# Introduction to Options

BUSS386. Futures and Options

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# Lecture Outline

- Introduction to Options
  - Terminology in option contracts
  - Payoff and profit

# Type of Derivatives - Review

- Depending on contract types, there are different types of derivatives.
  - Futures
  - Forward
  - Swaps

    :: Buyer of the contract has an **obligation** to trade.
  - Options

    :: Buyer of the contract has a **right** to trade.

# What Are Options?

Def. Option is a **contract** that gives an option-holder (or contract buyer) the **right to buy/sell** an asset in the future for a certain price.

- Comparison to forward
  - Option is similar to forward in that it is a contract to buy/sell an asset in the future.
  - A main difference is that the **buyer of option has the right** to buy/sell as opposed to the obligation in forward contract.
    - Thus, an option buyer can **choose** whether or not to exercise the contract.
  - In contrast, the **seller of option has the obligation** to follow what the buyer decides.

# Options - Terminology

- Strike (or exercise) price: the promised price to trade.
- Expiration (or maturity) date: the last date that option can be exercised.
- Option price (or option premium): the price to buy the option contract
- Call vs. Put options
  1. Call option: Holder has the right to **buy** the underlying asset for a fixed price.
  2. Put option: Holder has the right to **sell** the underlying asset for a fixed price.

# Options - Terminology

- European v.s. American options
  1. European option: Option can be exercised **only on the expiration date**.
  2. American option: Option can be exercised **at any time up to the expiration date**.

- Long v.s. Short positions
  1. Long position: to buy an option (paying the option price)
     - A buyer has the right to exercise the contract.
  2. Short position: to sell an option (receiving the option price)
     - A seller needs to follow what the buyer decides.

e.g. Long position of June European call option on Microsoft stock with a strike price of \$95.

# Options - Example

Options on Microsoft stock with the expiration date of 19 February 2021

**Calls** for February 19, 2021

| Contract Name | Last Trade Date | Strike | Last Price | Bid | Ask | Change | % Change | Volume | Open Interest | Implied Volatility |
|---|---|---|---|---|---|---|---|---|---|---|
| MSFT210219C00185000 | 2020-10-09 3:28PM EDT | 185.00 | 36.86 | 36.85 | 37.55 | +4.86 | +15.19% | 7 | 165 | 37.85% |
| MSFT210219C00190000 | 2020-10-09 1:42PM EDT | 190.00 | 32.48 | 33.20 | 33.85 | +3.30 | +11.31% | 42 | 133 | 37.28% |
| MSFT210219C00195000 | 2020-10-09 2:39PM EDT | 195.00 | 29.15 | 29.75 | 30.25 | +2.95 | +11.26% | 10 | 84 | 36.54% |
| MSFT210219C00200000 | 2020-10-09 2:14PM EDT | 200.00 | 26.17 | 26.50 | 26.95 | +2.27 | +9.50% | 7 | 383 | 36.06% |
| MSFT210219C00205000 | 2020-10-09 2:24PM EDT | 205.00 | 23.10 | 23.45 | 23.95 | +2.30 | +11.06% | 35 | 787 | 35.79% |
| MSFT210219C00210000 | 2020-10-09 3:57PM EDT | 210.00 | 20.74 | 20.65 | 21.20 | +2.39 | +13.02% | 75 | 1,621 | 35.59% |
| MSFT210219C00215000 | 2020-10-09 3:58PM EDT | 215.00 | 18.32 | 18.10 | 18.60 | +2.42 | +15.22% | 192 | 8,760 | 35.26% |
| MSFT210219C00220000 | 2020-10-09 3:30PM EDT | 220.00 | 15.75 | 15.70 | 16.00 | +1.45 | +10.14% | 69 | 947 | 34.52% |
| MSFT210219C00225000 | 2020-10-09 3:59PM EDT | 225.00 | 13.85 | 13.65 | 14.05 | +1.90 | +15.90% | 12 | 974 | 34.63% |
| MSFT210219C00230000 | 2020-10-09 3:35PM EDT | 230.00 | 11.70 | 11.70 | 12.15 | +1.48 | +14.48% | 106 | 1,453 | 34.44% |
| MSFT210219C00235000 | 2020-10-09 1:11PM EDT | 235.00 | 10.00 | 10.05 | 10.40 | +1.00 | +11.11% | 7 | 1,257 | 34.15% |
| MSFT210219C00240000 | 2020-10-09 3:54PM EDT | 240.00 | 8.67 | 8.50 | 8.80 | +1.22 | +16.38% | 118 | 1,578 | 33.78% |
| MSFT210219C00245000 | 2020-10-09 3:15PM EDT | 245.00 | 7.25 | 7.20 | 7.55 | +0.65 | +9.85% | 29 | 3,109 | 33.78% |
| MSFT210219C00250000 | 2020-10-09 3:28PM EDT | 250.00 | 6.23 | 6.10 | 6.30 | +0.68 | +12.25% | 71 | 1,399 | 33.41% |
| MSFT210219C00255000 | 2020-10-09 3:17PM EDT | 255.00 | 5.30 | 5.15 | 5.45 | +0.63 | +13.49% | 12 | 5,358 | 33.66% |
| MSFT210219C00260000 | 2020-10-09 1:49PM EDT | 260.00 | 4.38 | 4.35 | 4.50 | +0.38 | +9.50% | 14 | 764 | 33.32% |
| MSFT210219C00265000 | 2020-10-09 1:49PM EDT | 265.00 | 3.73 | 3.65 | 3.90 | +0.23 | +6.57% | 23 | 873 | 33.62% |

[source: Yahoo finance ]

# Investment Using Options

- Suppose that we buy a February Microsoft call option with strike price of 220.
- Today, we pay the option price, \$15.75.
- On 19 February, the option payoff depends on the stock price then.
  1. What if stock price becomes 250?
     - Using the option, we can buy the stock for 220, when its market value is 250.
     - Exercise the option!
     - Option payoff = 250 - 220 = 30.
     - Profit including initial cost = 30 - 15.75 = 14.25 (Ignoring time value of money)

# Common types of exchange-traded options

- Stock options
  - Exchanges: CBOE, AMEX, PHLX, ISE (Nasdaq) etc.
  - Over 1000 different stocks
- Index options
  - DJ Industrial, S&P100, S&P500, Nasdaq 100, Russell 2000, etc.
- Foreign currency options (traded mainly on PHLX)
- Options on futures
  - Interest rates, agricultural, oil, livestock, metals, currencies, cryptocurrencies, and stock indices
  - Typically traded on same exchange as underlying futures contracts
- As for futures, exchange-traded options require margin to ensure performance

# Investment Using Options

2. What if stock price becomes 200?
   - Through the option contract, we buy the stock for 220, but its market value is only 200.
   - Do not exercise the option.
   - Option payoff $= 0$.
   - Profit including initial cost $= 0$ - 15.75 $=$ -15.75 (Ignoring time value of money)

- Option holders have the **right** to buy or sell the underlying asset. So they exercise the option only when the exercise results in a positive payoff.

# Investment Using Options - Example

- Suppose that we buy a February Microsoft put option with strike price of 195. Its option price is \$9.75.

Q1. If stock price on the expiration date is 210, would you exercise? What is profit?

Q2. If stock price on the expiration date is 180, would you exercise? What is profit?

# Option Payoff and Profit - General Result

- Consider a European call option with expiration date $T$ and strike price $K$.
- The option payoff for a long position will depend on the future stock price $S_T$ on the expiration date:

$$\begin{cases} \text{If } S_T \geq K, & S_T - K \\ \text{If } S_T < K, & 0 \end{cases}$$

- In short, the payoff for the long position in a European call is

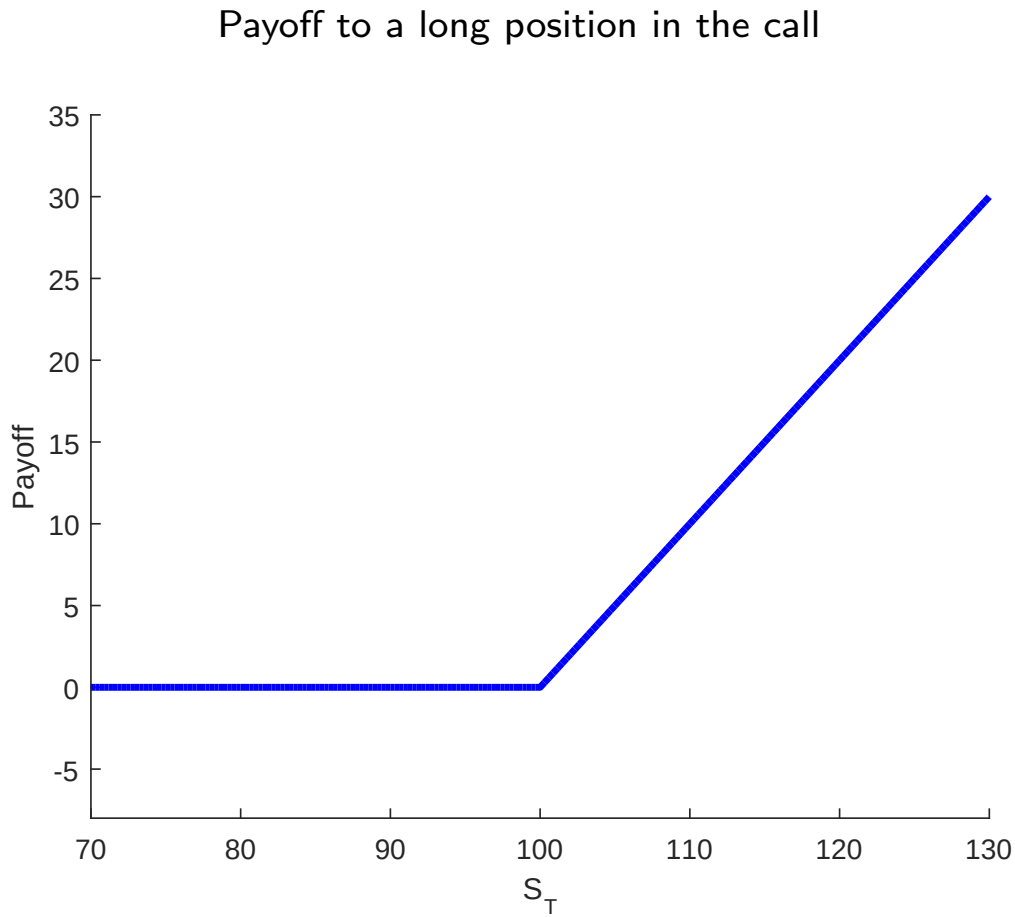
$$\max(S_T - K, 0)$$

- The option profit is a gain/loss considering the initial cost:

$$\text{profit} = \text{payoff} - \text{option price}.$$

# Option Payoff and Profit

e.g. Suppose that an investor buys a European call option on Microsoft shares with a strike price of \$100. The price of an option is \$5.




$$\text{Payoff} = \max(S_T - 100, 0)$$

# Option Payoff and Profit

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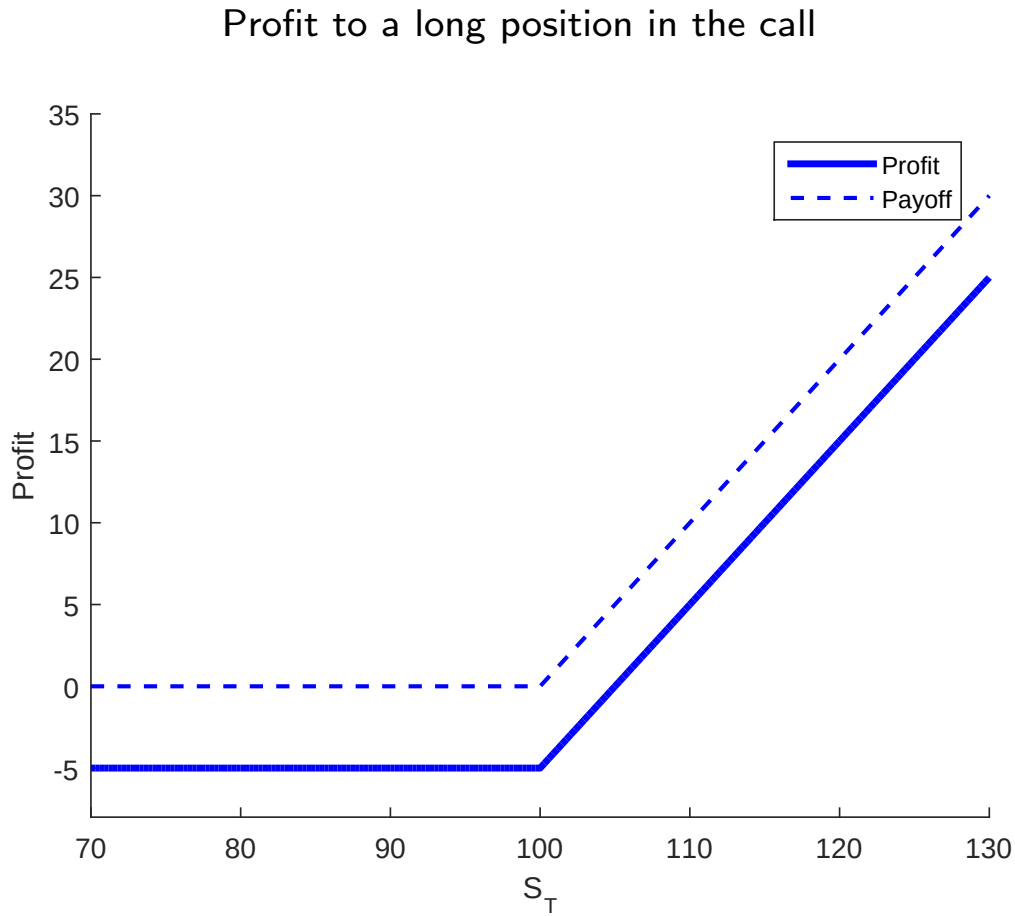



$$\text{Profit} = \max(S_T - 100, 0) - 5$$

# Option Payoff and Profit

- Consider a European put option with expiration date $T$ and strike price $K$.
- The option payoff for the long position will depend on the future stock price $S_T$ on the expiration date:

$$\begin{cases} \text{If } S_T \geq K, & 0 \\ \text{If } S_T < K, & K - S_T \end{cases}$$

- In short, the payoff for the long position in a European put option is

$$\max(K - S_T, 0)$$

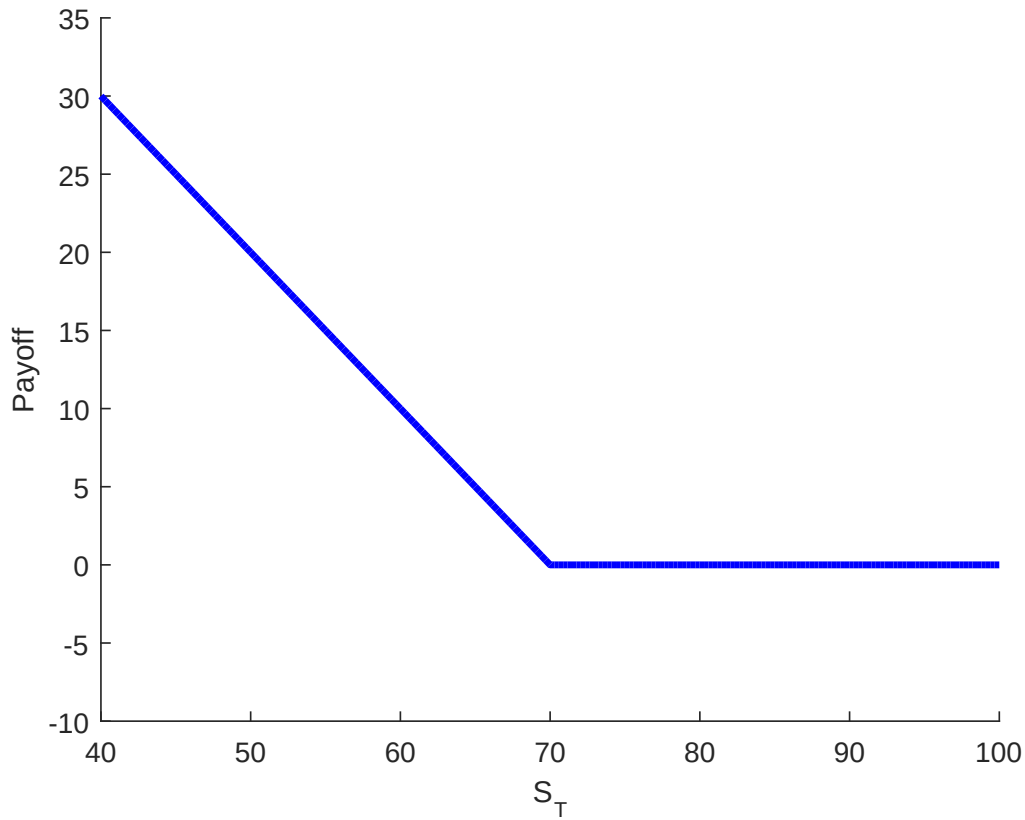
- The option profit is a gain/loss considering the initial cost:

$$\text{profit} = \text{payoff} - \text{option price}.$$

# Option Payoff and Profit

e.g Suppose that an investor buys a European put option with a strike price of \$70 to sell IBM shares. The price of an option is \$7.

Payoff to a long position in the put option.

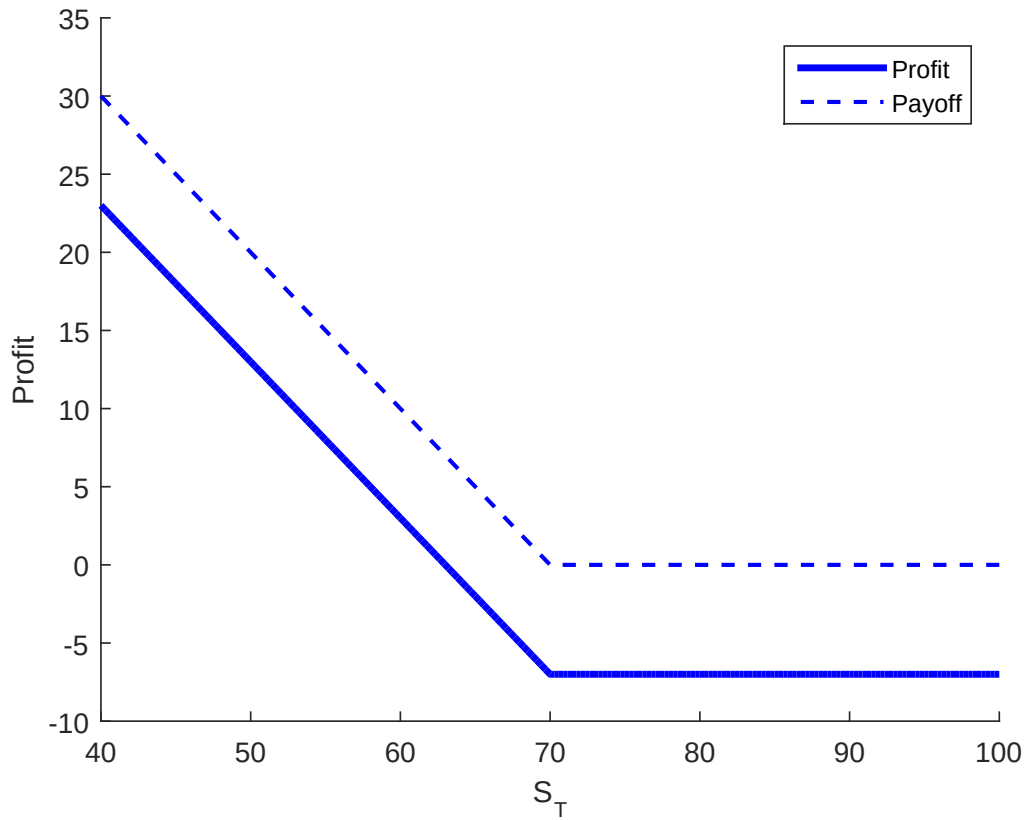



$$\text{Payoff} = \max(70 - S_T, 0)$$

# Option Payoff and Profit

e.g Suppose that an investor buys a European put option with a strike price of \$70 to sell IBM shares. The price of an option is \$7.

Profit to a long position in the put option.




$$\text{Profit} = \max(70 - S_T, 0) - 7$$

# Option Payoff and Profit

- We have looked at payoffs and profits for long positions in call/put options.
- Note that in profit diagrams, it is standard not to adjust for the time value of the upfront premium payment.
- The payoff for the short position is the opposite of long position.
- Payoff for the short position in a call option

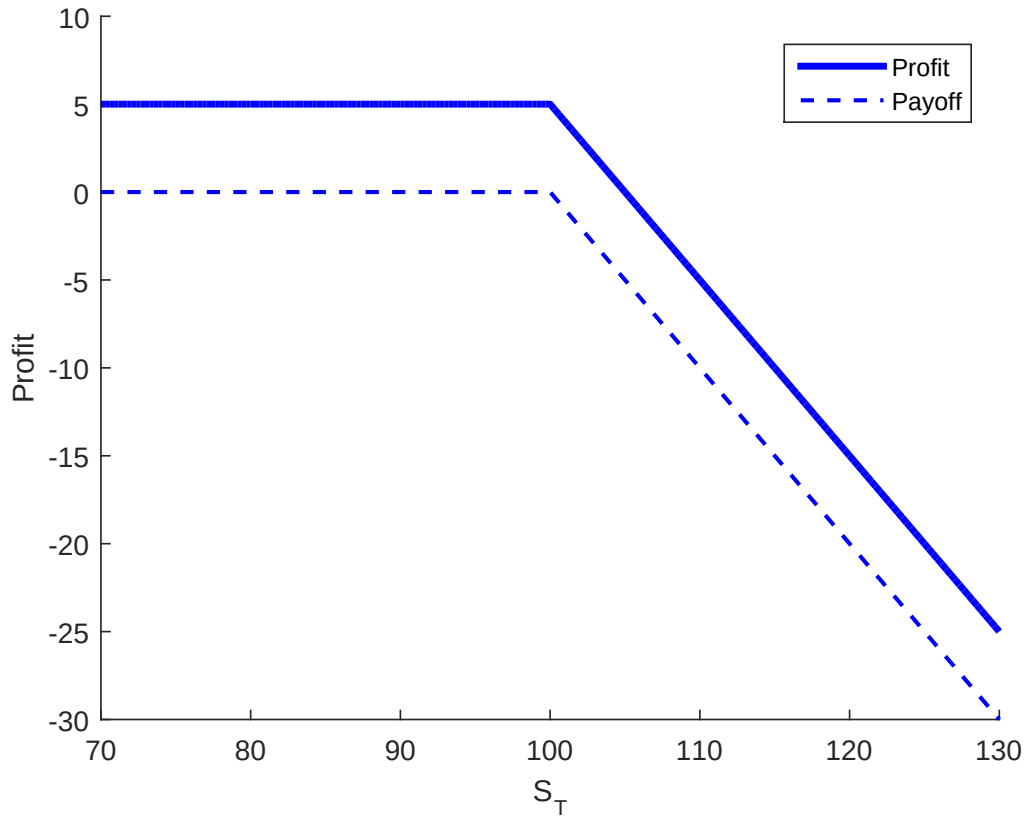
$$-\max(S_T - K, 0) = \min(K - S_T, 0)$$

- Payoff for the short position in a put option

$$-\max(K - S_T, 0) = \min(S_T - K, 0)$$

# Option Payoff and Profit

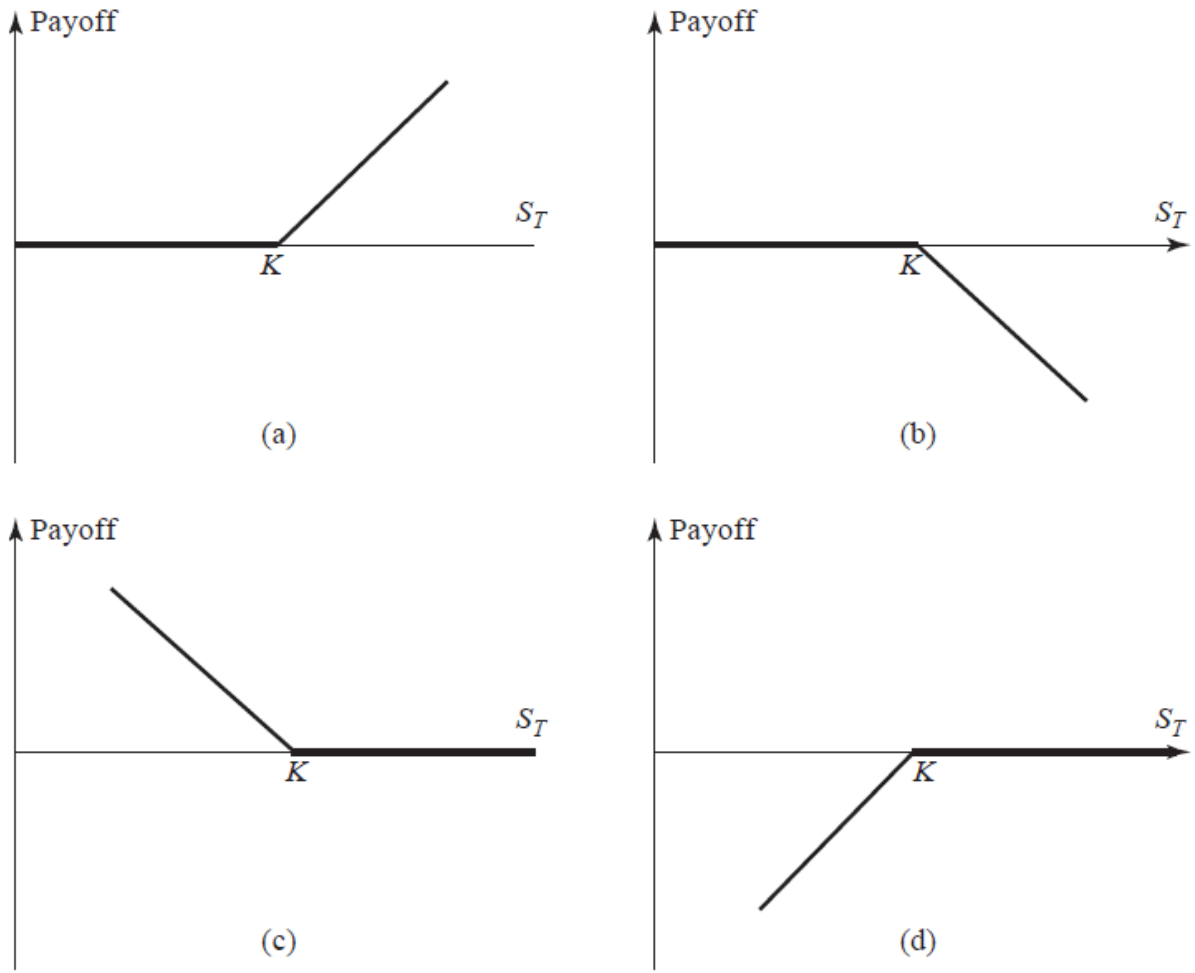
e.g Go back to the previous Microsoft call option with a strike price of \$100 and the option price of \$5. Payoff and profit to the option seller is as follows:




$$\text{Profit} = -\max(S_T - 100, 0) + 5$$

# Summary of Option Payoff

**Figure 9.5** Payoffs from positions in European options: (a) long call; (b) short call; (c) long put; (d) short put. Strike price = $K$; price of asset at maturity = $S_T$.



# More on Option Terminology

- In the money / At the money/ Out of the money
  - Options are referred to as in the money (out of the money), when they give positive (negative) payoff if exercised now.
  - They are at the money, when they give zero payoff if exercised now.

| | call | put |
|---|---|---|
| $S_t > K$ | in the money | out of the money |
| $S_t < K$ | out of the money | in the money |

- Intrinsic value

  = the maximum of zero and the payoff if options are exercised immediately.
  - Intrinsic value of call option $= \max(S_t - K, 0)$
  - Intrinsic value of put option $= \max(K - S_t, 0)$

# Exotic Options

- Asian Options
  - Payoffs depend on the average price of the underlying asset during at least some portion of the life of the option.
- Barrier Options
  - Payoffs depend on depend not only on some asset price at option expiration, but also on whether the underlying asset price has crossed through some "barrier."
- Lookback Options
  - Payoffs depend in part on the minimum or maximum price of the underlying asset during the life of the option.
- Digital Options
  - Fixed payoffs that depend on whether a condition is satisfied by the price of the underlying asset.