

Derivatives

CFA一级培训项目

讲师：洪波，CFA

101% contribution breeds Professionalism

◆ 洪波

- **工作职称：**金程首席培训师、英国纽卡斯尔大学国际金融分析硕士（优等学位）、CFA（注册金融分析师）、RFP（注册财务策划师）、香港财经分析师学会会员
- **教育背景：**英国纽卡斯尔大学国际金融分析硕士（优等学位毕业）、上海对外贸易学院商务日语学士学位
- **工作背景：**12年专业金融培训经验，深悉各类金融资格证书考试重点及行业热点。先后讲授CFA一级40班次，二级20班次，三级30班次，RFP课程10次，CFRM课程5次等。授课范围广泛，包括权益投资、固定收益投资、财务报表分析、经济学、衍生品投资、投资组合、资产配置、个人理财、私募投资、企业估值、债券投资组合管理等，同时也进行客户指定专题的培训。授课深入浅出，逻辑清晰，备受学员喜爱。拥有丰富金融从业经验，服务于摩根大通证券研究部和毕德投资咨询公司，从事行业与公司的分析和研究。在收购兼并等方面为跨国公司提供财务顾问咨询服务。并为国内中小企业寻找战略投资者和机构投资者提供咨询服务。精通日语，曾创立并领导日语小组支持东京的投资银行部门和债券市场部门。
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Topic Weightings in CFA Level I

Session NO.	Content	Weightings
Study Session 1	Ethics & Professional Standards	15
Study Session 2-3	Quantitative Analysis	12
Study Session 4-6	Economics	10
Study Session 7-10	Financial Reporting and Analysis	20
Study Session 11	Corporate Finance	7
Study Session 12	Portfolio Management	7
Study Session 13-14	Equity Investment	10
Study Session 15-16	Fixed Income	10
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● Framework

Derivatives

- SS17 Derivatives
 - R56 Derivative Markets and Instruments
 - R57 Basics of Derivative Pricing and Valuation

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Reading

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Derivative markets and instruments

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Framework

1. Derivative markets and instruments
 - Definition of derivative
 - Four main derivatives
 - Classification
 - Advantage & disadvantage of derivatives
2. Four main derivative products
 - Forward
 - Futures
 - Swap
 - Option
3. Risk free arbitrage

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◆ Derivative Markets and Instruments

- **Definition:** A **derivative** is a financial instrument (**contract**) that derives its performance from the performance of an underlying asset.

- **Buy or Sell Something:**

- ✓ Buy or Sell **now**
- ✓ Buy or Sell sometime **in the future**.

- **Example :**

- ✓ 3 month later → \$3/bottle → purchase water ;
- ✓ 3 month later → \$15/share → purchase stock ;
- ✓ 3 month later → 4% interest rate → borrow \$1million ;
- ✓ 3 month later → 6.5CNY/USD → exchange CNY.

➤ **Tips :**

- Contracts
- Hedge risk vs. Speculate
- Derives its performance from the performance of an underlying asset.

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◆ Derivative Markets and Instruments

Forward contract**Futures contract****Swap contract****Option contract**

➤ **Forward contract:**

- A **forward contract** is a **private agreement** that obligates one party to buy and the other party to sell a specific quantity of an underlying asset, at a **set price**, at a **future date**
- If the future price of the underlying assets increase, the buyer has a gain, and the seller has a loss.

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◆ Derivative Markets and Instruments

Forward contract**Futures contract****Swap contract****Option contract**

- **A Futures contract** is a specialized version of a forward contract that has been standardized and that trades on a futures exchange.

- A forward contract
- Are regulated
- Guarantee provided by the exchange through the clearinghouse
- the daily settlement for gains and losses.

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◆◆ Derivative Markets and Instruments

Forward contract**Futures contract****Swap contract****Option contract**

- A Swap contract is a series of forward contracts .

- Exchange a series of cash flows
- Default risk

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◆◆ Derivative Markets and Instruments

Forward contract**Futures contract****Swap contract****Option contract**

- An option contract:

- The owner has **the right**, but not **the obligation** to conduct a transaction
- **Right and obligations are not equal only in option contract, so the long position need to pay option premium.**

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◆◆ Derivative Markets and Instruments

Forward contract**Futures contract****Swap contract****Option contract**

- Basic characteristics of options

- An option to buy an asset at a particular price is termed a call option

Buyer of a call	Right to buy	
Seller of a call		Obligation to sell

- An option to sell an asset at a particular price is termed a put option

Buyer of a put	Right to sell	
Seller of a put		Obligation to buy

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◆ Derivative Markets and Instruments

➤ Classification

- According to contract features : Forward commitment & Contingent claim
 - ✓ Forward commitment: is an agreement between two parties in which one party, the buyer, agrees to buy from the other party, the seller, an underlying asset at a future date at a price established at the start → forward, futures and swap contracts
 - ✓ Contingent claim: is derivative in which the payoffs occur if a specific event happens → option contracts

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◆ Derivative Markets and Instruments

➤ Classification

- According to trading place : Exchange-traded & Over-the-counter traded
 - ✓ Exchange-traded : place where traders can meet to arrange their traded. (A→ Clearinghouse → B)
 - ✓ OTC traded: a decentralized market where buy and sell orders initiated from various locations are matched through a communications network. (A→B)
- Difference:

Exchange-traded	Over-the-counter
Standardized→ Liquid	Customized/Specific needs
Backed by a clearinghouse	Trade with counterparty (default risk)
Trade in a physical exchange	not trade in organized markets
Regulated	Unregulated

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◆ Derivative Markets and Instruments

➤ Main terminology:

- Forward commitment
 - ✓ **Long**: purchase an underlying asset
 - ✓ **Short**: sell an underlying asset
- Contingent claim
 - ✓ **Long**: acquire a right
 - ✓ **Short**: sell a right
 - ✓ **Call**: right to buy
 - ✓ **Put**: right to sell

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◆◆ Derivative Markets and Instruments

➤ Classification



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◆◆ Example



- Which of the following is the best example of a derivative?
 - A. A global equity mutual fund
 - B. A non-callable government bond
 - C. A contract to purchase Apple Computer at a fixed price
- **Correct answer: C**
- Which of the following statements about derivatives is not true?
 - A. They are created in the spot market.
 - B. They are used in the practice of risk management.
 - C. They take their values from the value of something else.
- **Correct answer: A**

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◆◆ Example



- The buyer of a call option has the:
 - A. right to buy the underlying asset in the future under certain conditions
 - B. obligation to sell the underlying asset in the future under certain conditions
 - C. right to sell the underlying asset in the future under certain conditions
- **Correct answer: A**
- A private agreement between two parties to exchange a series of future cash flows with at least one of the two series of cash flows determined by a later outcome, is best characterized as a(n):
 - A. Swap
 - B. Futures contract
 - C. Exchange-traded contingent claim
- **Correct answer: A**

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◆◆ Derivative Markets and Instruments

➤ **Advantage:**

- Price discovery
- Risk management: hedge and speculation
- Lowering transaction costs
- Low capital requirement
- Greater liquidity
- Ease of going short
- Enhance market efficiency

➤ **Disadvantage:**

- Too risky → High leverage
- Complex instruments
- Sometimes likened to gambling

➤ **Key point :**

- Always increase risk? → No.

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◆◆ Forward

➤ **Definition:** A **forward contract** is a bilateral contract that obligates one party to buy and the other party to sell a specific quantity of an underlying asset, at a set price, on a specific date in the future

➤ **Long and short forward position**

- **Long:** buy underlying
- **Short:** sell underlying
- No payments will be made at the inception of a forward contract. So both parties of a forward contract is exposed to potential default risk

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◆◆ Derivative Markets and Instruments

➤ **Risk-free arbitrage and no-arbitrage rule:**

- Arbitrage involves earning over the risk-free rate with no risk or earning an immediate gain with no future liabilities
- Arbitrage opportunities: arbitrage occurs when equivalent assets or combinations of assets sell for two different prices
- **Law of one price:** the condition in a financial market in which two equivalent financial instruments or combinations of financial instruments can sell for only one price. Equivalent to the principle that no arbitrage opportunities are possible.

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◆◆ Derivative Markets and Instruments

➤ **Risk-free arbitrage and no-arbitrage rule (Cont.):**

- The way of arbitrage: **sell high, buy low**
- If a portfolio consisting of A and B has a certain payoff, the portfolio should yield the risk-free risk
- The role of arbitrage is to eliminate mispricing and lead to the market efficiency. That is why arbitrage also plays a role in **pricing**.

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◆◆ Forward

➤ **Forward contracts classification:**

- Commodity forward contract
- Financial forward contract

➤ **Purposes of trading forward contracts:**

- Hedge risk: Lock the cost in the future, but not sure to make money;
Have default risk.
- Speculation : gambling the price movement.

➤ **Characteristics of Forward contracts:**

- Each party are exposed to **default risk** (or **counterparty risk**).
- Zero-sum game.

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◆◆ Forward

➤ **Settling a forward contract at expiration**

- **Physical settlement:** deliver an actual asset, has storage cost, mostly used in commodity forward.
- **Cash settlement:** the party that has a position with negative value is obligated to pay that amount to the other party, mostly used in financial forward.

➤ **Settling a forward contract prior to expiration**

- Entering into an opposite forward contract: with an expiration date equal to the time remaining on the original contract
 - ✓ Offsetting with a **different** party: some credit risk remains
 - ✓ Offsetting with the **original** party: can avoid credit risk

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◆ Example



- Which is the most common way to terminate a forward contract prior to expiration?
 - A. Cash settlement
 - B. Enter into an opposite contract
 - C. Delivers the actual instruments
- **Correct answer: B**
- How to eliminate the risk on a forward contract:
 - A. enter an opposite trade with same counterparty at same price
 - B. enter an opposite trade with different counterparty for any price
 - C. enter an opposite trade with same counterparty for any price
- **Correct answer: A**

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专业·创新·增值

◆ Forward

- **LIBOR, Euribor, and FRAs**
 - Eurodollar time deposit.
 - London Interbank Offer Rate (LIBOR).
 - ✓ USD interest rates.
 - ✓ Quoted as an annualized rates based on a 360-day a year
 - ✓ **Add-on rate**
 - ✓ Single interest
 - Euribor is a similar rate for borrowing and lending in Euros
 - A forward rate agreement (FRA) is a forward contract on an interest rate (LIBOR)

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专业·创新·增值

◆ Forward

- **LIBOR, Euribor, and FRAs (Con't)**
 - **Definition of FRA:** An FRA can be viewed as a forward contract to borrow/lend money at a certain rate at some future date.
 - ✓ **The long position:** is the party that would **borrow** the money
 - ✓ **The short position:** is the party that would **lend** the money
 - **FRA maturity.**
 - ✓ Maturity: 30、60、90、120 day Libor
 - ✓ Off-the-run FRA: non-standardized 45 day Libor
- **Quotation : Example 3×9FRA**

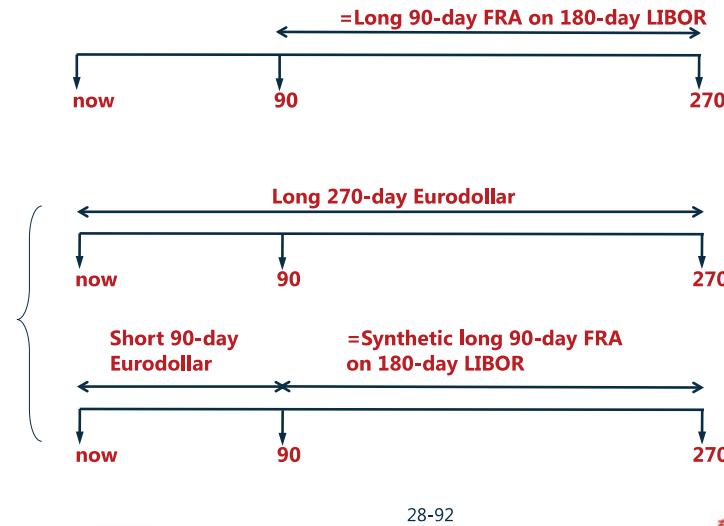


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专业·创新·增值

◆◆ Forward

- LIBOR, Euribor, and FRAs (Con't)



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◆◆ Forward Pricing and Valuation – FRA

- LIBOR, Euribor, and FRAs (Con't)

Settlement: settle in cash, but no actual loan is made at the settlement date

- Qualitative analysis on payoff:
 - ✓ If the reference rate at the expiration date is above the specified contract rate, the long will receive cash payment from the short;
 - ✓ If the reference rate at the expiration date is below the contract rate, the short will receive cash payment from the long
- Quantitative analysis on payoff

$$(\text{Notional principal}) \left[\frac{(\text{Floating rate at settlement-forward rate}) \left[\frac{\text{days}}{360} \right]}{1 + \text{Floating rate at settlement} \left[\frac{\text{days}}{360} \right]} \right]$$

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◆◆ Example



- Which of the following best describes the forward rate of an FRA?
 - The spot rate implied by the term structure
 - The forward rate implied by the term structure
 - The rate on a zero-coupon bond of maturity equal to that of the forward contract
- **Correct answer: B**
- The underlying asset of FRA is
 - Bond
 - Stock
 - Interest rate
- **Correct answer: C**

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专业·创新·增值

◆◆ Futures

➤ **Definition:**

- A **futures contract** is an agreement that obligates one party to buy and the other party to sell a specific quantity of an underlying asset, at a set price, at a future date.

➤ **Similarity with forward contract:**

- Both are settled with assets delivered or in cash;
 - ✓ **Deliverable contracts** obligate the long to buy and the short to sell a certain quantity of an asset for a certain price on a specified future date.
 - ✓ **Cash settlement** contracts are settled by paying the contract value in cash on the expiration date.
- Are priced to have zero value at the time an investor enters into the contract.

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专业·创新·增值

◆◆ Futures

➤ **Difference with forward:**

Forwards	Futures
Private contracts	Exchange-traded
Unique customized contracts	Standardized contracts
Little or no regulation	Regulated
Default risk is present	Guaranteed by clearinghouse
Settlement at maturity	Daily settlement (mark to market)
No margin deposit required	Margin required and adjusted

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专业·创新·增值

◆◆ Futures

➤ **Standardization :**

- Futures contracts specify the **quality and quantity** of goods that can be delivered, the **delivery time and the manner** of delivery.

➤ **Clearinghouse**

- **Each exchange has a clearing house** which is a third participant guaranteeing to each party that it ensures against the other party defaulting.
- A clearinghouse acts as the **counterparty** to each participant. The clearinghouse is the buyer to the seller and the seller to the buyer by crediting gains to the winners and charging losses to the losers.
- There is no need to worry about the **counterparty default risk**.
- Each participants are allowed by the clearinghouse to reverse their positions in the future.

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专业·创新·增值

◆◆ Futures

- Risk control of Futures contract
 - Margin;
 - Daily Price Limit;
 - Marking to market.

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专业·创新·增值

◆◆ Futures

- Risk control of Futures contract
 - Margin:
 - ✓ **Initial margin:** The first deposit is called the initial margin. Initial margin must be posted before any trading takes place;
 - ✓ **Maintenance margin:** is the amount of money that each participant must maintain in the account after the trade is initiated. If the margin balance is **lower than the maintenance margin**, the trader will get a margin call
 - ✓ **Variation margin:** used to bring the margin balance back up to the **initial margin level**.

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◆◆ Futures

-  Initial margin=\$5/contract, maintenance margin=\$2/contract, long 20 contract

Day	Beginning balance	Funds deposited	Futures price	Price change	Gain/Loss	Ending Balance
0	0	100	82			100
1	100	0	84	2	40	140
2	140	0	78	-6	-120	20
3	20	80	73	-5	-100	0
4	0	100	79	6	120	220
5	220	0	82	3	60	280
6	280	0	84	2	40	320

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专业·创新·增值

◆◆ Futures

➤ Risk control of Futures contract (Con't)

- Margin (Con't): difference between equity margin

	Futures margin	Equity margin
Purpose	As pledge, control default risk	Borrow capital, has leverage
Cash flow direction	Outflow	Inflow
Interest paid	No interest paid	Loan, interest paid needed
Replenish margin	Back to initial margin	Back to maintenance margin

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专业·创新·增值

◆◆ Example



- Do "margin" in the stock market and "margin" in the futures market, respectively, mean that an investor has received a loan that reduces the amount of his own money required to complete the transaction?

"Margin" in the stock market "Margin" in the futures market

- | | | |
|---|-----|-----|
| A | No | No |
| B | No | Yes |
| C | Yes | No |

➤ Correct answer: C

- A futures trader must keep the money in the margin account above the:
- initial margin requirement
 - variation margin requirement
 - maintenance margin requirement

➤ Correct answer: C

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专业·创新·增值

◆◆ Futures

➤ Risk control of Futures contract (Con't)

● Daily Price Limit:

- ✓ Limit on the extent of price movement from the settlement price of the previous trading day.
- ✓ **Limit move:** If traders wish to trade at prices outside these limit---no trades will take place.---the settlement price will be reported upper or lower price limits
- ✓ **Locked limit:** when the markets hits these limits (limit up or limit down) and trading stops.

- **Marking to market :** The margin requirement of a futures contract is low because at the end of every day there is a daily settlement process called marking to market.

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◆◆ Example



- Which of the following statements about futures contracts is **FALSE**?
 - A. The futures clearinghouse allows traders to reverse their positions without having to contract the other side of the initial trade.
 - B. To safeguard the clearinghouse, the exchange requires traders to post margin and settle their accounts on a weekly basis.
 - C. Offsetting trades rather than exchanges for physicals are used to close most futures contracts.
- **Correct answer: B**
- Which of the following **occurs** in the daily settlement of futures contracts?
 - A. Initial margin deposits are refunded to the two parties.
 - B. Gains and losses are reported to other market participants.
 - C. Losses are charged to one party and gains credited to the other.
- **Correct answer: C**

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专业·创新·增值

◆◆ Swap

- **Characteristics of Swap Contracts**
 - **Swap contract**: A swap contract obligates two parties to change a series of cash flows on periodic settlement dates over a certain time period.
 - **Similarity with forward**:
 - ✓ No payment required by either party at initiation except the principal values exchanged in currency swaps.
 - ✓ Custom instruments.
 - ✓ Traded in OTC markets(no secondary markets).
 - ✓ Much less regulated.
 - ✓ Subject to default risk.
 - ✓ Institutions dominate.

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◆◆ Swap

- **Three types of swap contracts- Interest Rate Swaps**
 - The **plain vanilla interest rate swap** involves trading fixed interest rate payments for floating-rate payment (paying fixed and receiving floating).
 - ✓ **Counterparties**: The parties involved in any swap agreement are called the counterparties
 - ✓ **Pay-fixed side**: The counterparty that makes fixed-rate interest payment in exchange for variable interest rate.
 - ✓ **Pay-floating side**: The counterparty that makes variable-rate interest payment in exchange for fixed payment.

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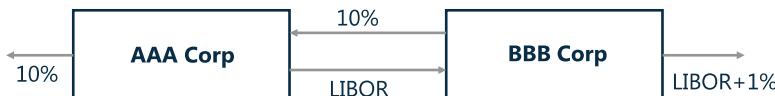
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◆ Swap

➤ Three types of swap contracts- Interest Rate Swaps

- The Comparative Advantage Argument
 - ✓ AAA Corp: wants to borrow floating.
 - ✓ BBB Corp: wants to borrow fixed.

	Fixed	Floating
AAA Corp	10.00%	6-month LIBOR + 0.30%
BBB Corp	11.20%	6-month LIBOR + 1.00%



- ✓ AAA Corp: LIBOR, save 0.3%
- ✓ BBB Corp: 11%, save 0.2%

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专业·创新·增值

◆ Option

➤ Basic Concepts

- **Definition of option:** An option is a derivative contract in which one party, the buyer, pays a sum of money to the other party, the seller or writer, and receives the right to either buy or sell an underlying asset at a fixed price either on a specific expiration date or at any time prior to the expiration date.
 - ✓ **Call option:** Long call & Short call
 - ✓ **Put option:** Long put & Short put
 - ✓ The seller or short position in an options contract is sometimes referred to as the **writer of the option**
- **Prices**
 - ✓ **Option premium:** option premium paid by the buyer of option;
 - ✓ **Exercise price:** Strike price (X) represents the exercise price specified in the contract.

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◆ Option

➤ Credit default swaps (CDS) is essentially an insurance contract for the reference, the reference obligation is the fixed income security on which the swap is written-usually a bond but potentially also a loan.

- Protection buyer receives a payment from the protection seller if default occurs on the reference entity.
- The protection buyer pays the seller a premium. The default swap premium is also referred to as the **CDS spread**.

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专业·创新·增值

◆◆ Option

- **Credit spread option:** the underlying is the credit(yield) spread on a bond, which is the difference between the bond's yield and the yield on a benchmark default-free bond.
 - The yield spread will increase as the bond's credit quality decreases.
 - The credit protection seller pays the credit protection buyer(bondholder) the established payoff.
- **Credit-linked note :** The credit protection buyer holds a bond or loan that is subject to default risk (the underlying reference security) and issues its own security (the credit-linked note)
 - if the bond or loan it holds defaults, the principal payoff on the credit-linked note is reduced accordingly.

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◆◆ Arbitrage, replication, and risk neutrality

- **It's more easy to conceive of derivative that would produce identical payoffs than many investments .**
 - The payoffs for most derivatives come directly from the value of the underlying at the expiration of the derivative.
 - The value of the derivative at expiration is certain.
 - The price of the derivative is tied to the price of the underlying.
 - The derivative can be used to hedge the underlying.
- **Limits to Arbitrage**
 - Transaction costs.
 - Borrow unlimited amounts of money at risk-free rate.
 - Transactions require additional capital to maintain position.
 - Gains from an offsetting position might not be liquid.
 - One position can not be perfect hedged in practice.

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专业·创新·增值

◆◆ Example



- Whether these two rules below can restrict the price discover function of the market?

Restrict sell short system

- A. yes
B. yes
C. no

limit the amount of arbitrage

- yes
no
yes

➤ Correct answer: A

- Sell short and arbitrage can facilitate the pricing of the market, affect the market function if limited.

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Reading

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Basics of Derivative Pricing and Valuation

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专业·创新·增值

Framework

1. Basic concepts
 - Definition of pricing and valuation
 - Forward pricing and valuation
 - Futures pricing and valuation
 - Swap pricing and valuation
2. Option pricing and valuation
 - Intrinsic value and time value
 - Risk factors analysis
 - Option valuation

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◆ Basics of Derivative Pricing and Valuation

- The price is the predetermined price in the contract that the long should pay to the short to buy the underlying asset at the settlement date
- Valuation of a derivative contract means determining the payoff of the contract to the long (or short) position at some time during the life of the contract.
- The no-arbitrage principle: there should not be a riskless profit to be gained by a combination of a forward contract position with position in other asset.
 - Two assets or portfolios with identical future cash flows, regardless of future events, should have same price.
- **Risk neutrality**
 - Risk-neutral investors are willing to buy risky investments for which they expect to earn only the risk-free rate. They do not expect to earn a premium for bearing risk.
 - The expected payoff of the derivative can be discounted at the risk-free rate. And should yield the risk-free rate of return, if it generates certain payoffs.

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◆◆ Pricing

- Pricing a forward contract is the process of determining the **no-arbitrage price** that will make the value of the contract be zero to both sides at the initiation of the contract.

Forward Price = price that would not permit profitable riskless arbitrage in frictionless markets

- $FP = S_0 \times (1 + R_f)^T + \text{Carrying Costs} - \text{Carrying Benefits}$

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专业·创新·增值

◆◆ Pricing with cost and benefit

- **Carry Costs, Costs of Storage, θ**
 - One cost incurred in owning commodity. E.g., corn, live cattle, and gold.
- **Carry Benefits, γ**
 - Monetary benefits: dividends, coupons, interest, etc
 - Non-monetary benefits: convenience yield
 - Convenience yield are primarily associated with commodities and generally exist as a result of difficulty in either shorting the commodity or unusually tight supplies.
 - $FP = (S_0 - \gamma + \theta) \times (1 + R_f)^T$ or $FP = S_0 (1 + R_f)^T - (\gamma - \theta)(1 + R_f)^T$
 - The net cost and benefit is often referred to by the term carry, or sometimes cost of carry. (Benefit-cost, $\gamma - \theta$)

53-92

专业·创新·增值

◆◆ Forwards Pricing :No-Arbitrage Principle

- Cash-and-Carry Arbitrage When the Forward Contract is Overpriced
 - If $FP > S_0 \times (1 + R_f)^T$

At initiation	At settlement date
<ul style="list-style-type: none"> ● Borrow S_0 at the risk-free rate ● Use the money to buy the underlying bond ● Short a forward contract 	<ul style="list-style-type: none"> ● Deliver the underlying to the long to get FP from the long ● Repay the loan amount of $S_0 \times (1 + R_f)^T$
	$\text{Profit} = FP - S_0 \times (1 + R_f)^T$

54-92

专业·创新·增值

◆◆ Forwards Pricing :No-Arbitrage Principle

- **Reverse Cash-and-Carry Arbitrage** when the Forward Contract is Under-priced

- If $FP < S_0 \times (1+R_f)^T$

At initiation	At settlement date
<ul style="list-style-type: none"> • Short sell the underlying bond to get S_0 • Invest S_0 at the risk-free rate • Long a forward contract 	<ul style="list-style-type: none"> • Pay the short FP to get the underlying bond • Close out the short position by delivering the bond • Receive investment proceeds
	$\text{Profit} = S_0 \times (1+R_f)^T - FP$

55-92

专业·创新·增值

◆◆ Forward Pricing and Valuation

- **T-bill (zero-coupon bond) forwards**
- **Bond Forward**
- **Equity Forward (forward contracts on a dividend-paying stock)**
- **FRA**

56-92

专业·创新·增值

◆◆ Forward Pricing and Valuation – T-Bill Forward

- T-bill (zero-coupon bond) forwards
 - buy a T-bill today at the spot price (S_0) and short a T-month T-bill forward contract at the forward price (FP)

$$FP = S_0 \times (1 + R_f)^T$$

- Forward value of long position at initiation, during the contract life, and at expiration

Time	Forward Contract Valuation
$t=0$	Zero, because the contract is priced to prevent arbitrage
$t=t$	$V_{long} = S_t - \frac{FP}{(1 + R_f)^{T-t}} \quad V_{short} = -V_{long} = \frac{FP}{(1 + R_f)^{T-t}} - S_t$
$t=T$	$ST - FP$

57-92

专业·创新·增值

◆◆ Forward Pricing and Valuation - Equity Forward

- Forward contracts on a dividend-paying stock

- Price:

$$FP = (S_0 - PVD_0) \times (1 + R_f)^T$$

- Value:

$$V_{long} = (S_t - PVD_t) - \frac{FP}{(1 + R_f)^{T-t}}$$

58-92

专业·创新·增值

◆◆ Forward Pricing and Valuation - Equity Forward



- Q1: Assuming a forward contract on a stock with 150 days, the market price of the stock is \$40.00. There will be a dividend of \$0.60 paid in 45 days. The risk free rate is 4%. Calculate the no-arbitrage forward price.
 - $PVD = \frac{\$0.60}{1.04^{45/365}} = \0.597106
 - $FP = (\$40 - \$0.597106) \times 1.04^{150/365} = \40.04
- Q2: Continued with previous example, after 80 days, the stock price is \$48.00. The value of the forward contract is:
 - V_{80} (long position) = $(\$48 - \$0) - \frac{\$40.04}{1.04^{70/365}} = \8.26

59-92

专业·创新·增值

◆◆ Forward Pricing and Valuation – Bond Forward

- Coupon bonds

- Similar to dividend-paying stocks, but the cash flows are coupons.

- Price: $FP = (S_0 - PVC_0) \times (1 + R_f)^T$

- Value: $V_{long} = (S_t - PVC_t) - \frac{FP}{(1 + R_f)^{T-t}}$

60-92

专业·创新·增值



◆ Examples

- Which of the following does not represent a benefit of holding an asset?
- The convenience yield
 - An optimistic expected outlook for the asset
 - Dividends if the asset is a stock or interest if the asset is a bond
- **Correct answer: B**
- Which of the following best describes an arbitrage opportunity? It is an opportunity to:
- earn a risk premium in the short run.
 - buy an asset at less than its fundamental value.
 - make a profit at no risk with no capital invested.
- **Correct answer: C**

61-92

专业·创新·增值



◆ Examples

- Which of the following best describes the difference between the price of a forward contract and its value?
- The forward price is fixed at the start, and the value starts at zero and then changes.
 - The price determines the profit to the buyer, and the value determines the profit to the seller.
 - The forward contract value is a benchmark against which the price is compared for the purposes of determining whether a trade is advisable.
- **Correct answer: A**

62-92

专业·创新·增值



◆ Examples

- Which of the following best describes the value of the forward contract at expiration? The value is the price of the underlying:
- minus the forward price.
 - divided by the forward price.
 - minus the compounded forward price.
- **Correct answer: A**

63-92

专业·创新·增值

◆◆◆ Futures Pricing and Valuation

➤ Prices of Futures vs. Forward Contracts

If the correlation between the underlying asset value and interest rate is...	Investors will...
Positive	Prefer to go long in a futures contract, and the futures price will be greater than the price of an otherwise comparable forward contract.
Zero	Have no preference
Negative	Prefer to go long in a forward contract, and the forward price will be greater than the price of an otherwise comparable futures contract.

64-92

专业·创新·增值

◆◆◆ Futures Pricing and Valuation

➤ Valuation of Futures Contracts

- The value of a futures contract is zero at contract inception.
- Futures contracts are marked to market daily, the value just after marking to market is reset to zero.
- Between the times at which the contract is marked to market, the value can be different from zero.

V (long) = current futures price – futures price at the last mark-to-market time.

- Another view of futures: settle previous futures, and then open another new futures with same date of maturity.

65-92

专业·创新·增值

◆◆◆ Arbitrage, replication, and risk neutrality

➤ Replication: replicate the payoffs on one asset or portfolio with those of a different asset or portfolio.

- An asset and a derivative on the asset can be combined to produce a position equivalent to a risk-free asset.
 - ✓ Asset + Derivative = Risk-free asset
- Or
 - ✓ Asset - Risk-free asset = - Derivative
 - ✓ Derivative - Risk-free asset = - Asset

66-92

专业·创新·增值

◆ Swap Pricing and Valuation

- A **swap contract** is an agreement between two parties to exchange a series of future cash flows. There are three kinds of swaps: interest rate swaps, currency swaps and equity swaps.
- A **plain vanilla swap** is an interest rate swap in which one party pays a fixed rate and the other pays a floating rate. The terms of the long and short are not used here, instead we say the fixed-rate payer and floating-rate (variable-rate) payer.
- Pricing of a plain vanilla swap:
 - The price is just the fixed rate (called the **swap rate**) that makes the contract value zero to both parties at initiation.
 - After some days the market situation changes, one party will make money and the other lose money. The contract value is no longer zero to both parties.

67-92

专业·创新·增值

◆ Swap Pricing and Valuation through Replication

- **Equivalence of swaps to bonds:**
 - An interest rate swap is identical to issuing a fixed-rate bond and using the proceeds to buy a floating-rate bond.
 - A currency swap is identical to issuing a fixed- or floating-rate bond in one currency, converting the proceeds to another currency, and using the proceeds to buy a floating- or fixed-rate bond in another currency.
 - An equity swap is identical to issuing a fixed- or floating-rate bond and using the proceeds to buy a stock or an index.

68-92

专业·创新·增值

◆ Swap Pricing and Valuation through Replication

- **Equivalence of swaps to forward contracts (FRA):**
 - A forward contract is an agreement to exchange future cash flows once, so a swap can be viewed as a series of forward contracts.
 - An interest rate swap, currency swap and equity swap are identical to a series of FRAs, currency forwards and equity forwards, respectively.
 - There are, however, some differences between swaps and forwards.
 - ✓ A series of FRAs will not all have the same forward rates, unless the yield curve is flat. So we often refer to a swap as a series of off-market forwards.
 - ✓ In addition, in interest rate swaps, the next payment is known one period ahead. This is not the case for an FRAs.

69-92

专业·创新·增值

◆◆ Examples



➤ **A swap is equivalent to a series of:**

- A. forward contracts, each created at the swap price.
- B. long forward contracts, matched with short futures contracts.
- C. forward contracts ,each created at their appropriate forward prices.

➤ **Correct answer: A**

- Each implicit forward contract is said to be off-market, because it is created at the swap price, not the appropriate forward price, which would be the price created in the forward market.

70-92

专业·创新·增值

◆◆ Examples



➤ **The price of a swap typically:**

- A. is zero at initiation.
- B. fluctuates over the life of the contract.
- C. is obtained through a process of replication.

➤ **Correct answer: C**

➤ **The value of a swap is equal to the present value of the:**

- A. fixed payments from the swap.
- B. net cash flow payments from the swap.
- C. underlying at the end of the contract.

➤ **Correct answer: B**

71-92

专业·创新·增值

◆◆ Option Valuation – A Qualitative View

➤ **Moneyness: on the long position**

● **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 generate a negative payoff.

- The following table summarizes the moneyness of options based on the stock's current price, S , and the option's exercise strike price, X .

Moneyness	Call option	Put Option
In-the-money	$S > X$	$S < X$
At-the-money	$S = X$	$S = X$
Out-of-the-money	$S < X$	$S > X$

72-92

专业·创新·增值

◆◆ Option Valuation – A Quantitative View

➤ Intrinsic Value: on the long position

- **Intrinsic Value:** the amount that it is in the money, and zero otherwise

✓ Intrinsic value of call option: $C = \max[0, S - X]$

✓ Intrinsic value of put option: $P = \max[0, X - S]$

● Time Value:

✓ The difference between the price of an option (called its premium) and its intrinsic value is due to its time value

✓ Option value = intrinsic value + time value

◆ Before expiration: option value > intrinsic value

◆ At expiration: option value = intrinsic value

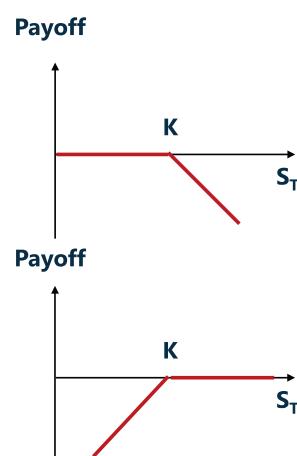
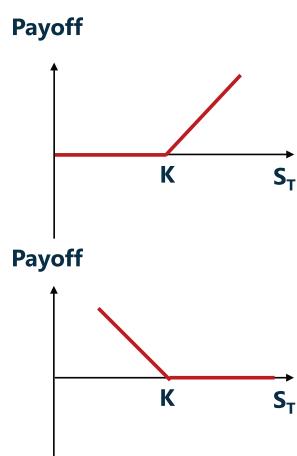
✓ Price of the option is **more volatile** than prices of underlying stock

73-92

专业·创新·增值

◆◆ Option Payoff – An Illustrative View

➤ Payoff

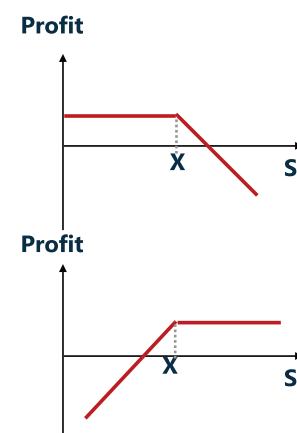
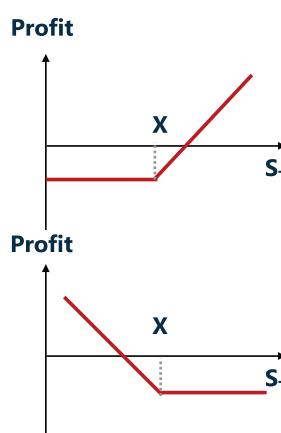


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专业·创新·增值

◆◆ Option Valuation – An Illustrative View

➤ Gain/Loss



75-92

专业·创新·增值

◆◆ Risk Factors on Option Valuation

- Factors affect the value of an option

Sensitivity Factor	Calls	Puts
Underlying price	Positively related	Negatively related
Volatility	Positively related	Positively related
Risk-free rate	Positively related	Negatively related
Time to expiration	Positively related	Positively related*
Strike price	Negatively related	Positively related
Payments on the underlying	Negatively related	Positively related
Carrying cost	Positively related	Negatively related

- * **There is an exception** to the general rule that European put option thetas are negative. The put value may increase as the option approaches maturity if the option is deep in-the-money and close to maturity.

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专业·创新·增值

◆◆ Example



- An investor purchases an equity call option priced at CHF3 with an exercise price of CHF41. If at expiration of the option, the underlying is priced at CHF38, the profit for the investor's position is closest to:
 - A. -CHF6.
 - B. CHF0.
 - C. -CHF3.
- **Correct Answer: C**
 - The option expires worthless, and the loss is equal to the premium paid.

77-92

专业·创新·增值

◆◆ Example



- Which of the following statements about call options at expiration is TRUE?
 - A. The profit potential to the buyer of the option is unlimited.
 - B. The call buyer's maximum loss is the call option's premium.
 - C. All of the answers are correct.
- **Correct answer: C**
 - Which of the below positions is the most risky, in the sense of having the largest potential losses?
 - A. A long position in call options.
 - B. A short position in put options.
 - C. A short (written) position in call options.
 - **Correct answer: C**

78-92

专业·创新·增值

◆ Example



- Consider a put option on Deter, Inc., with an exercise price of \$45. The current stock price of Deter is \$52. What is the intrinsic value of the put option, and is the put option at-the-money or out-of-the-money?

Intrinsic Value	Moneyness
A. \$7	At-the-money
B. \$0	Out-of-the-money
C. \$0	At-the-money

➤ **Correct answer: B**

- Which statement about option valuation is **FALSE**?

- A. Prior to maturity, out-of-the-money options have no value.
- B. The value of an option is its time value plus its intrinsic value.
- C. The buyer of a call option contract can never lose more than the initial premium.

➤ **Correct answer: A**

79-92

专业·创新·增值

◆ Price Parity of Options and their Underlying's

➤ **Put call parity**

- Put call parity. $c + X / (1 + R_f)^T = S + p$
or $c + K / (1 + R_f)^T = S + p$

- Positions replicating

- ✓ Condition A $-S = -c + p - X / (1 + R_f)^T$

- ✓ Condition B $p = c + X / (1 + R_f)^T - S$

- ✓ Condition C $c = p + S - X / (1 + R_f)^T$

- ✓ Condition D $-p = -c + S - X / (1 + R_f)^T$

- ✓ Condition E

$$-c = -p + X / (1 + R_f)^T - S$$

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专业·创新·增值

◆ Proof of Price Parity through Replication

- A fiduciary call is a portfolio consisting of:
- A long position in a European call option with an exercise price of X that matures in T years on a stock.
 - A long position in a pure-discount riskless bond that pays X in T years.
- The cost a fiduciary call is the cost of the call (C_0) plus the cost of the bond (the present value of X). The payoff to a fiduciary call will be X if the call is out-of-the-money and S_T if the call is in-the-money, as shown in the following:

	$S_T \leq X$ (Call is out-of or at-the-money)	$S_T > X$ (Call is in-the-money)
Long call payoff	0	$S_T - X$
Long bond payoff	X	X
Total payoff	X	S_T

81-92

专业·创新·增值

◆◆ Proof of Price Parity through Replication

- A protective put is a portfolio consisting of:
 - A long position in a European put option with an exercise price of X that matures in T years on a stock.
 - A long position in the underlying stock.
- The cost of a protective put is the cost of the put (P_0) plus the cost of the stock (S_0). The payoff to a protective put is X if the put is in-the-money and S_T if the put is out-of-the-money, as shown in the following:

	$S_T < X$ (put is in-the-money)	$S_T \geq X$ (put is out-of or at-the-money)
Long put payoff	$X - S_T$	0
Long stock payoff	S_T	S_T
Total payoff	X	S_T

82-92

专业·创新·增值

◆◆ Example



- As with all arbitrage trades, you want to "buy low and sell high." If put-call parity doesn't hold (if the cost of a fiduciary call does not equal the cost of a protective put), then you buy (go long in) the underpriced position and sell (go short) in the overpriced position.
- **Example: Exploit violations of put-call parity**
 - 90-day European call and put options with a strike price of \$45 is priced at \$7.50 and \$3.70. The underlying is priced at \$48 and makes no cash payments during the life of the options. The risk-free rate is 5%. Calculate the no-arbitrage price of the call option, and illustrate how to earn an arbitrage profit.

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专业·创新·增值

◆◆ Example



- **Answer:**

$$C_0 = P_0 + S_0 - X/(1+R_f)^T = \$3.70 + \$48 - \$45/1.05^{90/365} = \$7.24 < \$7.50$$
- Since the call is overpriced
 - we should sell the call for \$7.50 and buy the synthetic call for \$7.24.
 - To buy the synthetic call, buy the put for \$3.70, buy the underlying for \$48, and issue (sell short) a 90-day zero-coupon bond with a face value of \$45.
 - The transaction will generate an arbitrage profit of \$0.26 today.

84-92

专业·创新·增值

◆◆ Put – Call – Forward Parity

- The first portfolio (**Fiduciary call**) consist of:
 - A call option on the underlying with an exercise price of X.
 - A pure-discount bond that pays X at time T.
 - The cost of this portfolio is: $C_0 + \frac{X}{(1+R_f)^T}$
- The second portfolio (**Protective Put with a forward contract**) can be constructed by combining.
 - A put option on the underlying with an exercise price of X.
 - A pure-discount bond that pays X at time FP.
 - A forward contract that is agreed to buy the underlying at FP at time T.
 - The cost of this portfolio is: $P_0 + \frac{FP}{(1+R_f)^T} + 0$
- The payoff of the first portfolio at Time T is identical to that of the second portfolio. Then the cost of both portfolios must be equal.

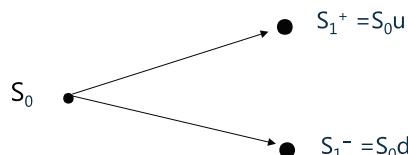
$$C_0 + \frac{X-F_T}{(1+R_f)^T} = P_0$$

85-92

专业·创新·增值

◆◆ Option Pricing – Binomial Model

- A **binomial model**: for pricing options in which the underlying price can move to only one of two possible new prices.
- We start off by having only one binomial period, which means that the underlying price moves to two new prices at option expiration. We let S_0 be the price of the underlying stock now. One period later, the stock price can move up to S_1^+ or down to S_1^- . We then identify a factor, u, as the up move on the stock and d as the down move. Thus, $S_1^+ = S_0u$ and $S_1^- = S_0d$. We further assume that $u = 1/d$.



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专业·创新·增值

◆◆ Option Pricing – Binomial Model

- Risk-neutral probability of an up move is π_u ; Risk-neutral probability of an down move is $\pi_d=1-\pi_u$;

$$\pi_u = \frac{1+R_f-d}{u-d}$$
- We start with a call option. If the stock goes up to S_1^+ , the call option will be worth C_1^+ . If the stock goes down to S_1^- , the call option will be worth C_1^- . We know that the value of a call option will be its intrinsic value on expiration date. Thus we get: $C_1^+ = \text{Max}(0, S_1^+ - X)$; $C_1^- = \text{Max}(0, S_1^- - X)$

$$\text{value of an option: } c = [\pi_u C_1^+ + \pi_d C_1^-] \times \frac{1}{(1+R_f)^T}$$

- Hedge ratio :

$$\text{Delta} = \frac{C^+ - C^-}{S^+ - S^-} (\text{shares per option})$$

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专业·创新·增值

◆◆ Option Pricing – Binomial Model

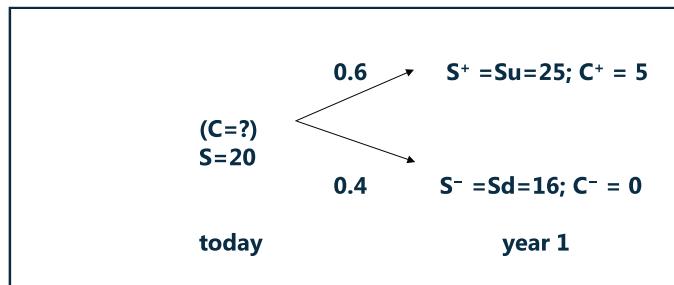
- **Example:** Calculate the value today of a 1-year call option on the stock with the strike price of \$20. The price of the stock is \$20 now, and the size of an up-move is 1.25. The risk-free rate is 7%.
- **Answer:**
 - **Step 1: Calculate the parameters:**
 - ✓ $u=1.25$; $d=1/u=0.8$; $S_u=20 \times 1.25=25$; $S_d=20 \times 0.8=16$
 - ✓ $C^+ = \max(0, 25-20) = 5$; $C^- = \max(0, 16-20) = 0$
 - **Step 2: Calculate risk-neutral probabilities, π_u and $\pi_d = 1 - \pi_u$:**
 - ✓ $\pi_u = (1+0.07-0.8)/(1.25-0.8) = 0.6$
 - ✓ $\pi_d = 1 - \pi_u = 0.4$

88-92

专业·创新·增值

◆◆ Option Pricing – Binomial Model

- **Step 3: Draw the one-period binomial tree:**



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专业·创新·增值

◆◆ Option Pricing – Binomial Model

- Pricing a put option is similar to that of a call. The only difference is that $P^+ = \max(0, X-S^+)$ and $P^- = \max(0, X-S^-)$.
- **Example: Use the information in the previous example to calculate the value today of a put on the same stock with the strike price of \$20.**
- **Answer:**

$P^+ = \max(0, 20-25) = 0$; $P^- = \max(0, 20-16) = 4$

$$P = (0.6 \times 0 + 0.4 \times 4)/1.07 = 1.6/1.07 = 1.50$$

90-92

专业·创新·增值

◆ Impact of Early Exercise on Option Pricing

➤ Early Exercise of American Options

● American call options

- ✓ when the underlying makes no cash payments(dividends and coupon interest), no reason to exercise the call early, $C_0 = c_0$,
- ✓ when the underlying makes cash payments(dividends and coupon interest) during the life of the option, early exercise can happen, $C_0 > c_0$

● American put options

- ✓ $P_0 > p_0$, nearly always true,
as long as there is a possibility of bankruptcy , P_0 always $> p_0$
(consider an American put on a bankrupt company, stock $\rightarrow 0$,
cannot go any lower, then put option holder may exercise it)

91-92

专业·创新·增值

◆ It's not the end but just the beginning.

Never stop smiling, not even when you're sad, someone

might fall in love with your smile.

永远都不要停止微笑，即使是在你难过的时候，说不定有

人会因为你的笑容而爱上你。

92-92

专业·创新·增值