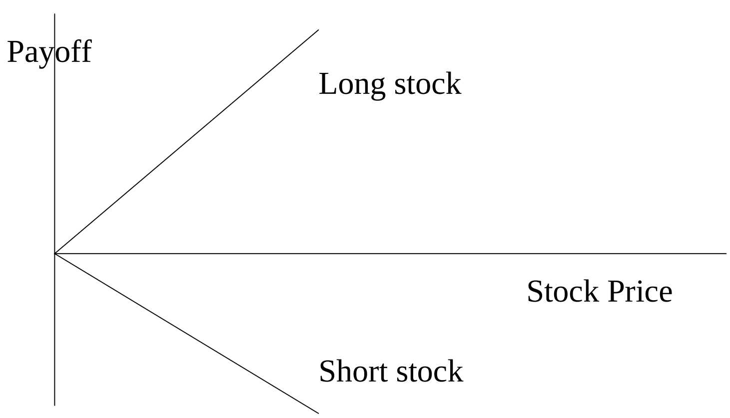
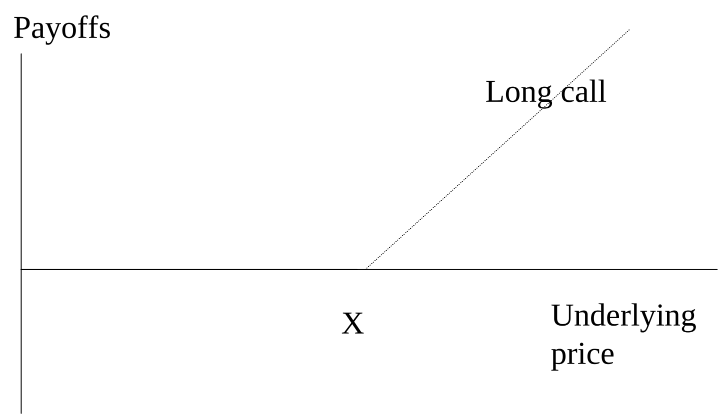
Objectives

- Options
  - – basic strategies
  - – introduction to some pricing restrictions
  - – introduction to binomial model

Payoff Diagrams

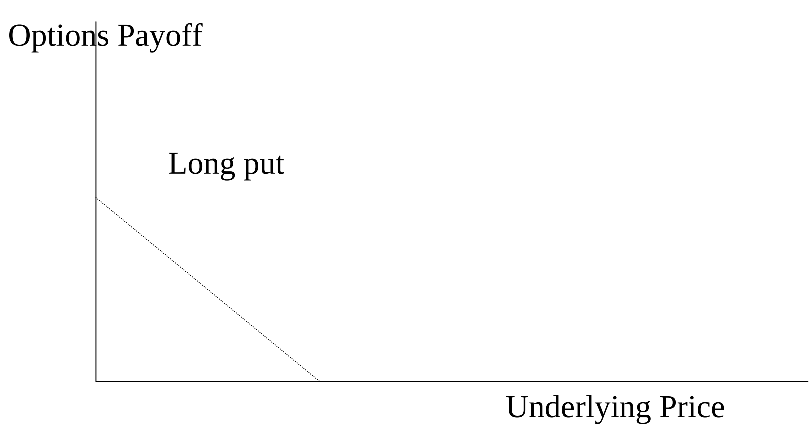


European call



4/16/99 Options 3

European Put



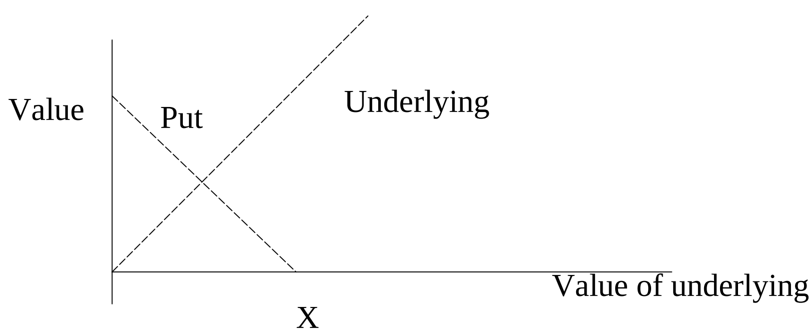
4/16/99 Options 4

Some strategies

- Naked
- Protective put
- Covered call
- Straddle

Protective put

- Purchase underlying security
- Purchase put option, exercise price X



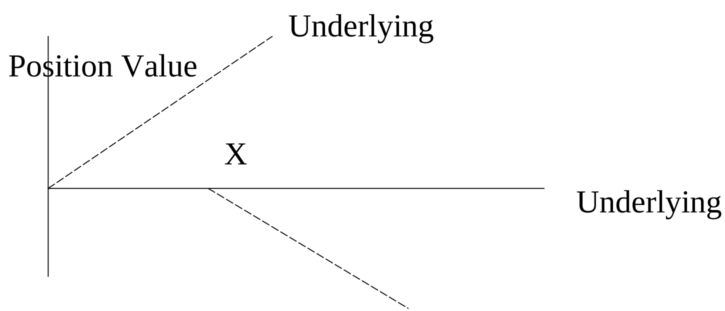
Algebraically

Position	$S_T < X$	$S_T > X$
Underlying	S_T	S_T
Put	$X - S_T$	S_T
Net	X	S_T

Why do this?

Covered call

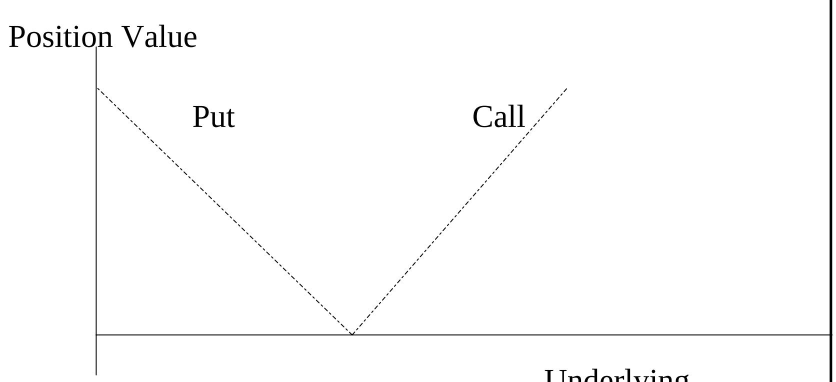
- Purchase underlying
- Write call option against it



4/16/99 Options 9

Straddle

- Buy put and call, both at the same strike



4/16/99 Options 10

Other spreads

- combination of 2+ calls or puts, same asset with differing exercise prices or times to expiration
  - Vertical or money spread
    - Same maturity and different exercise price
  - Horizontal or time spread
    - different maturities

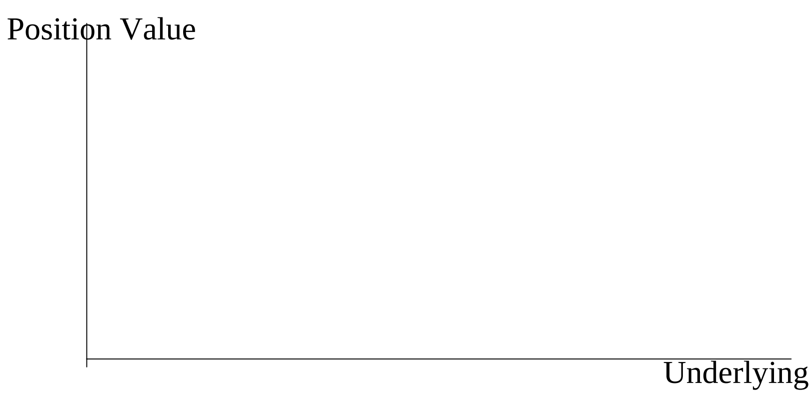
Main Points

- Lots of strategies possible
- Options allow you to customize cash flows across states in the future...

Put call parity

- Relationship between price of European call and put
- Independent of assumptions about randomness in underlying
  - stocks
  - indexes
  - bonds, currencies, etc.

Final Payoffs: Long call and short put



Arbitrage relationship

Example

- Stock price = $10
- maturity 1 year, interest rate 10%
- exercise price = $9.90
  - – Put price = $1
  - – Call price ?

Call price < stock price

- Suppose stock price = 10, call price = 11, exercise price = 4
- Strategy:
  - purchase stock
  - short option

Payoffs on strategy

Item	Today	Maturity $S_T<4$	$S_T \geq 4$
Long stock	-$10	S_T	S_T
Short option	+$11	0	4- S_T
Net	+$1	S_T	4

American calls

- Don’t exercise early without dividends

Binomial Model

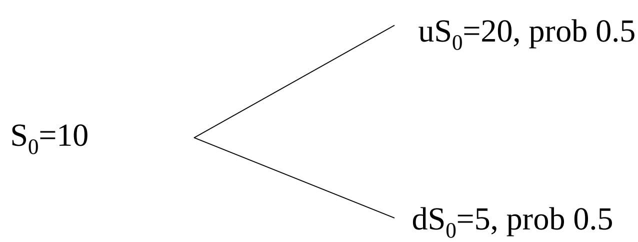
- Workhorse model for derivatives valuation
- Very flexible
- Basic Assumption about stock price moves
  - binomial process for stock price: either goes up or down next period

1 period example

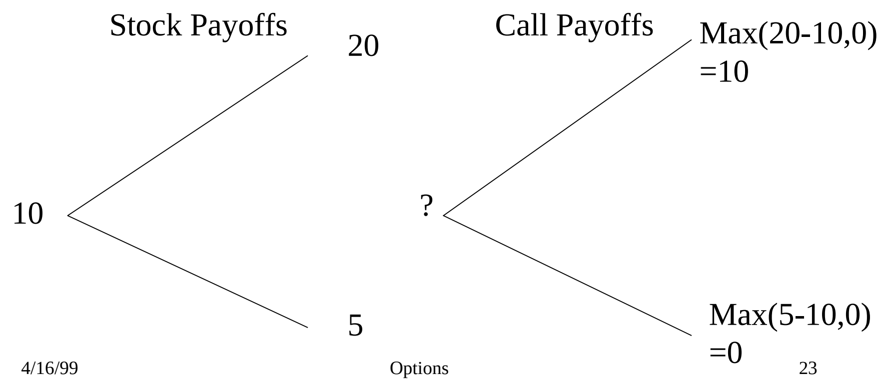
- S_0=10, current stock price, r= 1.1=riskfree rate
- probability stock increase = q=0.5
  - u: multiplicative upward movement =2
  - d: downward movement = 0.5
  - u > r > d
- Why?

Stock price movements

$$S_1 = \begin{cases} uS_0 = 2(10) = 20, & probability = 0.5 \\ dS_0 = 0.5(10) = 5, & probability = 0.5 \end{cases}$$



Call option,X=10, 1 period maturity



Valuation

- Basic idea: come up with strategy of stock and bonds with same payoff as option
  – arbitrage says: cost of strategy = cost of option
- α: number of shares, β: number of bonds
  – 'u': α20+ β1.05=10
  – 'd': α5+β1.05=0
  – Solving: α = (2/3),   β =-(2/3)(5/1.1)

Call value

- Value of call=value of portfolio
  - $\alpha(10)+\beta=(2/3)(10)-(2/3)(5/1.1)=3.64$

Implications

- 2 states in future: needed 2 securities (stock and bond) to hedge/price option
- Call = long stock and short bond: levered position in portfolio
- What happened to probability of u and d?

Recap

- Pricing via replication
- probabilities of up and down doesn’t matter!
- Steps:
  - – check if #securities ≥ # states
  - – if so, match cash flows state by state

Summary

- Options
  - – strategies
  - – basic pricing restrictions
  - – introduction to binomial model

Next Time

- Extend binomial model to deal with multiple periods
- Applying model to portfolio strategies
  - Sharpe and Perold in readings packet