behaves like a stock paying a dividend yield at the foreign risk-free rate.
- **Options on Futures**
  - Behaves like a stock paying a dividend yield at the domestic risk-free rate.
- **Warrants**
  - The payoff to an option holder if the option is exercised is

$$\frac{NS_T + MK}{N+M} - K = \frac{N}{N+M}(S_T - K) = \frac{N}{N+M} \cdot c$$

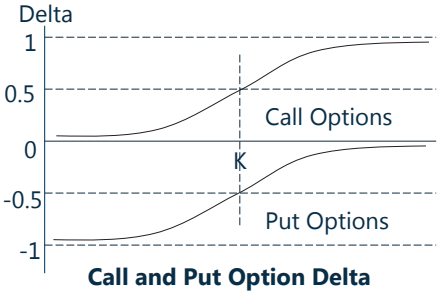
Six Factors

- **Six Factors that Affect Option's Price**

Factor	European call	European put	American call	American put
S	+	—	+	—
K	—	+	—	+
T	?	?	+	+
σ	+	+	+	+
r	+	—	+	—
D	—	+	—	+

Greek Letters

- **Impact of Underlying Asset Price – Delta**
  - The delta of an option, Δ, is defined as the ratio of change in option price to change in underlying asset price.
  - Call option Δ range from 0 to 1
  - Put option Δ range from -1 to 0
  - When t→T, delta is unstable



Call and Put Option Delta

Long Call	Δ > 0
Short Call	Δ < 0
Long Put	Δ < 0
Short Put	Δ > 0

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Greek Letters

- **Impact of Underlying Asset Price – Delta (cont'd)**
  - **According to the BSM Model, option delta is as follow**

$$\Delta = \frac{\partial c}{\partial S} = e^{-qT}N(d_1) \quad \Delta = \frac{\partial p}{\partial S} = e^{-qT}[N(d_1) - 1]$$

  - **Portfolio Delta:** summation of product of each position and its delta.
- **Delta Hedge**
  - A position with a delta of zero is called a delta neutral position.
  - Hedge against small changes in asset price.

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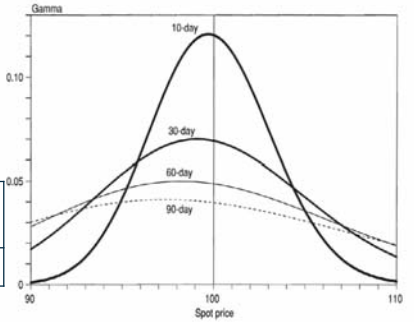
Greek Letters

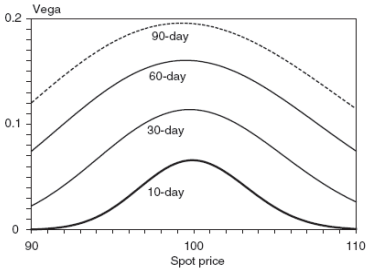
- **Impact of Underlying Asset Price – Gamma**
  - Rate of delta change with respect to price change of underlying asset.
  - Providing added protection against large movements.
  - If gamma is large, delta is very sensitive to the price change of the underlying asset.
  - Largest when is at-the-money.
  - Same for call and put options.
- **Gamma Hedge**
  - Hedge against larger changes

Long Call	Short Call	Long Put	Short Put
γ > 0	γ < 0	γ > 0	γ < 0



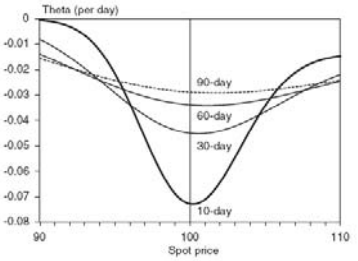
Greek Letters

- **Delta and Gamma Hedge**
  - **Example:** Suppose that a portfolio is delta neutral and has a gamma of -3,000. The delta and gamma of a particular traded call option are 0.62 and 1.50, respectively. Create a gamma-neutral position.
    - ✓ Buy 3,000/1.5 = 2,000 options
    - ✓ Sold 2,000 ×0.62 = 1,240 shares of the underlying position
  - You can also create a gamma needed position, e.g., gamma of -6,000.
- **Impact of Volatility – Vega**
  - Rate of change of the value of the option with respect to the volatility of the underlying asset.
  - Largest when is at-the-money.
  - Same for call and put options.



Greek Letters

- **Impact of Maturity – Theta**
  - Rate of change of the value of option with respect to the passage of time.
  - Time decay. As time to maturity decreases, option tends to become less valuable, so theta is usually negative for an long position, means option lose value as time goes by.
  - Short-term at the money option has a greatest negative theta.



- **Impact of Interest Rate – Rho**
  - Sensitivity to the interest rate
  - In the money calls and puts are more sensitive to changes in rates than out-of-the-money options.

Financial Institutions

Service Features

- **Investment Banking**
  - **Private Placement**: large institutional investors
  - **Public Offering**: general public
  - ✓ **Best Efforts**
  - Does as well as it can ; Paid a fee depends on its success.
  - ✓ **Firm Commitment**
  - Agrees to buy the securities and then attempts to sell them
  - **Initial Public Offering (IPO)**
  - ✓ Issues shares is note publicly traded
  - ✓ **Dutch auction approach:** Shares are first issued to the highest bidder, then to the next highest bidder, and so on, until all the shares have been sold. The price paid by all successful bidders is the lowest bid that leads to a share allocation.

Essentials of Management

- **Conflicts of Interest Problem**
  - **Main Problems**
  - ✓ **Between Security Trading and Investment Banking**
  - ✓ Tempted to recommend securities that the investment banking part is trying to sell or stuff difficult-to-sell securities into the fiduciary account
  - ✓ Tempted to recommend a company's share as a "buy" to please the company and obtain investment banking business
  - ✓ **Between Commercial Banking and Investment Banking**
  - ✓ Tempted to pass confidential information to mergers and acquisitions arm to help it provide advice on potential takeover opportunities
  - ✓ Tempted to ask the investment bank to arrange a bond issue for the company in order to replace its loan with a loan made by investors who were less well-informed
  - **Recommend Solutions - Internal Barriers (Chinese Walls)**
  - ✓ Prohibit the transfer of information from one part of the bank to another

The Risks in Banking

- **Three Main Types of Risk Facing Banks**
  - Market Risk
  - Credit Risk
  - Operational Risk
- **Banking Book and Trading Book**
  - **Banking Book**
  - ✓ Includes loans made to corporations and individuals
  - **Trading Book**
  - ✓ Includes all assets & liabilities bank has as a result of trading operations

Essentials of Management

- **Capital Management**
  - **Regulatory Capital**
    - ✓ Requirement for central bank regulators
  - **Economic Capital**
    - ✓ Own management requirement
- **Deposit Insurance**
  - Guaranty programs introduced by government regulators
  - Insure depositors against losses up to a certain level
- **Moral Hazard Problem**
  - ✓ Deposit insurance allowed banks to follow risky strategies that would not otherwise be feasible.
  - ✓ The introduction of risk-based deposit insurance premiums has reduced moral hazard to some extent.

Service Features

- **Life Insurance**
  - ✓ Mortality tables
  - ✓ Break-even Premium: calculated by finding the value of premium by equating PV of expected premium to PV of the expected payout.
  - **Basic Risks**
  - ✓ **Mortality Risk**: living not as long as expected
  - ✓ Adversely affects most types of life insurance contracts
  - ✓ Increase profitability of annuity contracts
  - ✓ **Longevity Risk**: living longer
  - ✓ Increases the profitability of most life insurance contracts
  - ✓ Adversely affects the profitability of most types of annuity contracts
  - ✓ **Hedging**: reinsurance, longevity derivative contract (longevity bond)

Life Insurance

	Males			Females		
Age (Years)	Probability of Death within 1 Year	Survival Probability	Life Expectancy	Probability of Death within 1 Year	Survival Probability	Life Expectancy
30	0.001498	0.97520	47.86	0.000673	0.98641	52.06
31	0.001536	0.97373	46.93	0.000710	0.98575	51.10
32	0.001576	0.97224	46.00	0.000753	0.98505	50.13
33	0.001616	0.97071	45.07	0.000805	0.98431	49.17
...	...	...	...	...	...	...
50	0.004987	0.92913	29.64	0.003189	0.95794	33.24
51	0.005473	0.92449	28.79	0.003488	0.95488	32.34
52	0.005997	0.91943	27.94	0.003795	0.95155	31.45
53	0.006560	0.91392	27.11	0.004105	0.94794	30.57
...	...	...	...	...	...	...
70	0.023380	0.73427	14.32	0.015612	0.82818	16.53
71	0.025549	0.71710	13.66	0.017275	0.81525	15.78
72	0.027885	0.69878	13.00	0.019047	0.80117	15.05
73	0.030374	0.67930	12.36	0.020909	0.78591	14.34

Life Insurance

- What is the minimum USD annual premium that an insurance company should charge for a two-year term life insurance policy with face value of USD 1 million when the policyholder is a woman aged 71? Assume an interest rate of 3% compounded annually.
  - A. 18,153
  - B. 17,874
  - C. 17,996
  - D. 17,767

Life Insurance

- **Correct Answer：B**
  - The probability of a payout in the first year (time 0.5years) is 0.017275. The probability of a payout in the second year (time 1.5 years) is
    (1-0.017275)×0.019047=0.018718
  - The PV of the expected cost of the policy is therefore
    17,275/(1.03^0.5)+18,718/(1.03^1.5)=34,928
  - The first premium is at time zero
  - The second premium, at time one year, has a probability of 1-0.017275=0.982725 of being made. If the premium is X, the expected present value is X+0.982725X/1.03=1.954102X The minimum premium is given by solving 1.954102X=34,928
  - It is17,874

Service Features

- **Property-Casualty Insurance**
  - **Performance Indicator**
    - ✓ **Loss Ratio**
    - ✓ Payouts/Premiums
    - ✓ **Expense Ratio**
    - ✓ Expenses/Premiums
    - ✓ **Combined Ratio**
    - ✓ Loss Ratio + Expense Ratio
    - ✓ **Combined Ratio after Dividends**
    - ✓ Combined Ratio + Dividend Yield
    - ✓ **Operating Ratio**
    - ✓ Combined Ratio after Dividend – Investment Income

Property and Casualty Insurance

- **Key Indicators**
  - **Operating Ratio for a Property-Casualty Insurance Company**

Loss Ratio	70%
Expense Ratio	26%
Combined Ratio	96%
Dividends	1%
Combined Ratio After Dividends	97%
Investment Income	(2%)
Operating Ratio	95%

Service Features

- **Pension Plan**
  - **Defined Benefit Plan**
  - ✓ Pension that employee will receive is defined by the plan.
  - ✓ All contributions are pooled and to retirees are made out of the pool.
  - ✓ Significant risks on employers because they are ultimately responsible for paying the promised benefits.
  - **Defined Contribution Plan**
  - ✓ Contributions are invested on behalf of the employee.
  - ✓ An account is set up for each employee and the pension is calculated only from the funds contributed to that account.
  - ✓ If the performance of the plan's investment is less than anticipated, the employee bears the cost.

Essentials of Management

- **Risks facing Insurance Companies**
  - **Moral Hazard**
  - ✓ Risk that existence of insurance will cause the policyholder to behave differently than he or she would without the insurance.
  - ✓ **Solution:** Aligning interest of policyholders more closely with those of insurance company: Deductible; Co-Insurance Provision; Policy Limit.
  - **Adverse Selection**
  - ✓ Risk arises when company cannot distinguish between good and bad risks and offers the same price. This will inadvertently attracts more of the bad risks.
  - ✓ **Solution:** Try to find out as much as possible about the policyholder before committing itself.

Essentials of Management

- **Guaranty System**
  - **Comparison between Banks and Insurance Companies**
  - ✓ For banks, a permanent fund is created from premiums paid by banks to the FDIC to protect depositors.
  - ✓ For insurance companies, no permanent fund is created but the companies make contributions after an insolvency has occurred.
- **Regulatory Requirement**
  - **In United States**
  - ✓ Regulated at the state level
  - **In Europe**
  - ✓ Regulated centrally
  - ✓ Solvency II

Mutual Funds Market

- **Different Types of Mutual Funds**
  - **Open-End Funds:** Shares in fund can be bought/sold back at any time.
  - ✓ **NAV**
    - ◆Market value of the portfolio/Number of Shares Outstanding
  - **Closed-End Funds:** Have a fixed number of shares outstanding.
  - ✓ **NAV**
    - ◆Price at which the shares of the fund are trading
    - ◆Market value of the fund's portfolio/Number of Shares Outstanding
  - **Exchange-Traded Funds**
  - ✓ Investors can give up shares they hold and receive the block of securities or they can deposit new block of securities and receive new shares.
  - ✓ Some or all of the shares in the ETF are then traded on a stock exchange.
  - ✓ No appreciable difference between trading price and fair market value

Hedge Funds Market

- **Mutual Funds vs Hedge Funds**
  - **Mutual Funds**
  - ✓ Relatively small investors
  - ✓ Are required to explain their investment policies in a prospectus that is available to potential investors.
  - **Hedge Funds**
  - ✓ Wealthy individuals and large investors such as pension funds.
  - ✓ Less regulation and free to use a wider range of trading strategies
  - ✓ Fees are relatively higher and dependent on performance
- **Fee Structure**
  - Management Fee
  - Incentive Fee
  - ✓ Hurdle Rate ✓ High-Water Mark Clause ✓ Clawback Clause

Hedge Funds Market

- What is the expected fee to a hedge fund if the fund uses a standard 2 and 20 incentive fee structure with an investment that has a 35% probability of making 55% and a 65% probability of losing 45%?
  A. 5.71%
  B. 6.12%
  C. 3.78%
  D. 5.28%

- **Answer: A**
  - The hedge fund could potentially earn fees of 12.6% [2% (flat fee) + 0.20 × 53% (incentive fee on return above the 2% flat fee)]. The expected payoff for fees then becomes 5.71% computed as follows:(0.35 × 12.6%) + (0.65 × 2%) = 5.71%

Hedge Funds Strategies

- **Global Macro**
  - Reflect global macroeconomic trends.
- **Managed Futures**
  - Attempt to predict future movements in commodity prices
- **Dedicated Short**
  - Look exclusively for overvalued companies and sell them short
- **Emerging Markets**
  - Specialize in investments associated with developing countries.

Hedge Funds Strategies

- **Distressed Securities**
  - Managers of funds are searching for debt that is undervalued by the market.
- **Merger Arbitrage**
  - Cash Deals
  - Share-for-Share Exchanges
- **Fixed Income Arbitrage**
  - Buy bonds that seem relatively cheap while shorting those that are relatively expensive.
- **Convertible Arbitrage**
  - They hedge risks related to a company's share price, credit spreads and interest rates.
- **Long/Short Equity**
  - The hedge fund manager identifies a set of stocks that are considered to be undervalued by the market and a set that are considered to be overvalued.

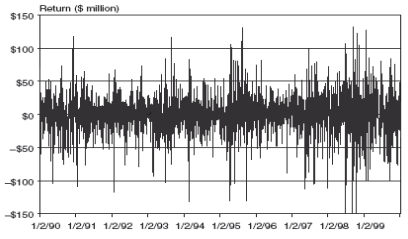
Market Risk Models

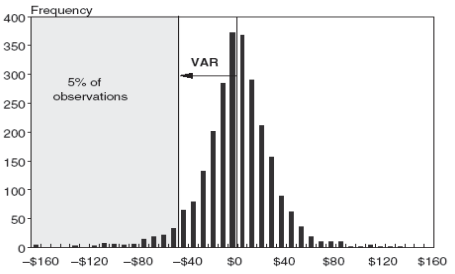
Coherent Risk Measure

- **Features of Coherent Risk Measures**
  - **Monotonicity**
  - ✓ If one portfolio consistently produces worse results than another, it should have a higher risk metric.
  - **Subadditivity**
  - ✓ For any two portfolios A and B, the risk measure for the portfolio formed by combining A and B should not be greater than the sum of the risk measures for portfolio A and B.
  - **Homogeneity**
  - ✓ Changing the size of the portfolio by multiplying the total amount of assets by λ results in a measure of risk multiplied by λ.
  - **Translation Invariance**
  - ✓ If an amount of cash K is added to a portfolio, its risk measure should decrease by K.

Measures of Financial Risk

- **Mean-Variance Framework**
- **Value at Risk**
  - VaR is the maximum loss over a target horizon and for a given confidence level.

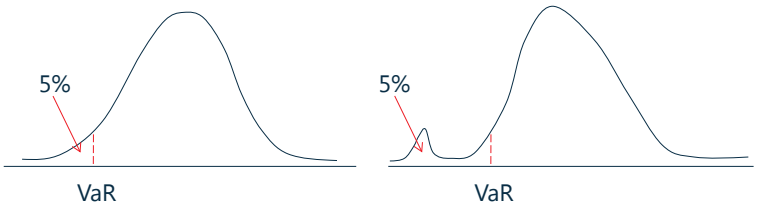




  - **Disadvantages of VaR**
  - ✓ Did not contain worst conditions, did not describe tail loss.
  - ✓ Not sub-additive.

Measures of Financial Risk

- **Expected Shortfall/Conditional VaR/Tail loss**
  - Average of the worst 100×(1-α)% of losses.



- **Spectral Risk Measures**
  - The risk measure is coherent only if the weight assigned to the loss percentile is a non-decreasing function of the percentile.

Measures of Financial Risk

- A one-year project has a 3% chance of losing USD10 million, a 7% chance of losing USD 3 million, and a 90% chance of gaining USD 1 million. What are
  - VaR
  - Expected shortfall

  when the confidence level is 95% and the time horizon is one year?

- Answer:
  - VaR is USD 3 million
  - Expected shortfall (USD) is 10×0.6+3×0.4=7.2.

Delta-Normal Model

- **Basic Measurement of VaR**
  - Given an expected return other than zero, VaR can be measured as:

$$\mathrm{VaR}(X\%) = |\mathrm{E}(R) - Z_{X\%} \times \sigma|$$

- **Square Root Rule**
  - Usually, the time horizon is chosen as one day.
  - If fluctuations in a stochastic process from one period to the next are independent (i.e., there are no serial correlations or other dependencies).
  - In the longer term, the assumption is that

$$\mathrm{VaR}(T, X) = \sqrt{T} \times \mathrm{VaR}(1, X)$$

$$\mathrm{ES}(T, X) = \sqrt{T} \times \mathrm{ES}(1, X)$$

Delta-Normal Model

- **Delta-Normal Approximation**
  - The linear approximation is assumed and the underlying factor is assumed to follow a normal distribution. It is not good for derivatives with extreme nonlinearities (MBS, Fixed-income securities with embedded option).

$$\mathrm{VaR}(dP) = |-D \times P| \times \mathrm{VaR}(dy) \quad \mathrm{VaR}(df) = |\Delta| \times \mathrm{VaR}(dS)$$

- **Delta-Gamma Approximation**

$$\mathrm{VaR}(dP) = |-D \times P| \times \mathrm{VaR}(dy) - \frac{1}{2} \times C \times P \times \mathrm{VaR}(dy)^2$$

$$\mathrm{VaR}(df) = |\Delta| \times \mathrm{VaR}(dS) - \frac{1}{2} \times \Gamma \times \mathrm{VaR}(dS)^2$$

Delta-Normal Model

- A non-linear portfolio depends on a stock price. The delta is 30 and the gamma is 5. Estimate the impact of a USD 2 change in the stock price on the value at risk of the portfolio with all else remaining the same.

- Answer:

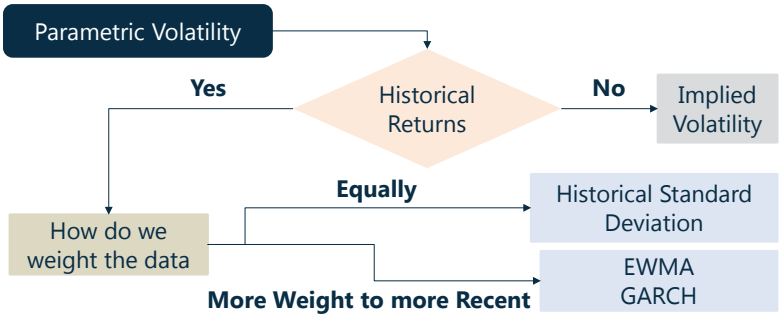
$$\mathrm{VaR}(df) = |\Delta| \times \mathrm{VaR}(dS) - \frac{1}{2} \times \Gamma \times \mathrm{VaR}(dS)^2 = 30 \times 2 - 0.5 \times 5 \times 2^2 = 50$$

Full Revaluation

- **Full Revaluation**
  - Full re-pricing of the portfolio under the assumption that the underlying risk factor(s) are shocked to experience a loss. i.e., what is the worst expected change in the risk factor, given some confidence and time horizon. Then, full revaluation prices the portfolio under changed risk factors.
  - **Historical Simulation**
  - ✓ Percentage change: Stock prices and exchange rates
  - ✓ Actual change: Interest rates and credit spreads
  - ✓ generate portfolio values for each of the scenarios and then calculate losses.
  - **Monte Carlo Simulation**
  - ✓ Monte Carlo simulations generate scenarios by taking random samples from a hypothetical distribution of the risk factors (rather than using historical data).
  - ✓ Suppose there is a total of 1000 simulation trials. The 99% VaR for the period considered will be the tenth worst loss.

Quantifying Volatility in VaR Models

- **Unconditional and Conditional Normality**
- **Parametric Approach**
  - Historical Standard Deviation
  - EWMA
  - GARCH



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Quantifying Volatility in VaR Models

- **Parametric Approach (cont'd)**
  - **Historical Standard Deviation Approach**
  - ✓ Assuming equally weighted
  - ✓ Each day, the forecast is updated by adding the most recent day and dropping the furthest day.
  - ✓ Raw returns are used instead of returns around the mean (i.e., the expected mean is assumed zero).

$$\sigma_n^2 = \left(\frac{1}{M}\right)\sum_{i=1}^{M} u_{n-i}^2$$

  - **Exponential Smoothing Method**
  - ✓ Exponential smoothing places exponentially declining weights on historical data, placing more weight on more recent information and less weight on past information.
  - ✓ Two models, **EWMA** and **GARCH** employ exponential smoothing.

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Quantifying Volatility in VaR Models

- **Parametric Approach (cont'd)**
  - **EWMA**

$$\sigma_n^2 = \lambda\sigma_{n-1}^2 + (1-\lambda)u_{n-1}^2$$

$$cov_n = \lambda cov_{n-1} + (1-\lambda)x_{n-1}y_{n-1}$$

  - **GARCH**

$$\sigma_n^2 = \omega + \alpha u_{n-1}^2 + \beta\sigma_{n-1}^2$$

$$V_L = \frac{\omega}{1-\alpha-\beta}$$

  - ✓ In GARCH (1,1), the sum of the alpha (α) and beta (β) parameters is called persistence.
  - ✓ GARCH (1, 1) is unstable if the persistence > 1. A persistence of 1.0 implies no mean reversion. A persistence of less than 1.0 implies "reversion to the mean," where a lower persistence implies greater reversion to the mean.
  - ✓ EWMA is a special case of GARCH.

Quantifying Volatility in VaR Models

- Suppose that the price of an asset at the close of trading yesterday was USD 20 and its volatility was estimated as 1.4% per day. The price at the close of trading today is USD 19. What is the new volatility estimate using the EWMA with a λ of 0.9?
  - The new return is -1/20=-0.05. The new variance rate estimate is
    $\sigma_n^2 = \lambda\sigma_{n-1}^2 + (1-\lambda)u_{n-1}^2$
    $= 0.9 \times 0.014^2 + (1-0.9) \times (-0.05)^2 = 0.000426$
  - The new volatility is the square root of this or 2.06%

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Quantifying Volatility in VaR Models

- If $\omega = 0.000002, \alpha = 0.04, \text{and } \beta = 0.94$ in a GARCH model, what is the long-run average variance rate? What volatility does this correspond to?
  - The long-run average variance rate is
    $$V_L = \frac{\omega}{1-\alpha-\beta} = \frac{0.000002}{1-0.04-0.94} = 0.0001.$$
  - This corresponds to a volatility of 1% per day
  - The new variance rate is:
    $\sigma_n^2 = \omega + \alpha u_{n-1}^2 + \beta\sigma_{n-1}^2$
    $= 0.000002 + 0.04 \times (-0.05)^2 + 0.94 \times 0.014^2 = 0.000286$
  - The new volatility is the square root of this which is 1.69%

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Foreign Exchange Quotes

- **Quotes**
  - Currency pairs are typically indicated as **XXXYYY or XXX/YYY** (with XXX as the base currency and YYY as the quote currency). It shows how much quoted currency is required to buy a unit of base currency.
  - **Bid-Ask Spread:** A bid-ask spread is the amount by which the ask price exceeds the bid price for an asset in the market.
- **Outright Transaction**
  - A forward foreign exchange transaction, where two parties agree on an exchange at some future date, is termed an **outright transaction or a forward outright transaction.**
- **FX Swap**
  - FX swap refers to buying (selling) a foreign currency in the spot market and then selling (buying) in the forward market.

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FX Risk

- **Transaction Risk**
  - Risk related to receivables and payables.
  - Transaction risk can be hedged with outright forward transactions.
  - FX swaps are useful when a company has the foreign currency it will use to buy in the future but wants to earn interest in its own currency.
- **Translation Risk**
  - Risk arises from assets and liabilities denominated in a foreign currency. These must be valued in a firm's domestic currency when financial statements are produced. Translation risk does not directly affect a company's cash flows, but it can have a big effect on its reported earnings.
- **Economic Risk**
  - Risk that an enterprise's future cash flow will be affected by exchange rate movements.
  - Economic risks are harder to quantify, but possible currency movements should be taken into account when making key strategic decisions.

FX Risk

- **Multi-Currency Hedging using Options**
  - When hedging, treasurers often prefer options to forward contracts
  - For example, a company can buy a basket option.
  - A less expensive strategy is to trade options based on the average exchange rate over the course of a year. These options are called Asian options.

FX Risk

- **Factors that Determine Exchange Rates**
  - Balance of Payments and Trade Flows
  - Inflation
  - Monetary Policy
- **Nominal and Real Rates**
  - Nominal interest rate is usually quoted in the market and indicates the return a currency will receive.
  - Real interest rates are adjusted for inflation.

$$R_{real} = \frac{1 + R_{nom}}{1 + R_{infl}} - 1 \qquad R_{real} = R_{nom} - R_{infl}$$

  - ✓ If the nominal interest rate is 2% and the rate of inflation is 3% what is the real interest rate? (-1%)
- **Covered Interest Parity**

$$F = S\frac{(1 + R_{YYY})^T}{(1 + R_{XXX})^T}$$

Credit Risk Models

Rating Scales

- **Long-Term Ratings**
  - Ratings for bonds are termed long-term ratings.

Explanation	S&P/Fitch	Moody's Services
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	B	B
Poor standing	CCC	Caa
Highly speculative	CC	Ca
Lowest quality, no interest	C	C
In default	D	
Modifiers: A+, A, A-, and A1, A2, A3		

Rating Scales

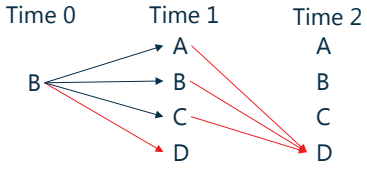
- **Short-Term Ratings**
  - Ratings for money market instruments are termed short-term ratings.

Moody's	S&P	Fitch
Investment Grade		
P-1	A-1+	F1+
	A-1	F1
P-2	A-2	F2
P-3	A-3	F3
Non-Investment Grade		
NP	B	B
	C	C
	D	D

External and Internal Ratings

- **Rating and Default**
  - Agencies publish cumulative default rates categorized by rating (i.e., the cumulative default rate per rating category) and transition matrices. Transition matrices plot the frequency of rating migrations over time;

Rating From	Rating To			
	A	B	C	D
A	97%	3%	0%	0%
B	2%	93%	2%	3%
C	1%	12%	64%	23%
D	0%	0%	0%	100%



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External and Internal Ratings

- **Point-in-Time and Through-the-Cycle**
  - **Point-in-Time**: assesses credit quality over the near term; i.e., a few months or one year.
  - **Through-the-Cycle**: rating agencies try to incorporate business cycles. Ratings are therefore typically considered "through-the-cycle". Through-the-cycle ratings try to "filter out" cycle fluctuations. Because they incorporate an average, when economic conditions vary from the average, through-the-cycle may over- and under-estimate credit quality.
- **Impact of Rating Changes on Corporate Security Price**
  - If ratings bring information about the credit quality of firms, a change in rating should lead to changes in the prices of corporate securities such as bonds issued by firm.
  - ✓ An upgrade is likely to have a positive impact on bond prices while a downgrade is likely to have a negative impact on bond price.
  - ✓ The result is statistically stronger for downgrades.

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External and Internal Ratings

- **Alternative to Ratings**
  - The default happens if the value of the assets falls below the face value of the debt repayment that is required at that time. If V is the value of the assets and D is the face value of the debt, the firm defaults when V<D. The value of the equity at the future time is

$$\max(V-D,0)$$

  - Value of Equity=Call on Firm= $VN(d_1) - De^{-rT}N(d_2)$
  - The firm defaults if the option is not exercised.
- **Internal Ratings**
  - Their ratings are usually based on several factors. In general, each factor is scored, and a weighted average score is calculated to determine the overall final rating.
  - Banks must back-test their procedures for calculating internal ratings.

Hazard Rates

- **Using Hazard Rate to Calculate Unconditional Default Probability**
  - Hazard Rate is the rate at which default are happening. We can use it to calculate unconditional default probabilities.
  - Suppose that $\bar{\lambda}$ is the average hazard rate between time zero and time t, the unconditional default probability between time zero and time t is:

$$1 - e^{-\bar{\lambda}t}$$

  - The unconditional probability of default between time t_1 and t_2 is:

$$e^{-\bar{\lambda}_1 t_1} - e^{-\bar{\lambda}_2 t_2}$$

  - Where $\bar{\lambda}_1$ and $\bar{\lambda}_2$ are the average hazard rates between today and time t_1 and t_2 (respectively).

Hazard Rates

- If the hazard rate is 1.5% per year for the first two years. What is the probability of default during the first two years?

- Answer:
  - The probability of default during the first two years is

$$1 - e^{-\bar{\lambda}t_1} = 1 - e^{-0.015\times 2} = 0.02955$$

Country Risk

- **Sources of Country Risk**
  - GDP Growth Rates
  - Political risk
  - Legal risk
  - The Economy
- **Composite Measures of Country Risk**
  - Political Risk Services (PRS)
  - Euromoney
  - The Economist
  - The World Bank
- **Sovereign Default**
  - Foreign Currency Defaults
  - Local Currency Defaults
  - ✓ There are three reasons why local currency default occurs. Gold Standard; Shared Currency; The Alternative of Printing more Currency to Pay Debt Obligations has Costs.

Country Risk

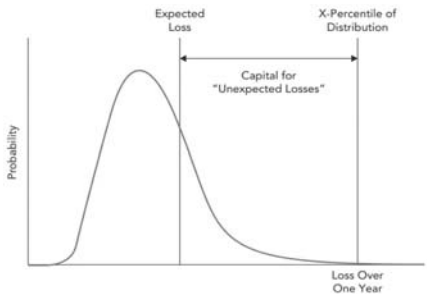
- **Sovereign Default (cont'd)**
  - **Using Sovereign Default Spread as a Predictor of Defaults**
  - ✓ **Sovereign Default Spread**
  - ✓ When a government issues bonds, denominated in a foreign currency, the interest rate on the bond can be compared to a rate on a riskless investment in that currency.
  - ✓ **Advantage**
  - ✓ Market differentiation for risk is more granular than the ratings agencies
  - ✓ Market-based spreads are more dynamic than ratings
  - ✓ **Disadvantages**
  - ✓ Tend to be more volatile than ratings
  - ✓ Can be affected by variables that have nothing to do with default. Liquidity and investor demand can cause shifts in spreads that have little or nothing to do with default risk.

Credit Risk

- **Credit Risk**
  - Default-related events
  - Credit migrations
- **Three Drivers**
  - **Probability of Default**: Probability that a borrower will default before the end of a predetermined period of time or at any time before the maturity of the loan.
  - The **Exposure Amount** of the loan at the time of default.
  - The **Loss Rate**, that is, the fraction of the exposure amount that is lost in the event of default, meaning the amount that is not recovered after the sale of the collateral.
  - **The Recovery Rates** of a bond is usually defined as the value of the bond shortly after its default and expressed as a percentage of its face value.

Model for Determining Capital

- **Capital Model**
  - Expected losses refer to the losses that banks take into account when setting lending rates.
  - The bank's capital is a buffer against unexpected loss (i.e., the actual loss in a given year above the expected loss).



Mean and Standard Deviation of Credit Losses

➢ **Mean and Standard Deviation**

- Assume: L_i is the amount borrowed in the ith loan; p_i is the probability of default for the ith loan; R_i is the recovery rate.

$$\mu_i = p_i \times L_i(1 - R_i) + (1 - p_i) \times 0 = p_i L_i(1 - R_i)$$

$$\sigma_i = \sqrt{p_i - p_i^2}(L_i(1 - R_i))$$

- Assume all loans have the same principal L, all recovery rates are the same and equal to R, all default probabilities are the same and equal to p. The standard deviation of the loss is then the same for all i.

$$\sigma_P^2 = n\sigma^2 + n(n-1)\rho\sigma^2$$

- The standard deviation of the loss from the loan portfolio as a percentage of its size

$$\alpha = \frac{\sigma_P}{nL} = \frac{\sigma\sqrt{1 + (n-1)\rho}}{L\sqrt{n}}$$

Mean and Standard Deviation of Credit Losses

➢ A USD 1 million loan has a probability of 0.5% of defaulting in a year. The recovery rate is estimated to be 40%. What is the expected credit loss and the standard deviation of the credit loss?

➢ Answer:

- The expected loss in USD is $0.005 \times 1 \times (1 - 0.4) = 0.003$
  - ✓ This is USD 3,000.
- The variance of the loss is

$$0.005 \times 0.6^2 - (0.005 \times 0.6)^2 = 0.001791.$$

- The standard deviation is the square root of this, or USD 0.04232 million.
  - ✓ This is USD42,320

Gaussian Copula Model

➢ **Gaussian Copula Model**

- Suppose we have already known the probability distributions for variables V_1, and V_2, If they are not normally distributed, we can transform each distribution to a standard normal distribution by transforming their percentiles to the corresponding percentiles of a standard normal distribution. Then we can define the joint distribution of the transformed variables.

➢ **One-Factor Correlation Model**

- When we have many variables and each can be mapped to a standard normal distribution U_i. We can use a one-factor model to defining the correlation between the U_i distributions.

$$U_i = a_i F + \sqrt{1 - a_i^2} Z_i$$

- Where F is a factor common to all the U_i, Z_i is the component that is unrelated to the common factor F, a_i are parameters. The variables F and Z_i have standard normal distributions.

Vasicek Model

- **Vasicek Model**
  - a_i are assumed to be the same for all i, then the correlation between each pair of U-distributions is a^2.
  - For each value of F, the distribution of each U_i has a mean of aF and a standard deviation of $\sqrt{1-a^2}$. For a large portfolio, the default rate is the probability U_i is less than $N^{-1}(PD)$.

$$\text{Default Rate as a function of F} = N\left(\frac{N^{-1}(PD) - aF}{\sqrt{1-a^2}}\right)$$

$$99.9 \text{ percentile for default rate} = N\left(\frac{N^{-1}(PD) - aN^{-1}(0.001)}{\sqrt{1-a^2}}\right)$$

$$99.9 \text{ percentile for default rate} = N\left(\frac{N^{-1}(PD) + \sqrt{\rho}N^{-1}(0.999)}{\sqrt{1-\rho}}\right)$$

Vasicek Model and CreditMetrics

- **Vasicek Model**
  - Used by regulators to determine capital for loan portfolios. It uses the Gaussian copula model to define the correlation between defaults.
  - The Basel II capital requirement use the IRB approach is:

$$(WCDR - PD) \times LGD \times EAD$$

  - where the WCDR (worst case default rate) is the 99.9 percentile of the default rate distribution.
  - Assume the PD is the same for all companies in a large portfolio. The binary probability of the default distribution is mapped to a standard normal distribution U_I. Values in the extreme left tail of this standard normal distribution correspond to a default.
- **CreditMetrics**
  - One of the differences between CreditMetrics and Vasicek model is that it takes into account the impact of rating changes as well as defaults.

Vasicek Model

- A bank has a USD 100 million portfolio of loans with a PD of 0.75%. What is the 99.9 percentile of the default rate given by the Vasicek model? Assume a correlation parameter of 0.2.

$$N^{-1}(0.0075) = -2.43$$

$$N^{-1}(0.001) = -3.09$$

$$\text{default rate} = N\left(\frac{N^{-1}(0.0075) + \sqrt{0.2}N^{-1}(0.999)}{\sqrt{1-0.2}}\right) = N(-1.17) = 0.12$$

- In the situation considered in the previous question, the recovery rate in the event of a default is 30%. What is the required regulatory capital?

$$(0.12 - 0.0075) \times 100 \times 0.7 = 7.88$$

Vasicek Model

z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.937	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.983	0.9834	0.9838	0.9842	0.9846	0.985	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.989
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.994	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

Operational Risk Models

Operational Risk

- **Operational Risk**
  - The risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events.
- **Three Large Operational Risks**
  - Cyber Risks
  - Compliance Risks
  - Rogue Trader Risk
- **Basel's Seven Categories of Operational Risk**
  - Internal Fraud
  - External Fraud
  - Employment Practices and Workplace Safety
  - Clients, Products, and Business Practices
  - Damage to Physical Assets
  - Business Disruption and System Failures
  - Execution, Delivery, and Process Management

Regulatory Capital Requirement

- **Basic Indicator Approach:** through a simple calculation of the average gross revenue for the past 3 years, multiplied by 15%.

$$\mathrm{ORC}^{\mathrm{BIA}} = \left[\left(\mathrm{GI}_{1,\ldots,n} \times \alpha\right)\right]/n,\ \alpha = 15\%$$

- **Standardized Approach:** The total capital charge is calculated as the three-year average of the simple summation of the regulatory capital charges across each of the business lines in each year.

$$\mathrm{ORC}^{\mathrm{TSA}} = \frac{\Sigma_{\text{year } 1-3} \max(\Sigma(\mathrm{GI}_{1-8} \times \beta_{1-8}), 0)}{3}$$

Corporate Finance	18%	Angency and custody services	15%
Trading and sales	18%	Asset management	12%
Settlement and payment activities	18%	Retail brokerage	12%
Commercial banking	15%	Retail banking	12%

Regulatory Capital Requirement

- **Advanced Measurement Approach (AMA)**
  - Allows a bank to design its own model for calculating operational risk capital. Three main requirements:
  - ✓ Must hold capital for a 1-year horizon at 99.9% confidence level.

$$\mathrm{ORC}^{\mathrm{AMA}} = \mathrm{UL}(1\text{-year}, 99.9\%\ \text{confidence})$$

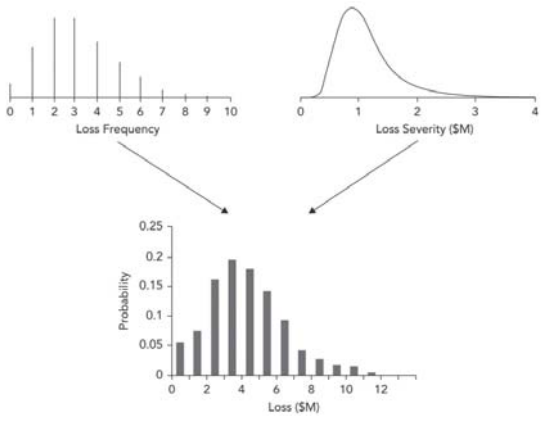
  - ✓ All four elements of the framework must be included in the model: internal loss data, external loss data, scenario analysis, and business environment internal control factors.
- **Standardized Measurement**
  - SMA first defines a quantity called Business Indicator (BI). It is similar to gross income, but it is designed to be a more relevant measure of bank size.
  - The Basel committee provides a formula for calculating the required capital from the loss component and the BI component.

Loss Distribution Approach

- **Loss Frequency Distribution**
  - Models number of losses
  - Common probability distribution: Poisson Distribution
- **Loss Severity Distribution**
  - Models size of a loss
  - Common probability distribution: Lognormal Distribution
- **Loss Distribution**
  - Assume that loss severity and loss frequency are independent
  - The frequency and severity distributions must be combined; Monte Carlo simulation can be used for this purpose.
  - ✓ Sample from frequency distribution to determine number of losses
  - ✓ Sample n times from the loss severity distribution to determine the loss experienced for each loss events
  - ✓ Determine the total loss experienced

Basel II Regulations

- **Advanced Measurement Approach (AMA)**



Reducing Operational Risk

- **Causes of Losses**
  - Sometimes operational risk loss may be related to other manageable factors.
- **Education**
  - It is important to educate employees about unacceptable business practices and (more importantly) to create a risk culture that recognizes these practices as unacceptable.
- **Risk Control and Self Assessment**
  - May lead to improvements reducing the frequency of losses, the severity of losses, or both.
- **Key Risk Indicators**
  - These are data points which may indicate an increased likelihood of operational risk losses in certain areas.

Stress Testing

Governance over Stress Testing

- **Key Elements of Effective Governance over Stress Testing**
  - The Board and Senior Management
  - Policies and Procedures
  - Validation and Independent Review
  - Internal Audit
- **The Board and Senior Management**
  - **Board of Director:** Has the responsibility to oversee the key strategies. It is also responsible for the firm's risk appetite and risk culture.
  - **Senior Management:** Is responsible for ensuring that stress testing activities authorized by the board are implemented correctly. Senior Management is also responsible for ensuring the organization is adhering to the appropriate policies and procedures.
  - It is important for the board and senior management to ensure stress testing covers all business lines and exposures

Governance over Stress Testing

- **Policies and Procedures**
  - **Stress Testing Policies should:**
  - ✓ Describe the overall purpose of stress-testing activities.
  - ✓ Indicate stress-testing roles and responsibilities.
  - ✓ Define the frequency at which stress testing is to be performed
  - ✓ Outline the process for choosing stressful conditions for tests.
  - ✓ Be reviewed and updated as necessary to ensure that stress testing practices remain appropriate and keep up to date with changes.
  - ✓ Document the operation of models and other software acquired from vendors or other third parties.
  - Documentation is important so far as it ensures continuity if key employees leave and satisfies the needs of senior management, regulators, and other external parties.

Governance over Stress Testing

- **Validation and Independent Review**
  - The reviews themselves should be unbiased and provide assurance to the board that stress testing is being carried out in accordance with the firm's policies and procedures.
  - The reviewers of stress-testing procedures be independent of the employees conducting the stress test. The review should:
  - ✓ Cover the qualitative or judgemental aspects of a stress test
  - ✓ Ensure that tests are based on sound theory
  - ✓ Ensure that limitations and uncertainties are acknowledged
  - ✓ Monitor results on an ongoing basis.

Governance over Stress Testing

- **Internal Audit**
  - It should ensure that stress tests are carried out by employees with appropriate qualifications, that documentation is satisfactory, and that the models and procedures are independently validated.
  - It assesses the practices used across the whole financial institution to ensure they are consistent.
  - It can then provide advice to senior management and the board on changes it considers to be desirable .

Choosing Scenarios

- **Historical Scenarios**
  - It is assumed that all relevant variables will behave as they did in the past.
  - ✓ The 2007- 2008 U.S. housing-related recession.
- **Stress Key Variables**
  - Assume that a large change takes place in one or more key variables.
  - ✓ A 25% decline in equity prices
  - ✓ A 4% increase in the unemployment rate
- **Ad Hoc Stress Tests**
  - It is important for firms to develop other scenarios reflecting current economic conditions, the particular exposures of the financial institution, and an up-to-date assessment of possible future adverse events.
- **Using the Results**

Stress Testing and Other Risk Management Tools

- **Relationship between Stress Testing and Other Risk Measure**
  - In practice, **stress tests** usually focus on a few scenarios, whereas **VaR measures** commonly utilize a very large number of scenarios.
  - ✓ The objective in stress testing should be to obtain an enterprise-wide view of the risks facing a financial institution.
  - One is a **backward-looking analysis** where a loss distribution can be estimated. The other is a **forward-looking analysis** where different scenarios a reassessed.
  - **Time horizon:** The VaR/ES approach often has a short time horizon (perhaps only one day), whereas stress testing usually looks at a much longer period.

Principles for Sound Stress Testing

- **Stress Testing Principles for Banks**
  - Providing forward-looking assessments of risk
  - Overcoming the limitations of models and historical data
  - Supporting internal and external communications
  - Feeding into capital and liquidity planning procedures
  - Informing and setting of risk tolerance, and
  - Facilitating the development of risk mitigation or contingency plans across a range of stressed conditions.

It's not the end but just beginning.

Thought is already is late, exactly is the earliest time.

感到晚了的时候其实是最快的时候。

问题反馈

- 如果您认为金程**课程讲义/题库/视频**或其他资料中**存在错误，欢迎您告诉我们，**所有提交的内容我们会在最快时间内核查并给与答复。
- **如何告诉我们？**
  - 将您发现的问题通过电子邮件告知我们，具体的内容包含：
  - ✓ 您的姓名或网校账号
  - ✓ 所在班级（eg.1911FRM一级长线无忧班）
  - ✓ 问题所在科目（若未知科目，请提供章节、知识点）和页码
  - ✓ 您对问题的详细描述和您的见解
  - 请发送电子邮件至：academic.support@gfedu.net
- **非常感谢您对金程教育的支持，您的每一次反馈都是我们成长的动力**。后续我们也将开通其他问题反馈渠道（如微信等）。