Lecture 20
Options and Futures

- Readings
  - BM, chapter 20
  - Reader, Lecture 20

Options and Derivatives

- A **derivative** is any security whose payoff derives from the value of another asset or security. For example,
  - **Futures Contract**: Agreement to buy or sell a fixed quantity of a commodity, financial asset etc. at a set price on a fixed date. Trades are made on organized futures exchanges.
  - **Forward Contract**: Identical in spirit to a futures contract, but trade is made directly with "counterparty" (such as a bank).
  - **American Option**: The right to buy (**call** option) or sell (**put** option) an underlying asset at a specified price (the **strike** price or **exercise** price) on or before the **expiration date**.
  - **European Option**: Same as an American except that it may only be exercised on the expiration date.

Derivatives and Risk: Hedging and Speculation

- Derivative securities are often considered very “risky”.
  - For example, a call option on a stock has a higher beta than the underlying stock.
  - Risk, however, can be good or bad, depending on application.
- **Hedging**: Derivative is used to offset risk of existing position, leading to lower net risk.
- **Speculating**: Derivative is used to increase risk, so that large gains are achieved when market moves “right” way.
  - Large loss occurs in opposite case.

Derivatives and Risk: Big losses 1 – Barings PLC

- In January 1995, Nick Leeson had losses of $320 million.
  - He had made huge bets on the direction of movements in the Nikkei index using futures contracts.
  - No oversight or controls to prevent this.
  - Nobody even knew (he'd set up dummy accounts to hide losses)
  - Bonuses based on performance, with no penalty for poor performance.
- He used "straddles" to bet Nikkei wouldn't move much.
  - Kobe earthquake hit on Jan. 17, 1995.
  - Leeson's losses were $1.3 billion by Feb. 23.
  - No more bank.

Derivatives and Risk: Big losses 2 – Orange County

- In Nov. 1994, WSJ printed a long article about how municipalities (inc. Orange County) were "lowering their borrowing costs" by using derivatives.
  - Robert Citron (Orange County treasurer) had invested in a lot of "inverse floaters".
    - » Payments rise as interest rates fall.
  - Interest rates rose…
  - Investment pool lost $1.64 billion in December 1994.
  - Much of this was recovered in settlements with financial institutions (esp. Merrill Lynch). Arguments included:
    - » Investors were "unsophisticated".
    - » Risks were not adequately disclosed.
    - » Investments violated California constitution.

Derivatives and Risk: Lessons from big losses

- Anything that looks like a free lunch ("borrowing costs are low as long as rates fall…") almost certainly has a catch.
- Derivatives make it very easy to take big risks, which may not be well understood.
  - Trading in derivatives needs to be accompanied by adequate monitoring and control.
  - Complex derivatives need to be well explained to unsophisticated investors.
    - » Need separate application to trade options at Schwab or E-Trade.
- **Key point:** (Almost) anything we can do with a derivative we can also do with the underlying asset directly.
  - This fact allows us to price derivatives relative to underlying asset.
  - Derivatives just make it easier to make large changes in risk exposure than trading in huge quantities of the underlying asset.

Hedging with Futures: Farmer Example

- A farmer plants corn today, to sell in 9 months.
- Without hedge, profits depend on market price 9 month later, for good or bad. Or…
- Solution 1: The farmer sells **corn futures** today, in order to **hedge market price risk**:
  - This commits the farmer to sell a certain amount of corn in the future, but at a price determined today.
  - Actual market price 9 months later then does not affect profits.

Hedging with Options: Farmer Example

- Solution 2: The farmer buys a **put option** on corn, with an exercise price equal to the minimum acceptable price for the crop.
  - This provides farmer the option to sell at this price.
  - The put option is thus an insurance policy that guarantees a floor below which the price will never fall.
  - If actual market price turns out to be higher, then let option expire unused.
- The amount paid for the option – called the **option premium** – is the insurance premium.

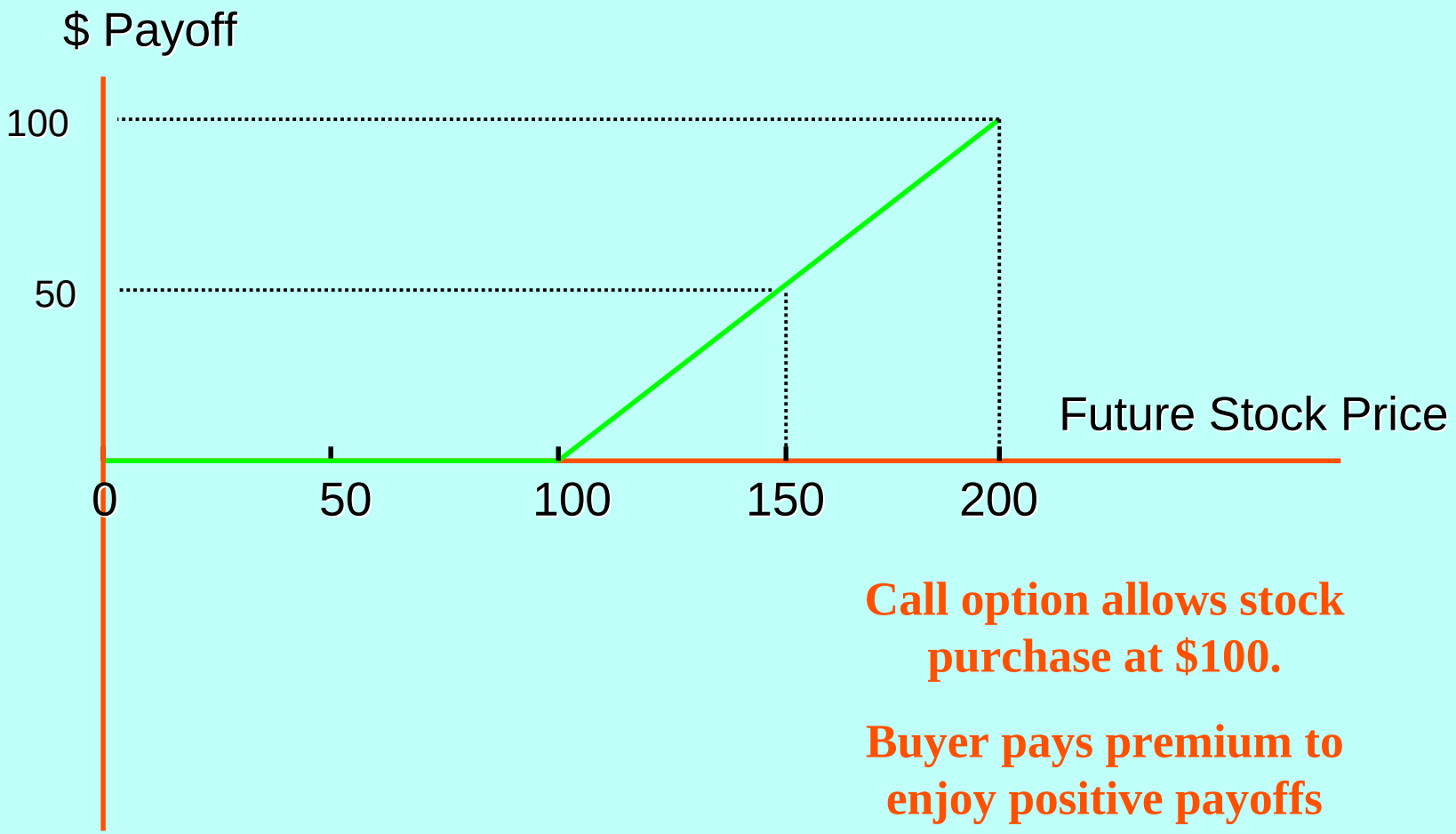
Options: Other Examples

- Holders of **convertible preferred stock** and **bonds** have the option to convert their securities into common stock.
- **Warrants** are sometimes issued with other securities.
  - Warrants give the holder the right to buy a specified number of shares at a specified price
- Many companies offer some compensation in the form of **employee stock options.**
- Most corporate bonds are **callable**
  - Issuing firm can "call" its debt by paying strike price (usually slightly above the par value).
- Mortgage loans usually have a **refinancing option**
  - Borrower can pay off existing loan with proceeds of new loan
- Common stock = call option on assets of firm

Option Terminology

- Strike Price: the price at which the option holder can purchase the stock (or other underlying asset).
- Expiration Date: the final date at which the option can be used.
- Exercising an Option: to use the option to purchase stock.
- Four option positions:
  - Call option buyer or seller
  - Put option buyer or seller
- For lots of information on options, see CBOE Web page, http://www.cboe.com/education.

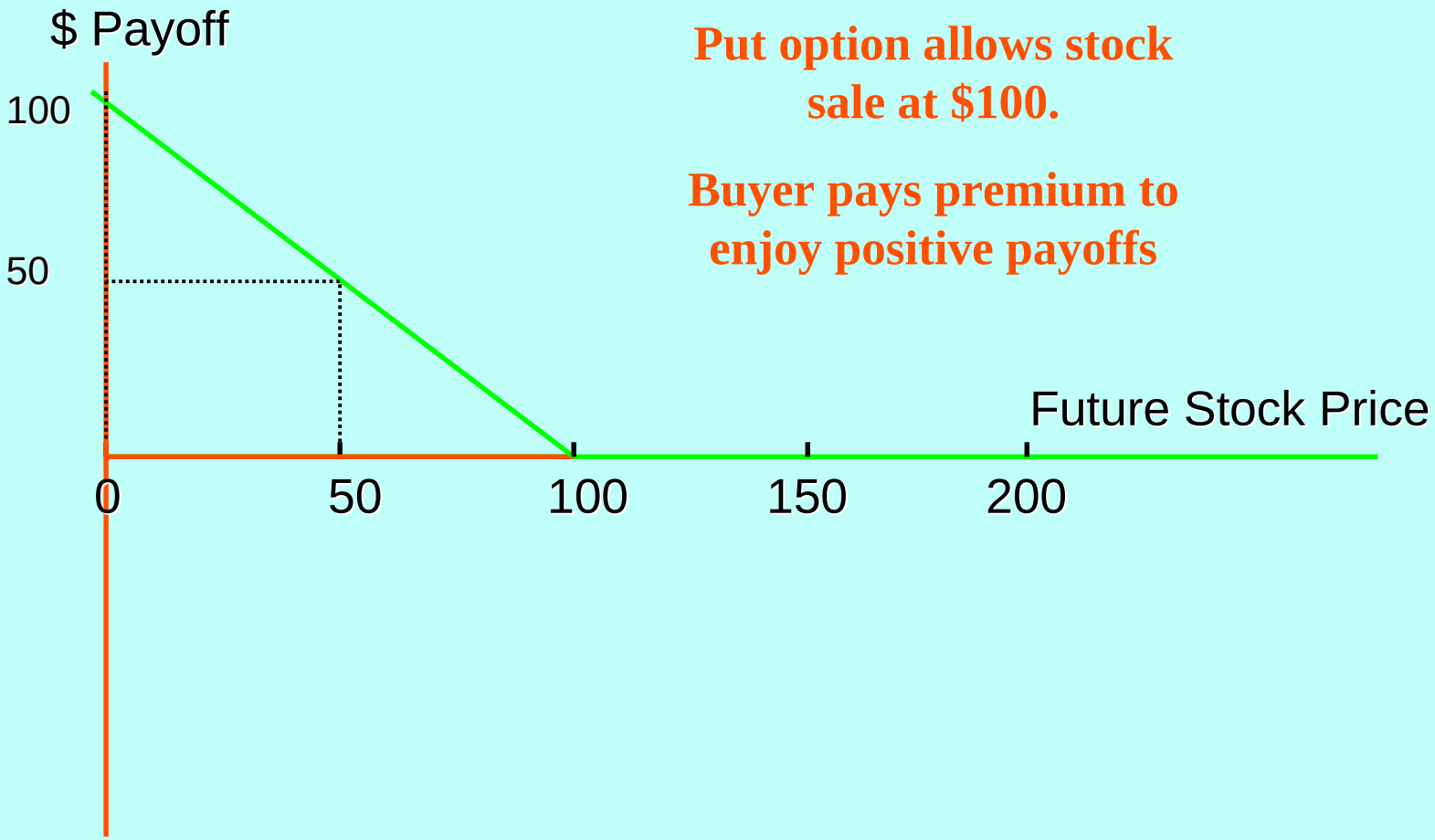
Call Buyer Payoff At Expiration Date, Strike Price = 100



Call option allows stock purchase at $100.

Buyer pays premium to enjoy positive payoffs

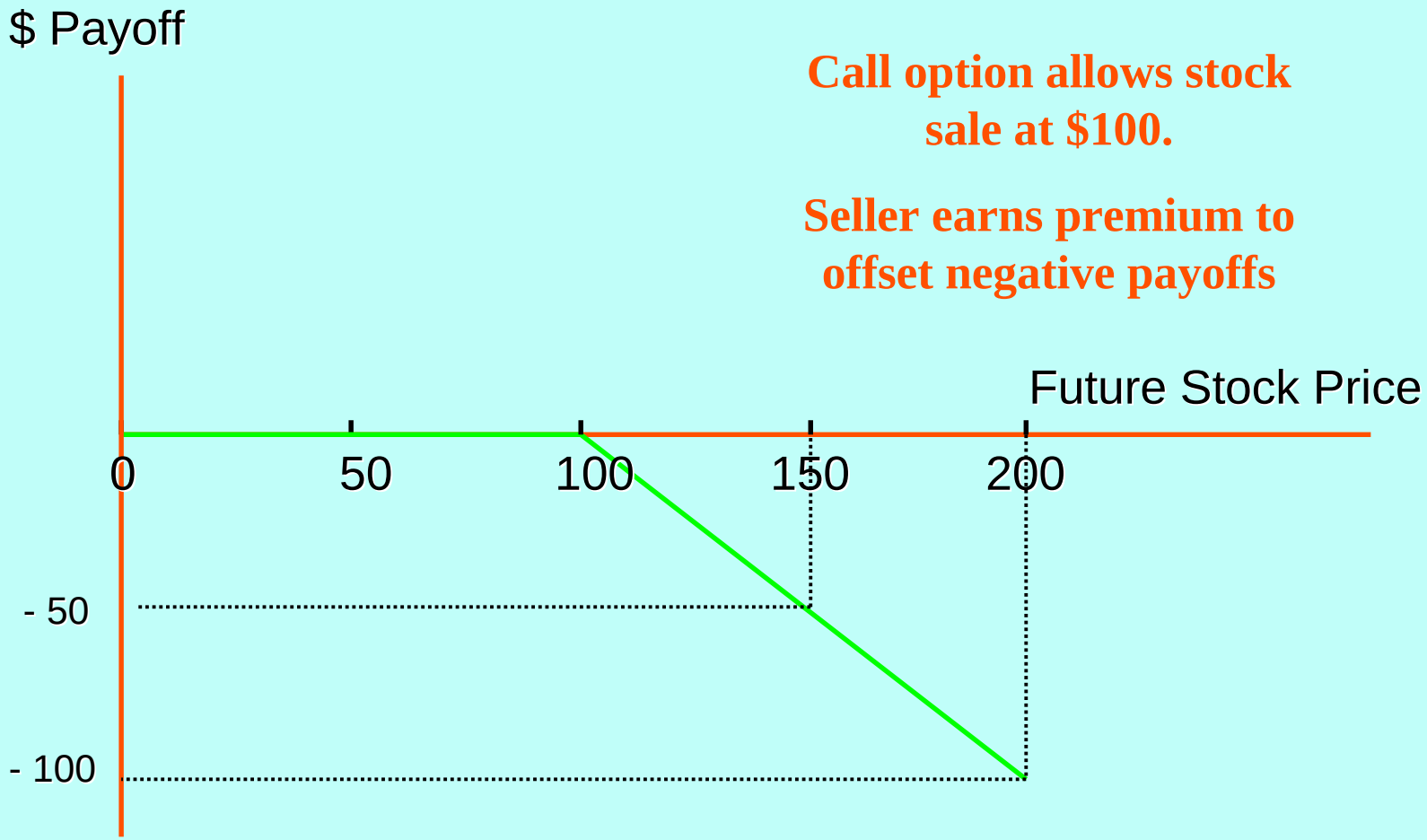
Put Buyer Payoff At Expiration Date, Strike Price = 100



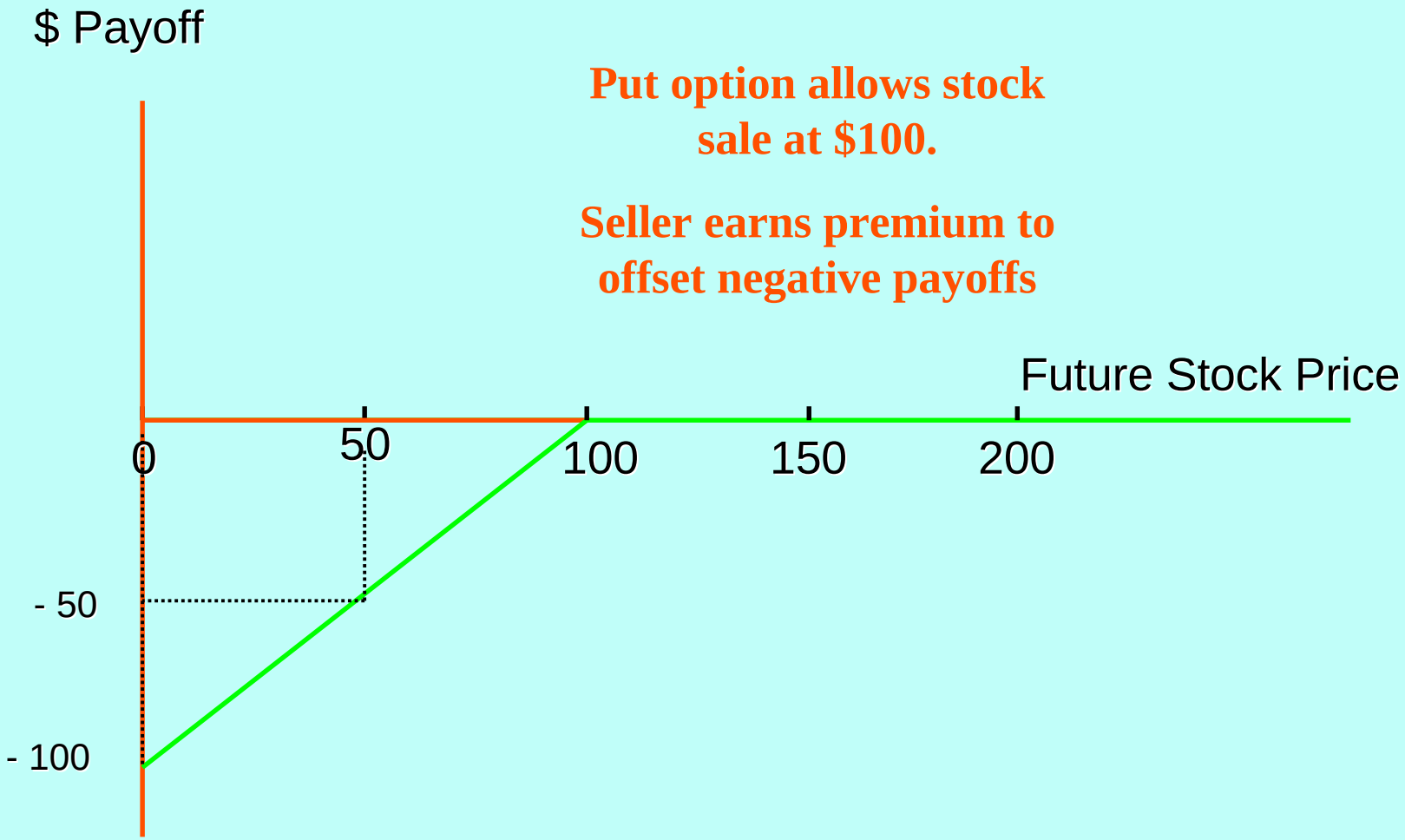
Put option allows stock sale at $100.

Buyer pays premium to enjoy positive payoffs

Call Seller Payoff At Expiration Date, Strike Price = 100



Put Seller Payoff At Expiration Date, Strike Price = 100



Option Payoffs

- These payoffs can be written in the form:

Call: $C^* = \text{Max}[0, S^* - K]$

Put: $P^* = \text{Max}[0, K - S^*]$

where S^* = underlying asset price at expiration

K = exercise price

Option Exercise Strategy at Expiration Date

- The current market price of a stock is $100. You hold an expiring option. Should you exercise it, if…
- It is a call option with exercise price $90?
  - Answer: Always exercise "**in the money**" option at expiration.
  - What is the option's payoff?
- It is a put option, with exercise price also $90?
  - Answer: Never exercise "**out of the money**" option at expiration.
- It is a call option, with exercise price $120?
  - Answer: Never exercise "**out of the money**" option at expiration.
- It is a put option, with exercise price of $120.
  - Answer: Always exercise "**in the money**" option at expiration.

Relationship between Put and Call Values

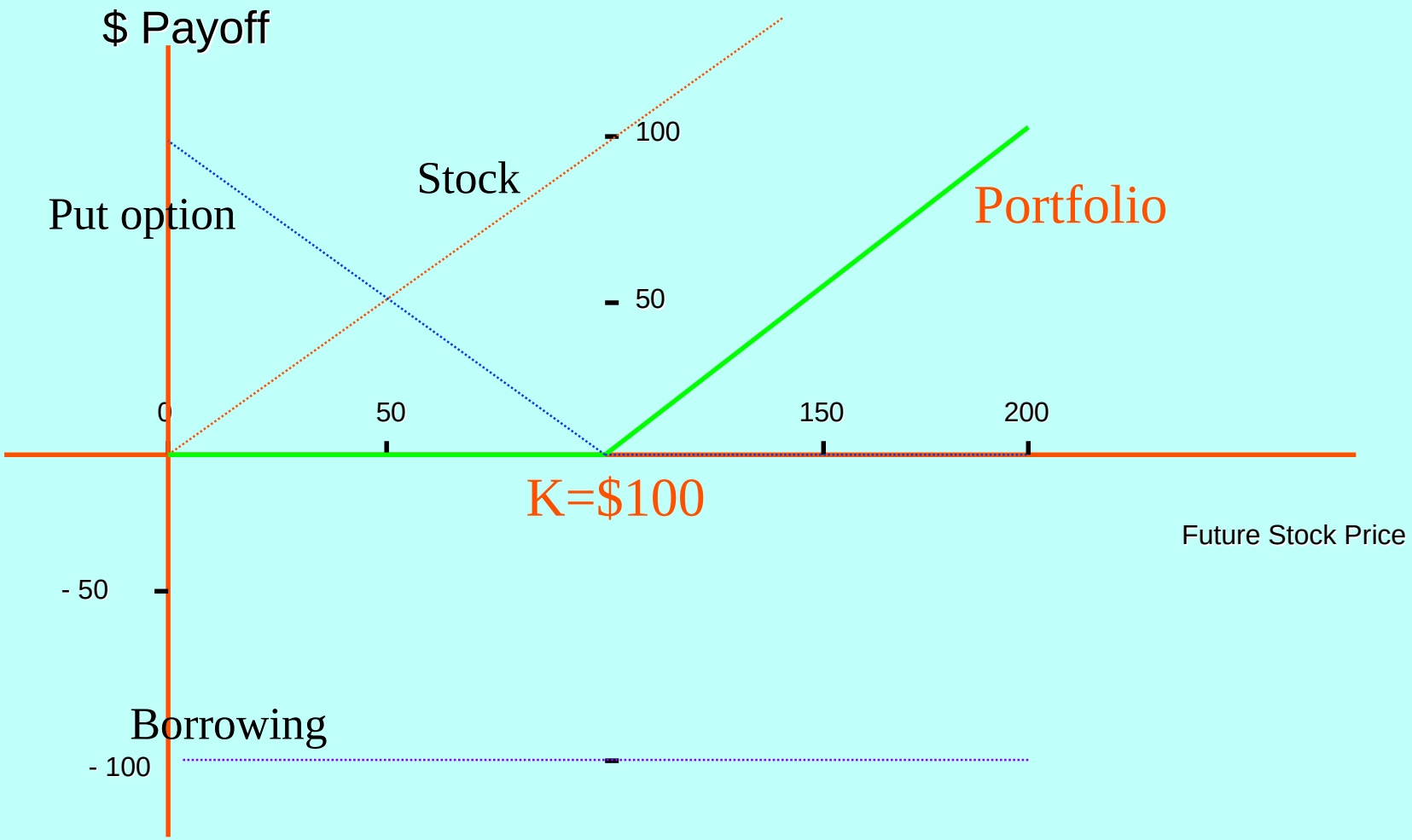
- Suppose a stock pays no dividends, and that the riskless interest rate is r.
- What are the payoffs in one year from the following investment strategy:
  - Buy one share.
  - Buy a European put option with exercise price K.
  - Borrow the present value of K.

Payoffs from Portfolio

	Present Date	Expiration Date $S^* < K$	Expiration Date $S^* > K$
Buy stock	- S	S*	S*
Buy Put	- P	K - S*	0
Borrow	K/(1+r)	- K	- K
Total	- S - P + K/(1+r)	0	S* - K

- What does this payoff look like?

Payoff to Portfolio on Expiration Date ($K \equiv 100$)



Put-Call parity

- The payoff of the portfolio is identical to that of a European call option.
- The price of the call option must therefore equal the total cost of the portfolio, i.e.

$$C = S + P - K / (1+r)^T$$

- This is called **Put-Call parity**.

Early Exercise

- Put-call parity gives us an important result about exercising American call options.

$$\begin{aligned} C &= S + P - K/(1+r)^T \\ &\geq S - K/(1+r)^T \\ &> S - K. \end{aligned}$$

- In words, the value of a European (and hence American) call is strictly larger than the payoff of exercising it today.