Session 22: Options I

Fall 2025

Outline

- Option contract
- Option valuation on expiration date
- Option strategies

Derivatives

- A *derivative* is a security with a payoff that depends on the price of another security
- The other security is called the *underlying* (security)
- Examples: options, futures, swaps
- Derivatives are used for
  - Risk management, hedging
  - Executive compensation
  - Speculation

Option Terminology

- Option types
  - *Call* option: *right* to *buy* underlying
  - *Put* option: *right* to *sell* underlying
- At *exercise price* or *strike price*
- At (or before) *expiration* (European vs. American)
- *Price* or *premium*
- *In-the-money*, *out-of-the-money*, *at-the-money*

Value of Options at Expiration

- At expiration (time T), if the stock price is S_T, a call option with strike price X is worth:

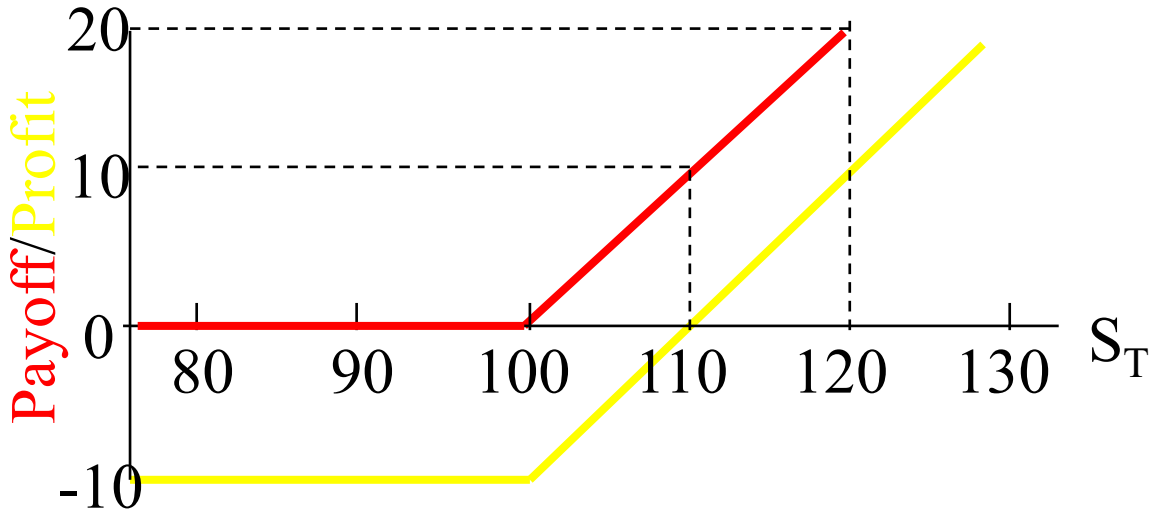
$$C_T = \begin{cases} S_T - X & \text{if } S_T > X \\ 0 & \text{if } S_T \leq X \end{cases}$$

- At expiration (time T), if the stock price is S_T, a put option with strike price X is worth:

$$P_T = \begin{cases} 0 & \text{if } S_T \geq X \\ X - S_T & \text{if } S_T < X \end{cases}$$

Value of Call at Expiration

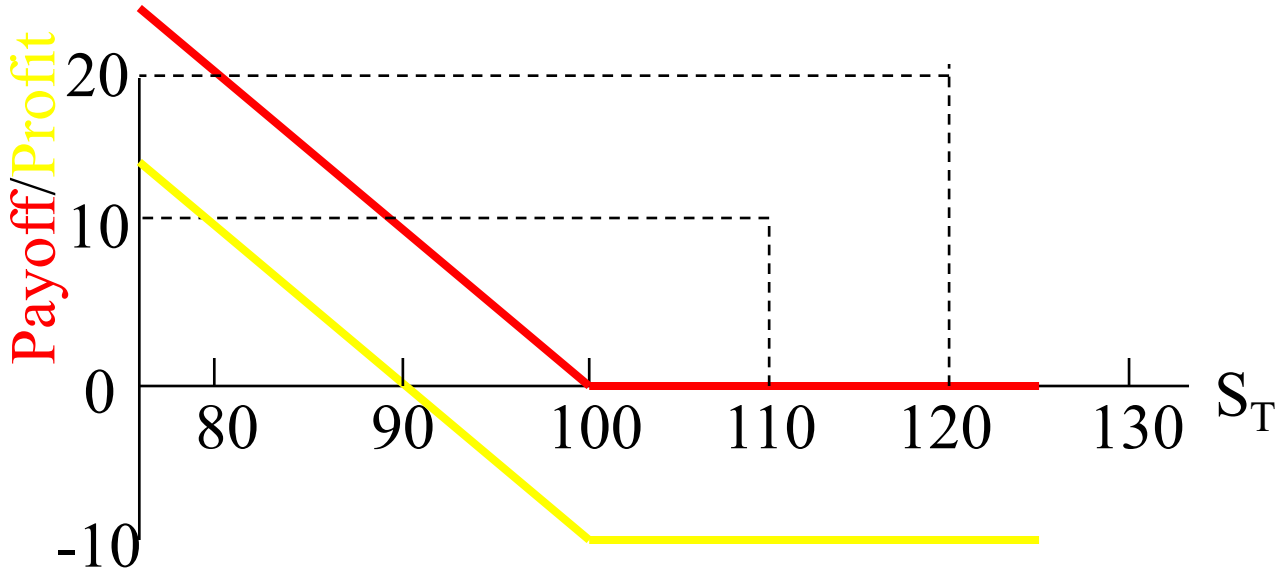
Payoff and net profit: call option with a strike/exercise price of X=$100 and premium of $10



S_T	80	90	100	110	120	130
Payoff	0	0	0	10	20	30
Profit	-10	-10	-10	0	10	20

Value Put at Expiration

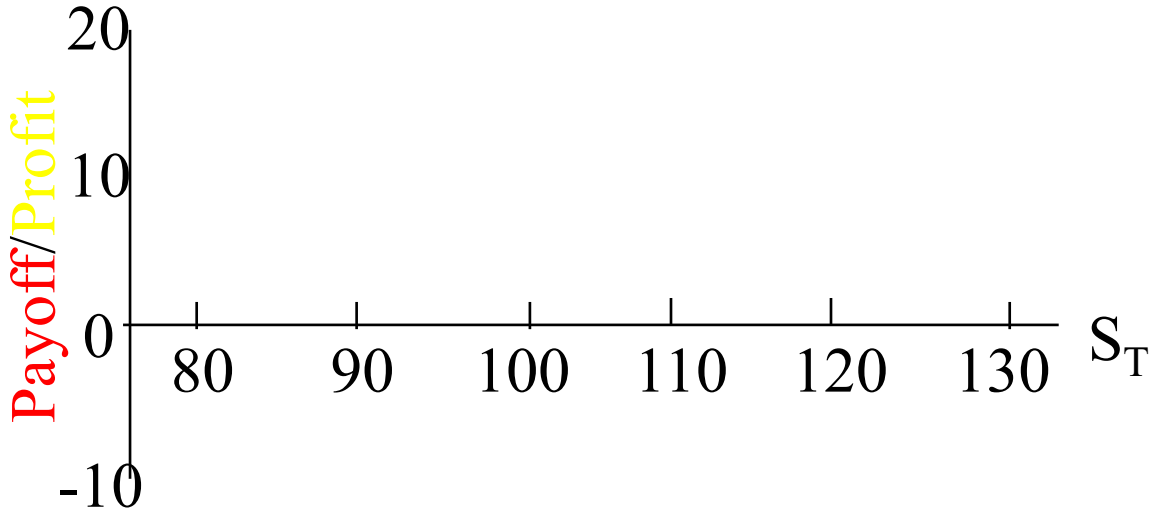
Payoff and net profit: call option with a strike/exercise price of X=$100 and premium of $10



S_T	80	90	100	110	120	130
Payoff	20	10	0	0	0	0
Profit	10	0	-10	-10	-10	-10

Value Short Call at Expiration

Determine payoff and net profit: *short* a call with a strike of X=$100 and premium of $10



S_T	**80**	**90**	**100**	**110**	**120**	**130**
Payoff						
Profit						

Option Strategies

1. Using calls for leverage
2. Protective put
3. Straddle
4. Covered call, collar, bull spread, bear spread, butterfly spread,…

1. Call Options for Leverage

- Example
  - Microsoft share price is S_0=\$70
  - A call option with X=\$70 and 6-month maturity costs C_0=\$10
- What is the payoff to investing \$7000
  A. Buy 100 shares of Microsoft
  B. Buy 700 call options with X=\$70

S_T	**60**	**65**	**70**	**75**	**80**	**85**	**90**
Payoff A:	__	__	__	__	__	__	__
Payoff B:	__	__	__	__	__	__	__

2. Protective Put

You buy a share in Microsoft for S_0=\$70. You are afraid that the stock price will drop. How do you limit your possible losses by trading options?

S_T	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Stock	40	50	60	70	80	90	100
Put (X=70)	30	20	10	0	0	0	0
Total Payoff	70	70	70	70	80	90	100

This payoff is the same as that of a long call with X=70 + a bond with a face value of 70!

3. Straddle

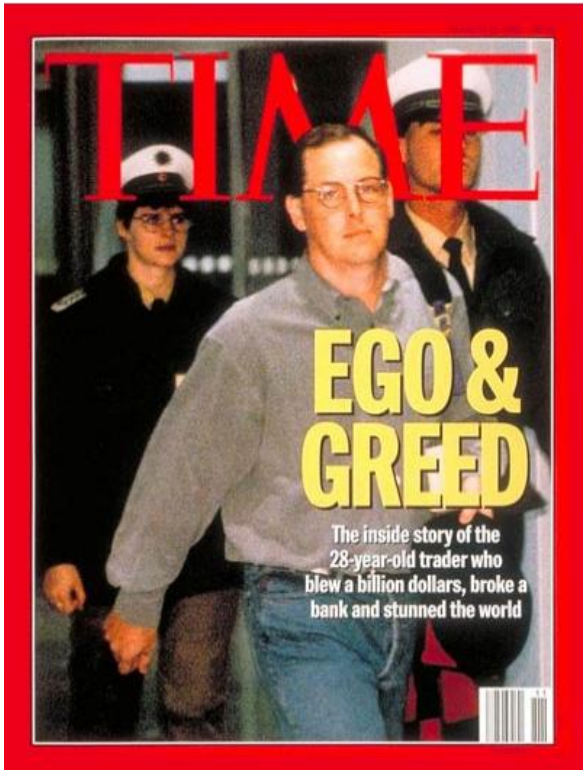
You believe that a stock's price will change dramatically soon (S_0=\$60), but you do not know if it will go up or down. So you buy

- Put (X=60) + Call (X=60)

S_T	30	40	50	60	70	80	90
Call	0	0	0	0	10	20	30
Put	30	20	10	0	0	0	0
Total	30	20	10	0	10	20	30

- Strangle: Put (X=55) + Call (X=65)

Nick Leeson



On January 16, 1995, Nick Leeson placed a **short straddle** on the Singapore and Tokyo stock exchanges, essentially betting that the Japanese stock market would not move significantly overnight. However, the Kobe earthquake hit early in the morning on January 17, sending Asian markets, and Leeson's investments, into a tailspin.

After further losses, Leeson left a note reading "I'm sorry" and fled on February 23. Losses eventually reached £827 million (US$1.4 billion), twice the bank's available trading capital. After a failed bailout attempt, Barings was declared insolvent on February 26.

http://en.wikipedia.org/wiki/Nick_Leeson

Option Strategies

1. Calls for leverage
2. Protective put = stock + put
3. Straddle (strangle) = ATM (OTM) put + ATM (OTM) call
4. Covered call = stock + short call
5. Collar = stock + put + short call
6. Bull spread = call(X_1) + short call(X_2) $X_1<X_2$
7. Bear spread = call(X_2) + short call(X_1) $X_1<X_2$
8. Butterfly spread = call(X_1) + 2*short call(X_2) + call(X_3) $X_1<X_2<X_3$

Conclusion

Options are a right, NOT an obligation

- Interesting (convex) payoff function
- The possibility of designing “customized” strategies

Assignments

- Reading
  - BKM: Chapters 16.1, 16.2
  - Problems: 16.1
- Assignments
  - Problem Set 6 due 1st December