

Options Part 2

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Vanilla vs Exotic

- ▶ Options come in a lot of different varieties: European, American, Asian, digital, look-back, etc.
- ▶ European and American options are considered the simplest and for that reason they are collectively referred to as *vanilla* options.
- ▶ All other options are considered more complicated and are therefore referred to as *exotic*.
- ▶ Vanilla options are transacted more than exotic options.
- ▶ In this class we will focus on vanilla options.

American Options as Insurance

- ▶ American (equity) options are insurance contracts that have as their underlying publicly traded stocks.
- ▶ They are called *options* because owning them gives you a right to do something, but you are **not required** to exercise that right.
- ▶ You have the *option* exercise, if it happens to be beneficial to you.
- ▶ This *right with out obligation* has the effect of creating an insurance benefit.

American Options as Insurance

- ▶ American options come in two varieties: **puts** and **calls**.
- ▶ **Put** contracts are insurance for entities that already own the underlying stock.
 - ▶ Puts protect them from the event that the value of their stock falls.
- ▶ **Call** contracts are insurance for entities that are thinking about buying the stock in the future.
 - ▶ Calls protect them from the event that the price of the stock rises before they've had a chance to buy it.

American Options as Insurance

- ▶ In reality, you don't have to purchase puts or calls as insurance.
- ▶ You don't have to already own the underlying buy puts, nor do you have to intend to buy the underlying to buy calls.
- ▶ You can buy and/or sell either contract freely to express different views on the underlying.

American Option Contract Specification

- ▶ Let's consider American options on some stock S .
- ▶ Puts and calls on S are defined by two contract features: the **strike price** and the **expiration date**.
- ▶ **Call:** is the right, but not the obligation, to **buy** a share of S at the strike price at any time before the expiration date.
- ▶ **Put:** is the right, but not the obligation, to **sell** a share of S at the strike price at any time before the expiration date.

Option Buyers and Option Sellers

- ▶ There are two sides to any options transaction
- ▶ The option buyer, pays premium and owns a right.
- ▶ The option seller, receives premium and obligated to respect the option buyer's right.
- ▶ Put: if the option buyer exercises their right to sell the underlying, the option seller must buy the underlying from them.
- ▶ Call: if the option buyer exercises their right buy the underlying, the options seller must sell the underlying to them.

SPY Option Example - Context

- ▶ Ruobing has purchased an call on SPY, with a strike price of \$250. He paid \$10 in premium.
- ▶ Farez was the option seller on this transaction.
- ▶ It's now the final day of the contract and Ruobing has still not exercised his right.

SPY Option Example - Exercises

1. Under what circumstances will Ruobing choose to exercise his right?
2. Under what circumstances does Ruobing make money?
3. Under what circumstances does Farez make money?
4. What are the min and max of Ruobing's PNL?
5. What are the min and max of Farez's PNL?
6. Answer the same questions for a put with the same strike, expiration, and premium.

American vs European

- ▶ European options are very similar to American options.
- ▶ The only difference is that with a European options you can only exercise your right immediately after the final trading day of the contract.
- ▶ With American options you can *early exercise* anytime before the expiration.
- ▶ **European** options have an **exercise date (point)**.
- ▶ **American** options have an **exercise window**.

American vs European

- ▶ **Fact:** It is never optimal to early exercise an American call, and it is almost never optimal to early exercise an American put.
- ▶ **Corrollary:** In this class will consider American and European options to be the same. (Only the most pedantic of quants will take issue with this.)
- ▶ The notion of a *payoff function* of an American option will be based around the right to exercise at the time of expiration.

Option Payoff Functions (1 of 4)

- ▶ Suppose the current time is t .
- ▶ Consider a put and call on the same underlying stock, both with expiration $T > t$.
- ▶ Suppose they both have strike K .
- ▶ Let S_T be the price of the stock at the time of expiration.
- ▶ Let π_p be the put buyer's payoff, and let π_c be the call buyer's payoff.

Option Payoff Functions (2 of 4)

- ▶ Put Buyer Payoff: $\pi_p(S_T) = \max\{(K - S_T), 0\}$
- ▶ Call Buyer Payoff: $\pi_c(S_T) = \max\{(S_T - K), 0\}$
- ▶ **Exercise:** convince yourself that the above is true given the contract specification of vanilla puts and call.
- ▶ **Exercise:** graph π_p and π_c as a function of S_T .
- ▶ **Exercise:** Write the expressions for seller's payoff of both puts and calls. Draw the graphs.

Option Payoff Functions (3 of 4)

- ▶ Consider π_c and π_p as functions of $S_T \in (0, +\infty)$.
- ▶ Both functions are differentiable at all points except for $S_T = K$.
- ▶ **Exercise:** What are the two values of $\frac{d\pi_c}{dS_T}$?
- ▶ **Exercise:** What are the two values of $\frac{d\pi_p}{dS_T}$?

Option Payoff Functions (4 of 4)

- ▶ Let's say it's time $t < T$, and S_t is the current price of the stock.
- ▶ **Exercise:** If you own the put, what inequality to you have is true between S_t and S_T . What inequality do you hope holds true between S_T and K ?
- ▶ **Exercise:** If you own the call, inequality do you want to hold true between S_t and S_T ? How about between S_T and K ?

Trader Talk: *Long vs Short*

1. Google the meaning of “long” and “short” the way that traders use the words.
2. If you buy a put, are you long or short the underlying?
3. If you sell a put, are you long or short the underlying?
4. If you buy a call, are you long or short the underlying?
5. If you sell a call, are you long or short the underlying?