

Options (1)



Class 19
Financial Management, 15.414

Today

Options

- Risk management: Why, how, and what?
- Option payoffs

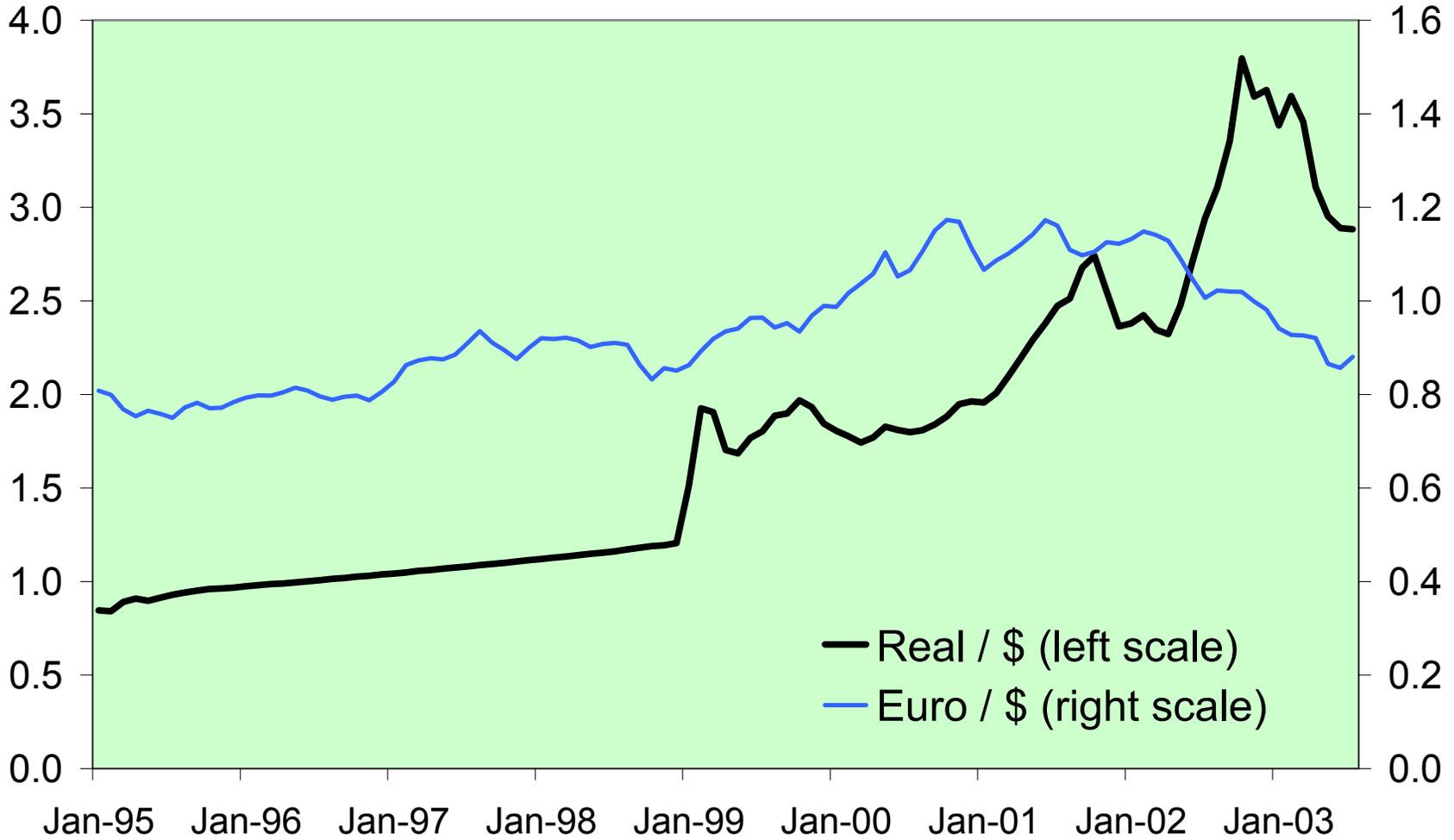
Reading

- Brealey and Myers, Chapter 20, 21
- Sally Jameson

Types of questions

- Your company, based in the U.S., supplies machine tools to manufacturers in Germany and Brazil. Prices are quoted in each country's currency, so fluctuations in the € / \$ and R / \$ exchange rate have a big impact on the firm's revenues. How can the firm hedge these risks? Should it?
- Your firm is thinking about issuing 10-year convertible bonds. In the past, the firm has issued straight debt with a yield-to-maturity of 8.2%. If the new bonds are convertible into 20 shares of stocks, per \$1,000 face value, what interest rate will the firm have to pay on the bonds? Why?
- You have the opportunity to purchase a mine that contains 1 million kgs of copper. Copper has a price of \$2.2 / kg, mining costs are \$2 / kg, and you have the option to delay extraction one year. How much is the mine worth?

Exchange rates, 1995 – 2003



Example

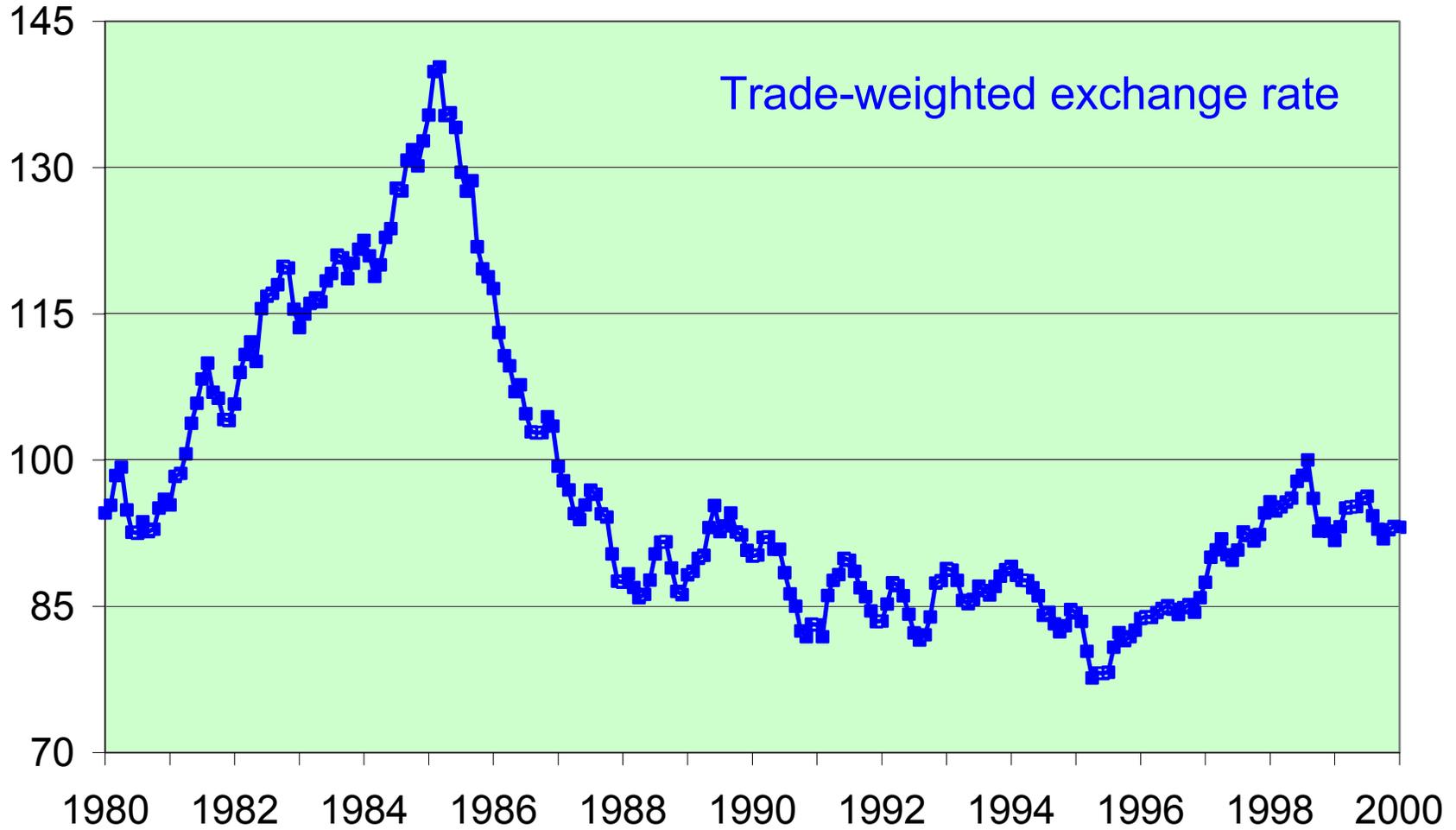
Caterpillar

- **Global leader, construction and mining equipment**
Sales in nearly 200 countries
- **In 1980s, dollar up, then down 50%**

Year	1980	1984	1988
Sales	\$8,598	\$6,576	\$10,435
Net income	565	-428	616
Cap exp	749	234	793

\$ millions

\$ exchange rate, 1980 – 2000



Risk management

What is the goal?

How can firms create value through risk management?

➤ **View 1: Hedging is irrelevant (M&M)**

Purely financial transaction

Diversified shareholders don't care about firm-specific risks

➤ **View 2: Hedging creates value**

Helps ensure that cash is available for positive NPV investments

Reduces dependence on external finance

Reduces probability of financial distress

Improves performance evaluation and compensation

Other benefits: reduce taxes, undiversified shareholders

Why hedge?

Three gold producers

- **Homestake Mining**

Does not hedge because “shareholders will achieve maximum benefit from such a policy.”

- **American Barrick**

Hedges aggressively to give the company “extraordinary financial stability... offering investors a predictable, rising earnings profile in the future.”

- **Battle Mountain Gold**

Hedges up to 25% because “a recent study indicates that there may be a premium for hedging.”

Derivative use

Evidence

- **Random sample of 413 large firms**

Average cashflow from operations = \$735 million

Average PP&E = \$454 million

Average net income = \$318 million

- **How much hedging?**

57% of firms use derivatives in 1997

For derivative users, if 3σ event, then cashflows up by \$15 million and market value up by \$31 million

Financial derivatives

➤ Options

Gives the holder the right to buy (call option) or sell (put option) an asset at a specified price.

Buyer has the choice

➤ Forwards and futures

A contract to exchange an asset in the future at a specified price and time.

Obligation for both

➤ Swaps

An agreement to exchange a series of cashflows at specified prices and times.

Obligation for both

Financial derivatives

Assets

- **Financial assets**

Stocks, bonds, stock indices, Tbonds (interest rates), foreign exchange

- **Commodities**

Oil, gold, silver, corn, soybeans, OJ, pork bellies, coffee

- **Other events and prices**

Electricity, weather, etc.

- **Imbedded options**

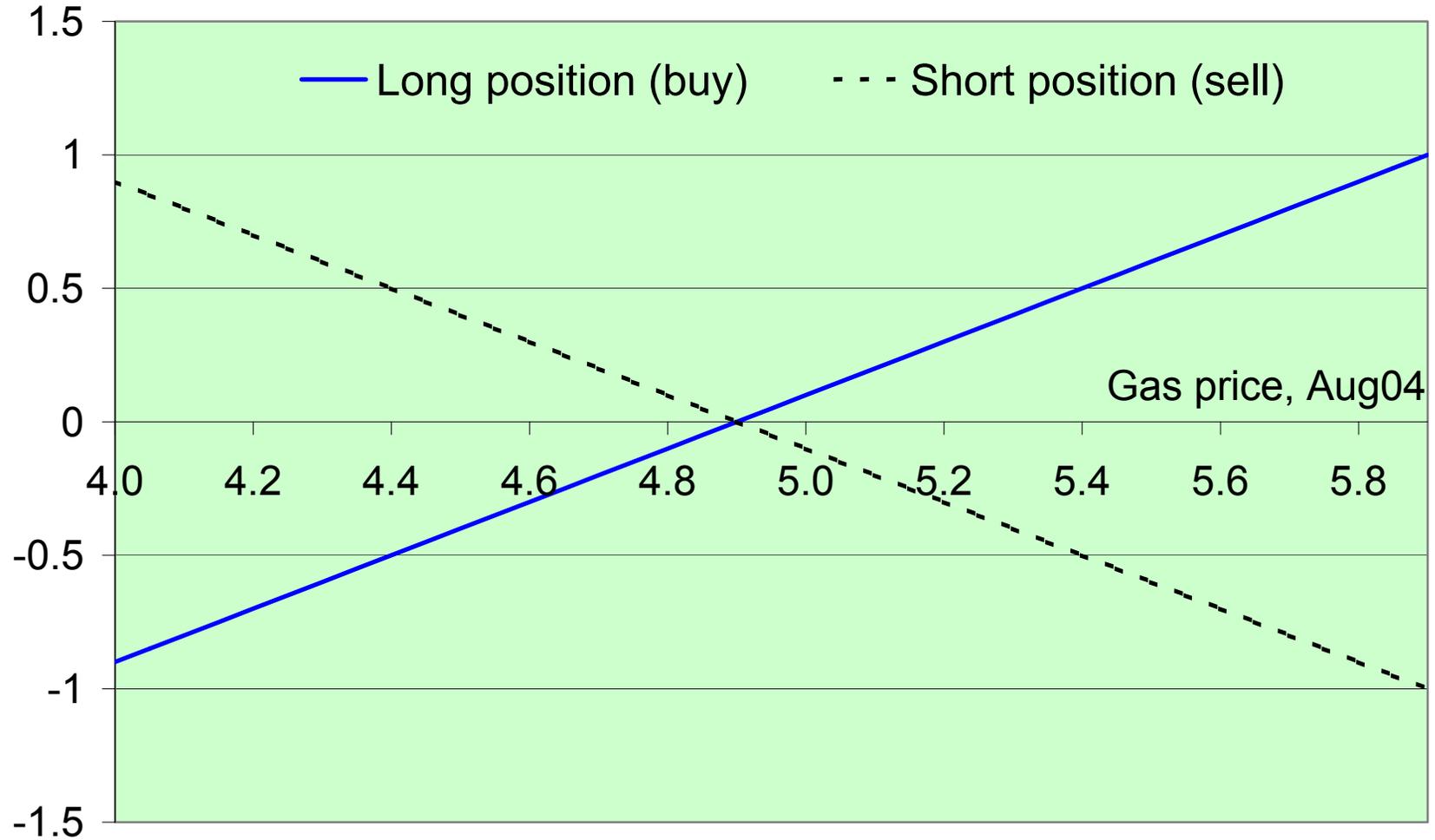
Convertible bonds, warrants, real options, mortgages

Futures contract

On Thursday, the NYM traded natural gas futures with delivery in August 2004 at a price of 4.900 \$ / MMBtu.

- **Buyer has a 'long' position**
Wins if prices go up
- **Seller has a 'short' position**
Wins if prices go down
- **The price of the contract is zero**
No cash changes hands today

Futures contract: Payoff diagram



Option contract

Thursday, the CBOE traded 4,258 call option contracts (100 shares each) on Cisco stock with a **strike price** of \$20.00 and an expiration date in October. The option price is \$0.30.

- **Buyer has the right to buy Cisco at \$20**
Option will be exercised if $\text{Cisco} > \$20$
- **Seller is said to 'write' the option**
- **American options** can be exercised anytime *on or before* the maturity date.
- **European options** can be exercised *only on* the maturity date.
- **Out of the money** if the stock price is lower than the strike price.
In the money if the stock price is greater than the strike price.

WSJ option quotes

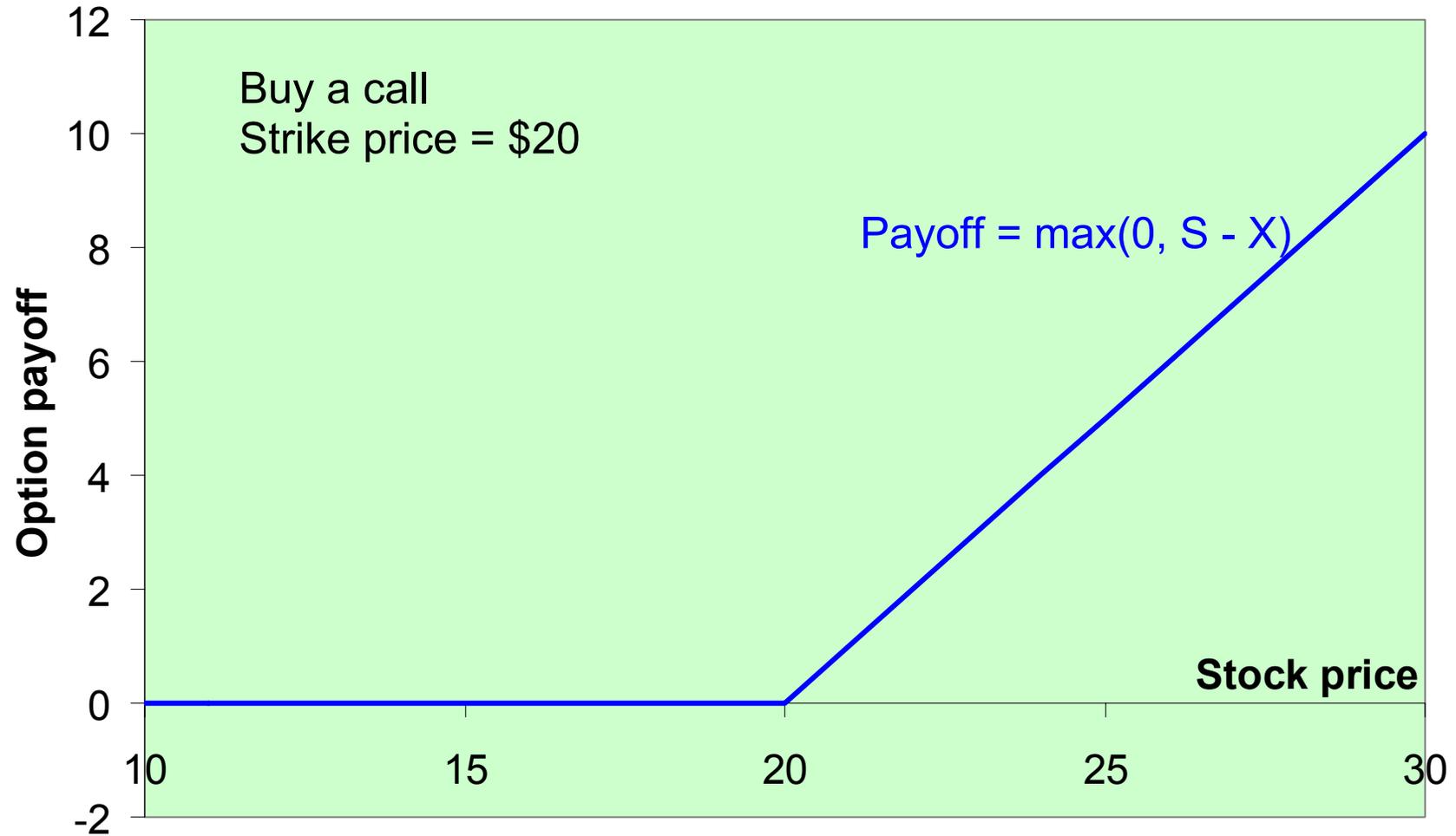
Option/Strike		Exp	Call		Put	
			Vol	Last	Vol	Last
<i>Cisco</i>	15	Jan	4128	3.60	25	0.70
17.83	17.50	Aug	5307	0.40	4410	0.15
17.83	20	Oct	4258	0.30	100	2.60

↓
Stock price

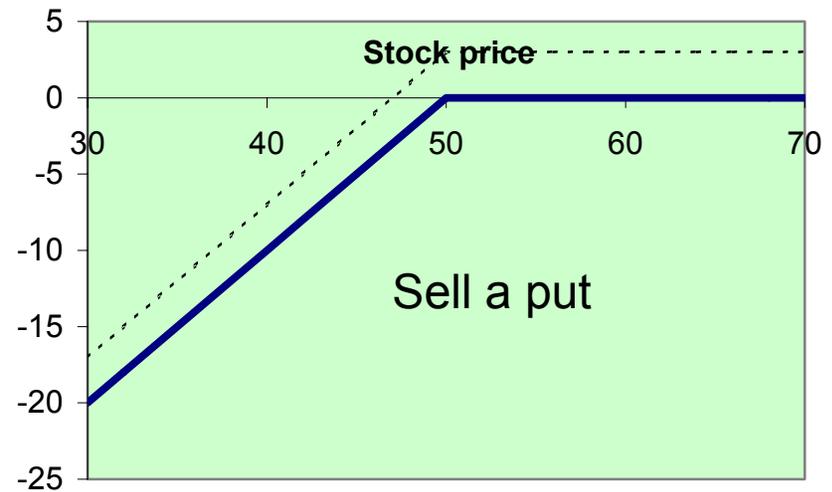
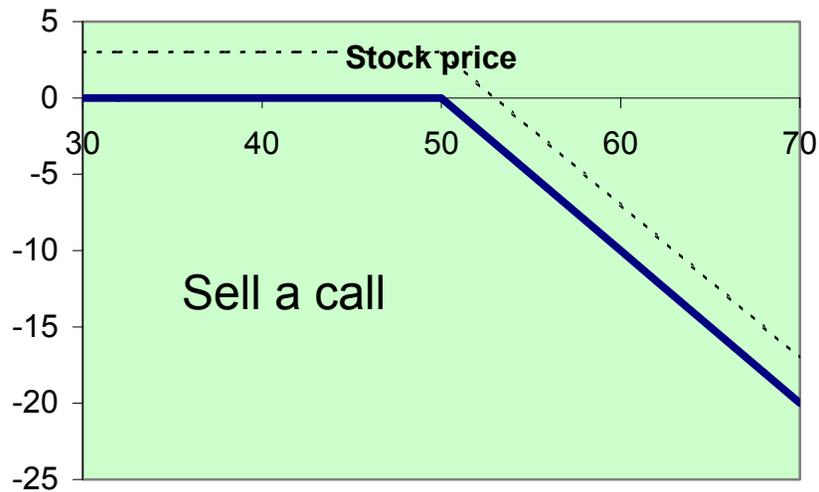
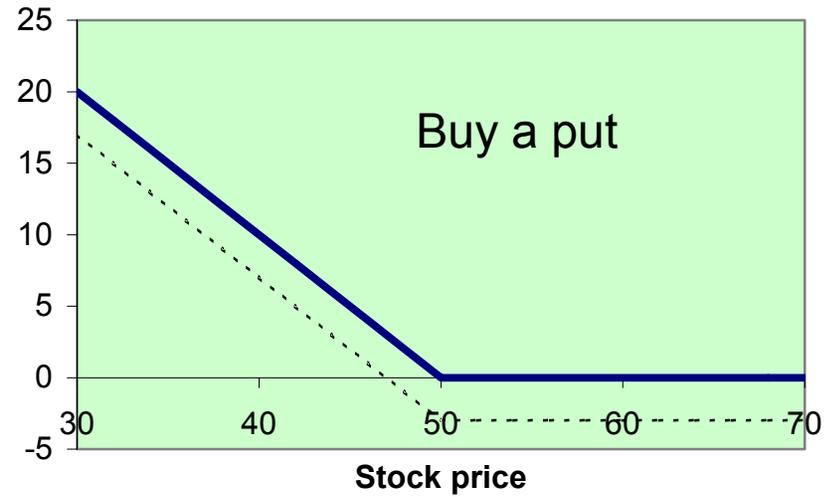
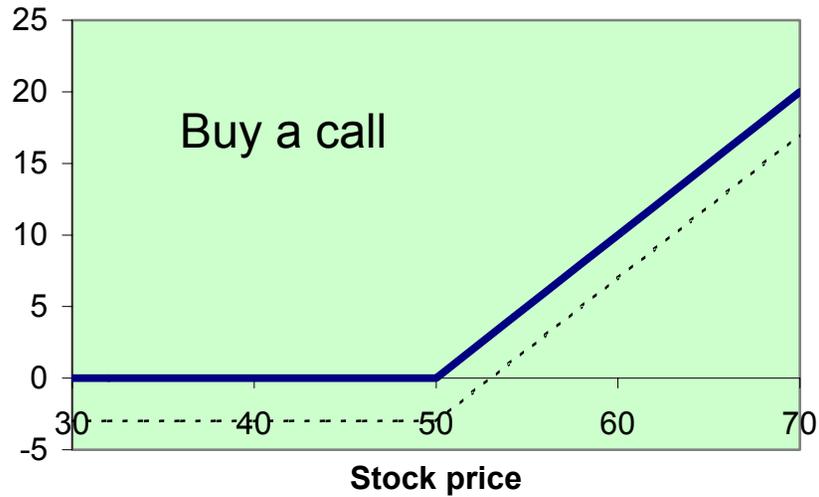
↓
Call price

↓
Put price

Call option: Payoff diagram



Option payoffs (strike = \$50)



Options

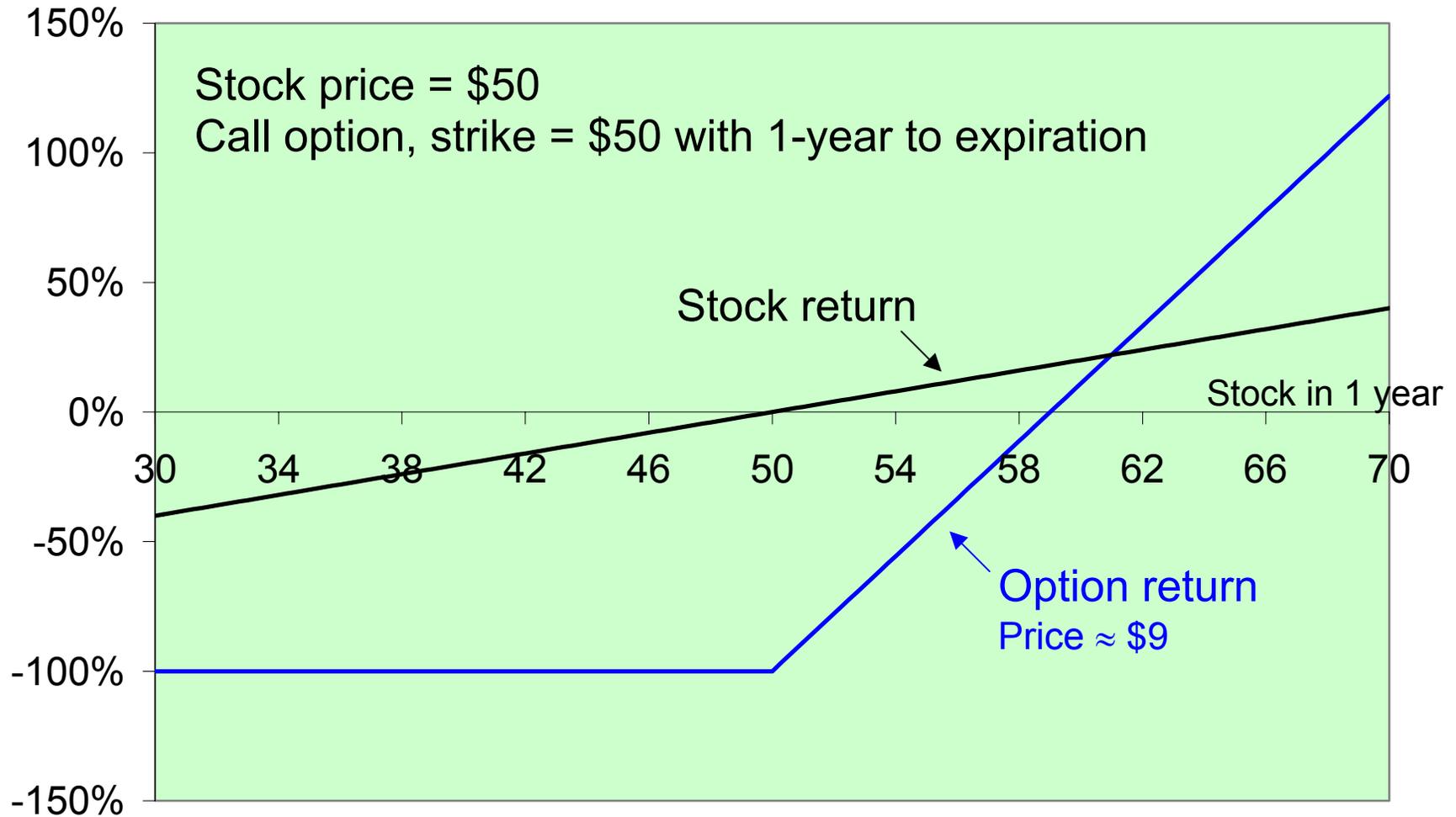
Option payoffs

Asset price = S , strike price = X

Buyer of the option

	$S < X$	$S > X$	} Risky if used alone
Call	0	$S - X$	
Put	$X - S$	0	

Returns, stock vs. option



Option strategies

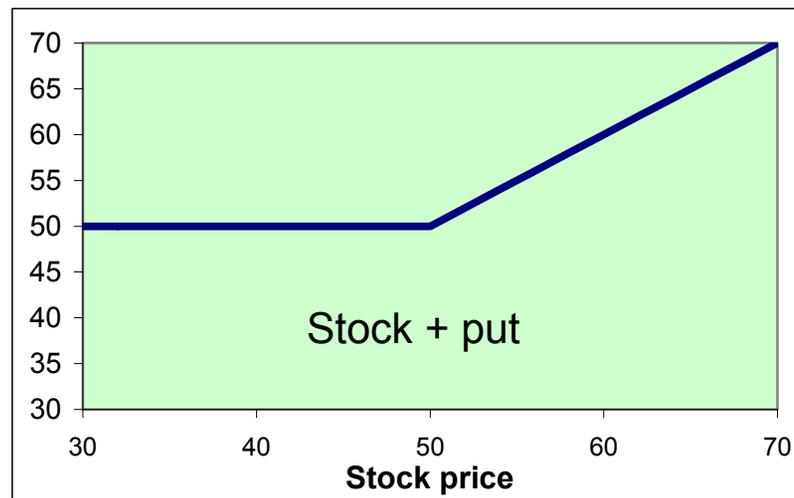
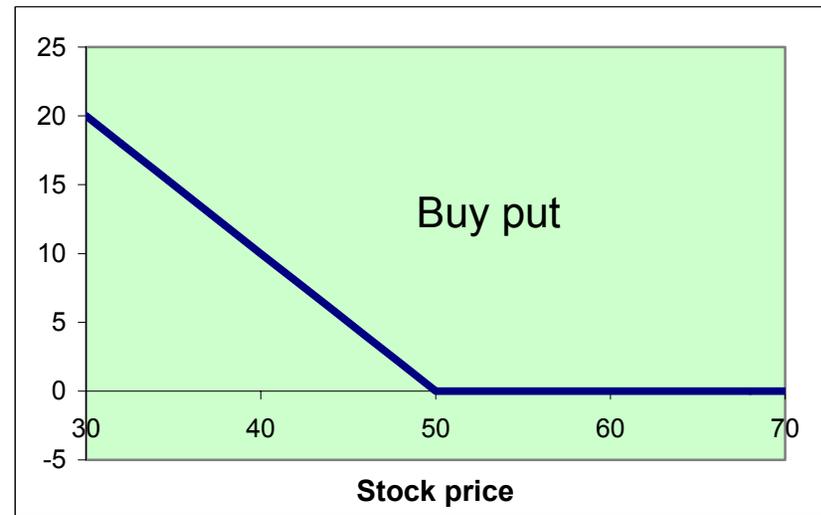
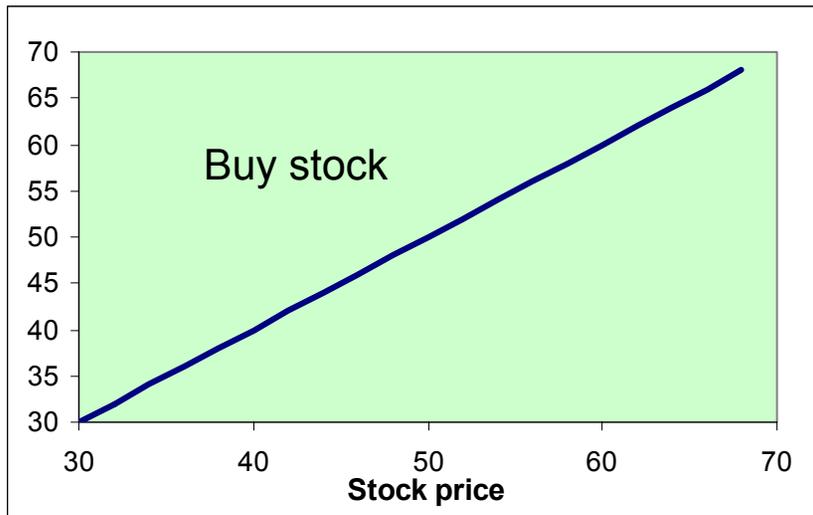
Financial engineering

Options can be mixed in various ways to create an unlimited number of payoff profiles.

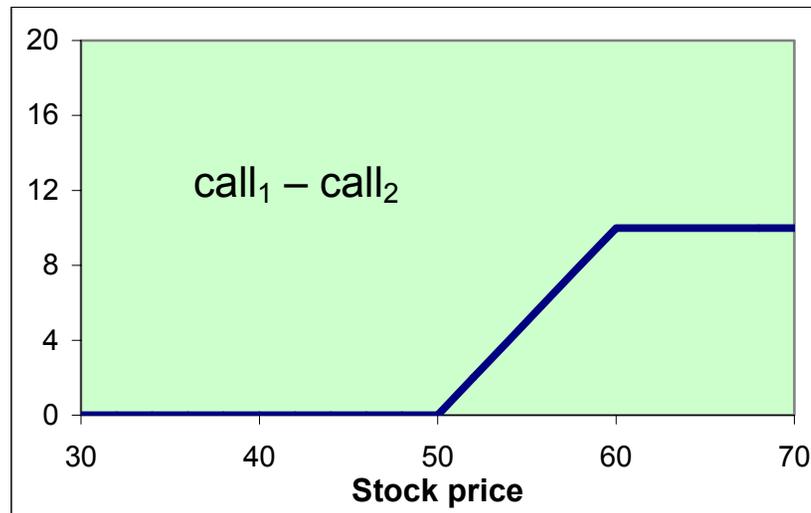
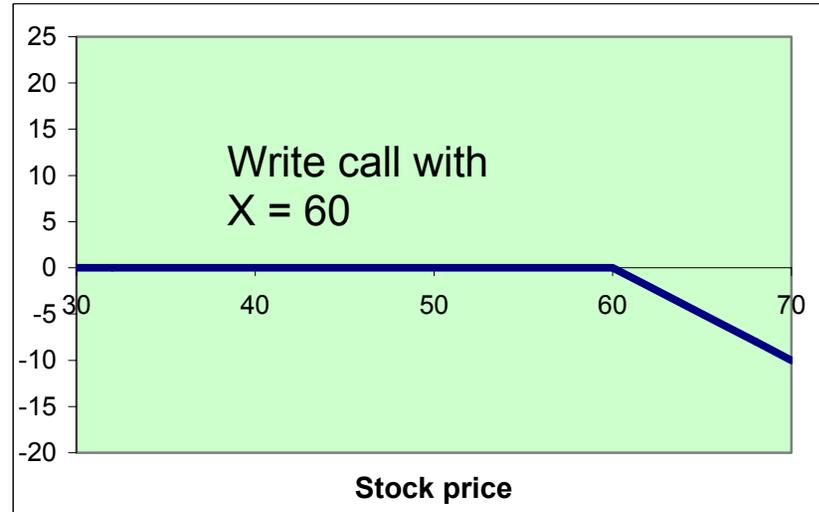
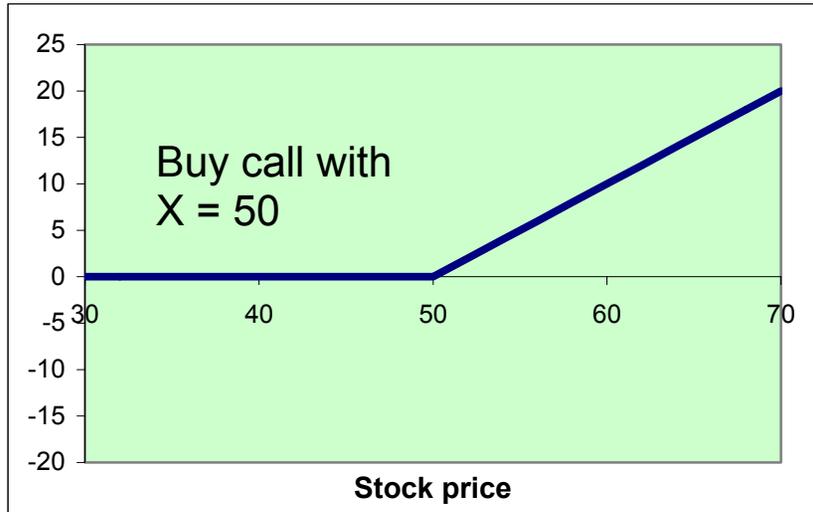
Examples

- Buy a stock and a put
- Buy a call with one strike price and sell a call with another
- Buy a call and a put with the same strike price

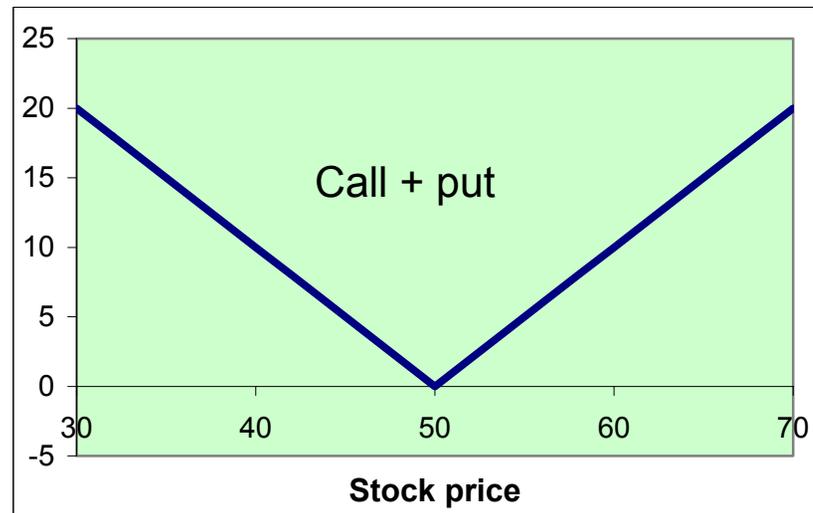
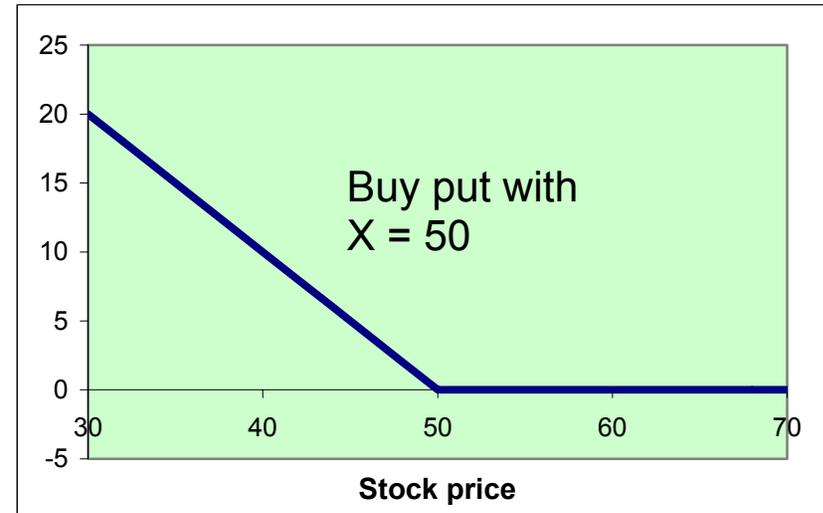
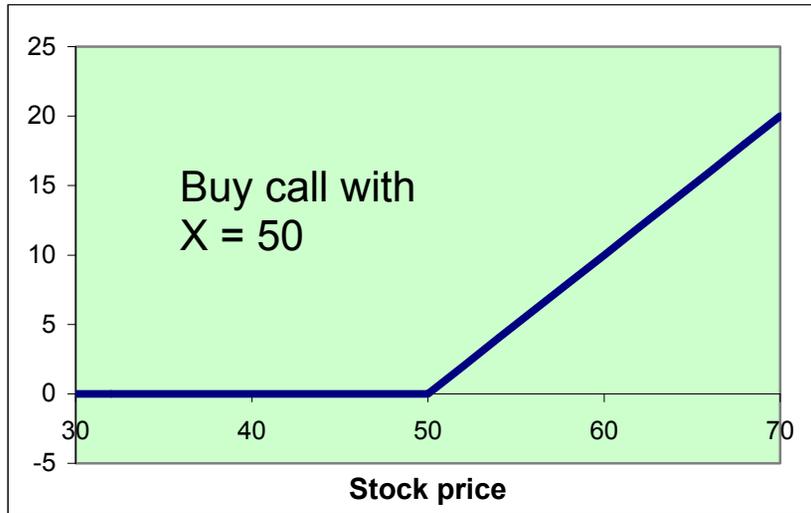
Option strategies: Stock + put



Option strategies: $\text{Call}_1 - \text{call}_2$



Option strategies: Call + Put



Option pricing

What is an option worth?

How can we estimate the expected cashflows?

How risky is an option? What is the appropriate discount rate?

Two formulas to know

- Put-call parity
- Black-Scholes formula

Put-call parity

Relation between put and call prices

$$P + S = C + PV(X)$$

S = stock price

P = put price

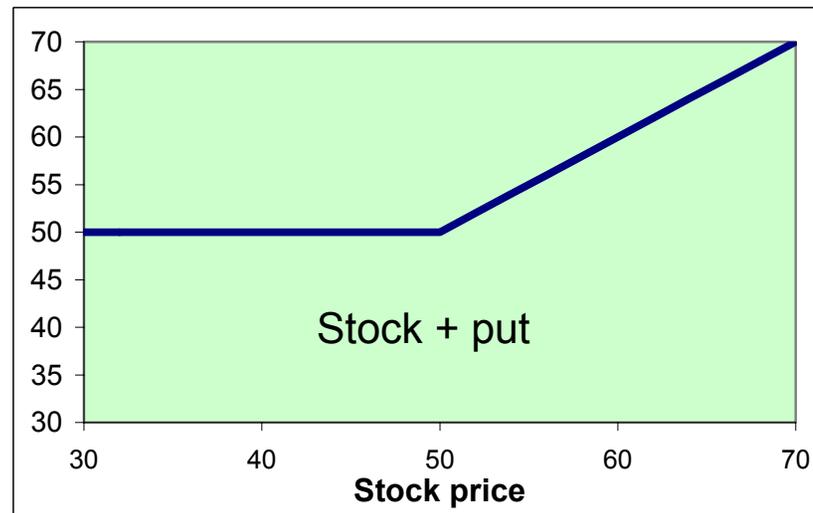
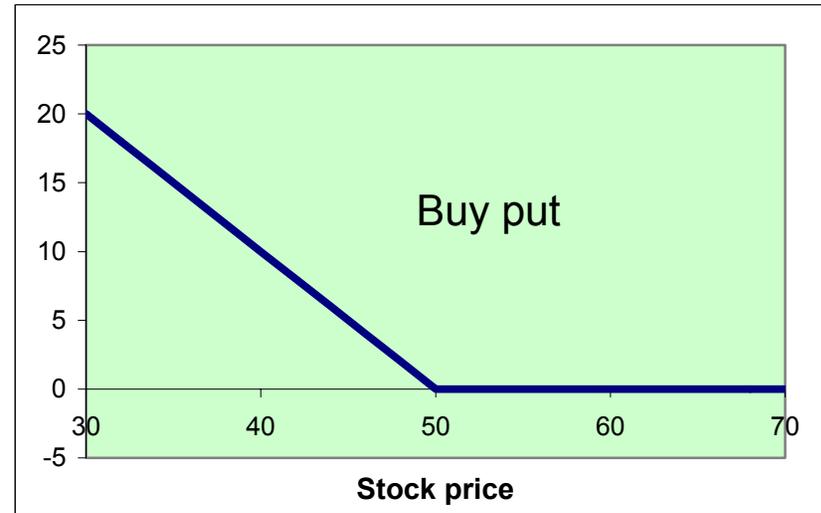
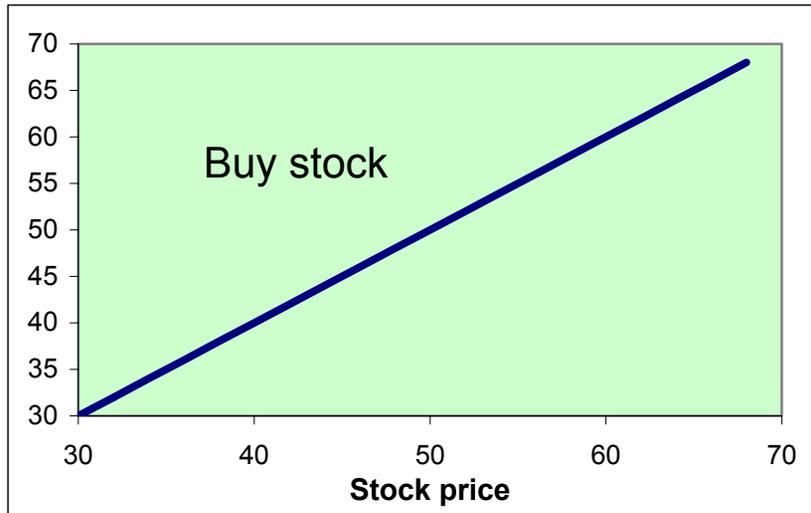
C = call price

X = strike price

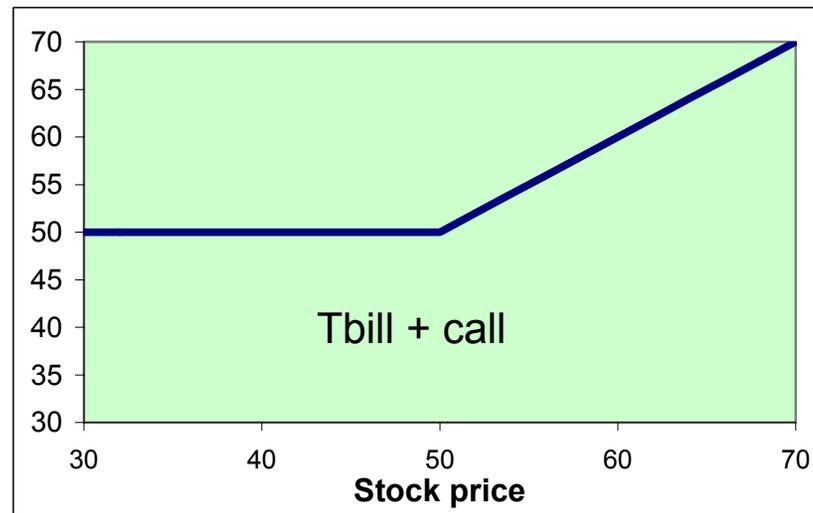
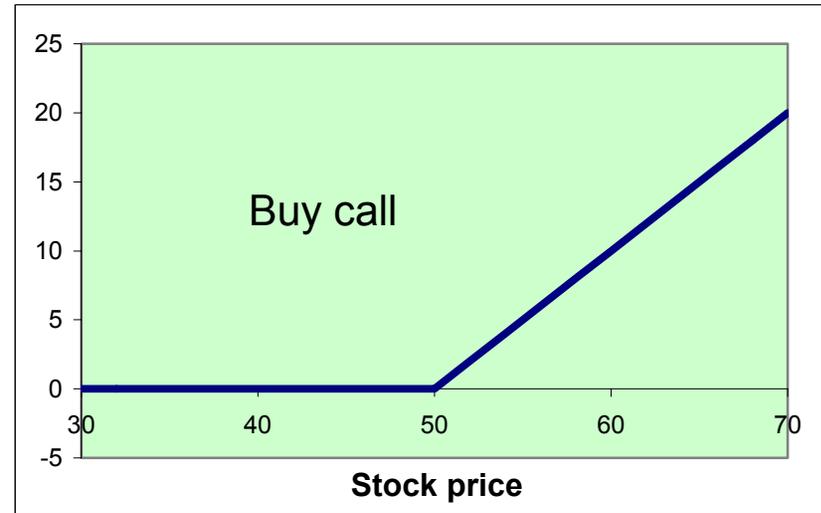
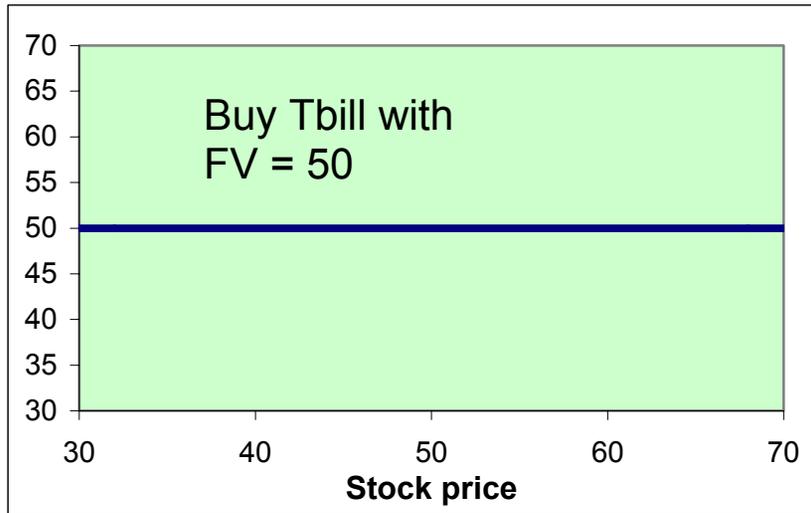
PV(X) = present value of \$X = $X / (1+r)^t$

r = riskfree rate

Option strategies: Stock + put



Option strategies: Tbill + call



Example

On Thursday, call options on Cisco stock with an expiration date in October and a strike price of \$20 sold for \$0.30. The current price of Cisco is \$17.83. How much should put options with the same strike price and expiration date sell for?

Put-call parity

$$P = C + PV(X) - S$$

$$C = \$0.30, \quad S = \$17.83, \quad X = \$20.00$$

$r = 1\%$ annually $\rightarrow 0.15\%$ over the life of the option

$$\text{Put option} = 0.30 + 20 / 1.0015 - 17.83 = \$2.44$$

(WSJ price = \$2.60)

Option pricing

Factors affecting option prices

Option prices depend on S , X , T , σ^2 , r , D

	Call option	Put option
Stock price (S)	+	-
Exercise price (X)	-	+
Time-to-maturity (T)	+	+
Stock volatility (σ)	+	+
Interest rate (r)	+	-
Dividends (D)	-	+