Andreas Krause

Put-Call parity

- It is common in option theory to focus most attention on call options only, rather than put options.
- We will here use the ideas to develop an option strategy that shows how call and option values are related.

Option payoffs at maturity

- → We compare the payoff of different combinations of options and the underlying asset at the maturity of the options.
- ▶ We can use combination of options and the underlying asset to generate different pay-off profiles.
- ▶ We know that hedging a long position in the underlying asset by buying a put option is equivalent to a call option.
- ▶ We can use this strategy to of underlying asset and put option to obtain a call option.
- → We thus have created a connection between the put and the call option.

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Hedging with a put option

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- → We graphically can show how this call can be created.
- We look at the profits that on investor obtains for different values of the underlying asset.
- Firstly, we select a strike price.
- Relative to the strike price, we see that the underlying asset generates profits the higher its value is.
- The investor now buys a put option with this specified strike price.
- Combining these two positions gives us a covered put.
- This covered put has the same characteristics as buying a call option.
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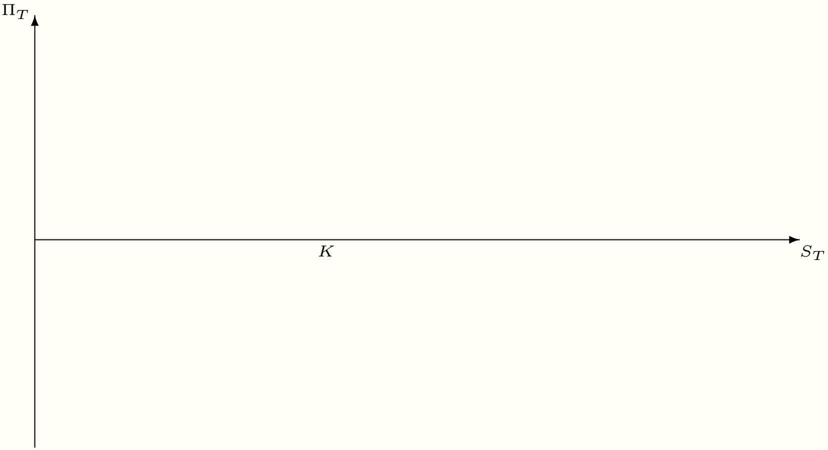

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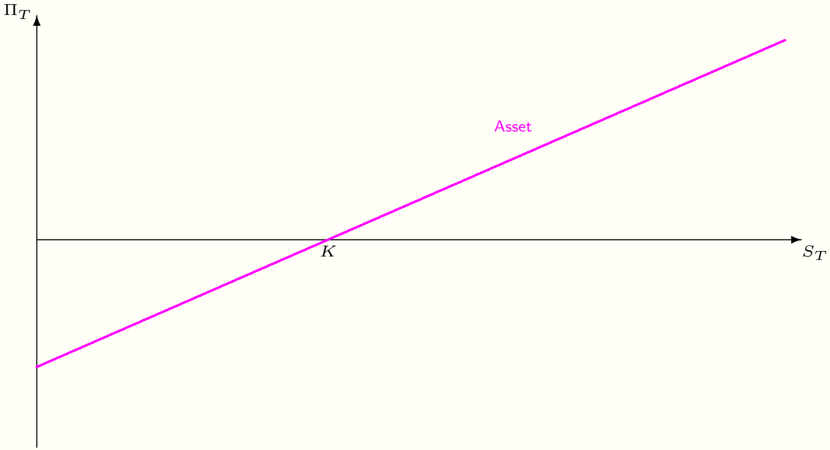

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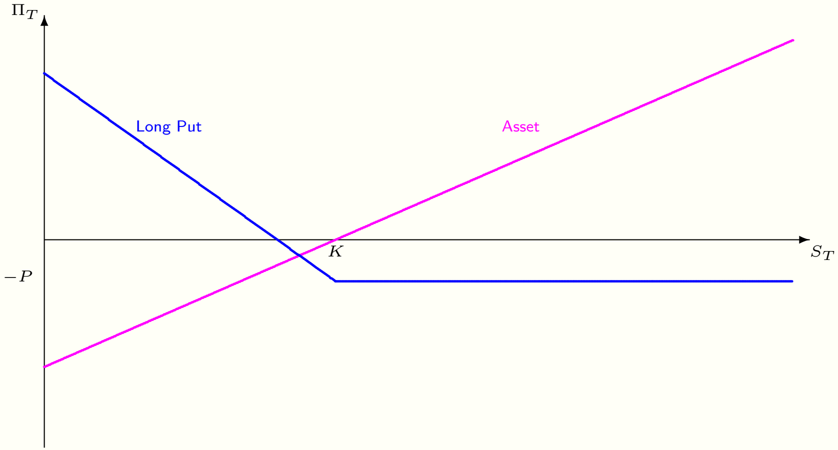

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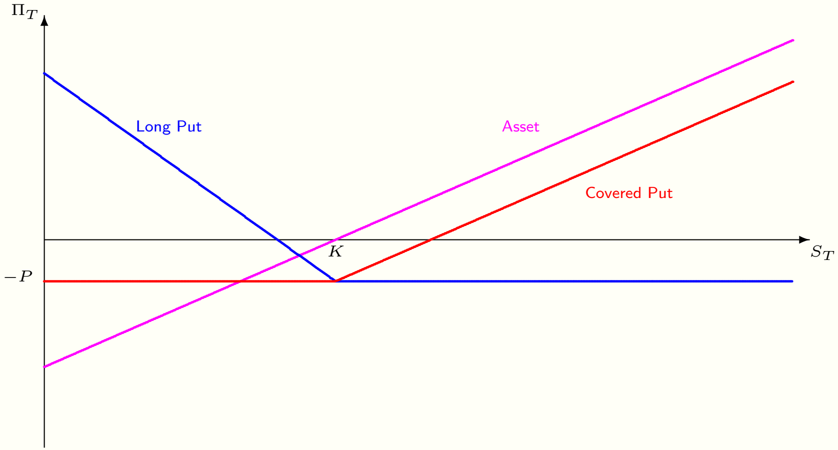

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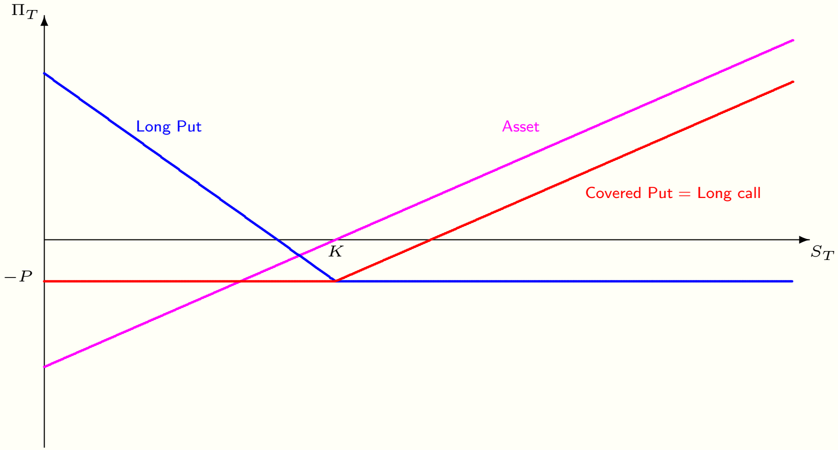

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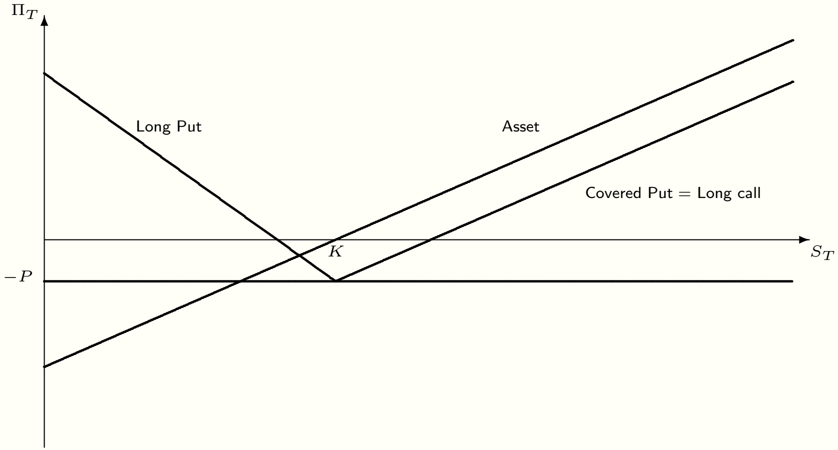

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Investment strategies

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→ We now compare the investment strategies with options in more detail and look at the values at maturity of the option.

- The underlying asset will give its value at the time of maturity.
- The call option will give the difference to the strike price, provided it is positive and zero otherwise as then the option is not exercised.
- The put option will give the difference to the strike price, provided it is positive and zero otherwise as then the option is not exercised. The sign will be different to that of a call option as a put option gives the right to sell the underlying asset, while a call option gives the right to buy.
- In addition we have available a risk free asset that pays some interest.

→ We can now look at the details of the investment strategies required to established the relationship between the value of call and put options.

Investment strategies

- We can invest into the underlying asset and will always obtain the value at maturity of the option, S_T

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Comparing portfolio payoffs

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- We compare two portfolios and investigate the payoffs they generate at maturity of the options. With the payment from the options changing at the strike price, we will distinguish cases where the underlying asset has a value at maturity which is below and above the strike price.
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Portfolio A		
Initial investment	Payoff at maturity	
	$S_T < K$	$S_T \geq K$

Portfolio B		
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P	$K - S_T$	

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→ We can now use these two portfolios to establish the relationship between call and put values.

- - Regardless of the value of the underlying asset, the two portfolios have the same value at maturity of the options.
  - If they have the same value at maturity, they must have the same value before maturity to prevent arbitrage.

⇒ Using the initial values of the underlying asset, put option, call option and the investment into the risk-free asset, we set these two portfolio values equal and solve for the value of the put option.

- This formula is known as the Put-Call parity for European options. It applies to put and call options on the same underlying asset and the same strike price.

→ We have therefore established how put and call prices are related and knowing the value of one, allows us to determine the value of the other.

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Implications of the Put-Call parity

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→ We can now explore some implications of the Put-Call parity.

▶ Let us now assume that the strike price is equal to the current value of the underlying asset.

⇒
- Inserting this relationship into the Put-Call parity, we get this *formula*.
- It is immediately clear that this expression is smaller than the value of the call option.

▶
- If the strike price and the current value of the underlying asset are the same, at put option is wirth less than a call option.
- If the strike price is equal to the current value of the underlying asset, this is also known as at-the money; if the current value of a call option is above the strike price this is in-the money and if it is below the strike price it is ou-of money, for put options this is reversed.

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- This is because profits from put options are limited, given the lowest possible price of underlying asset is zero.
- The possible profits from a call are unlimited as the price increase of the asset is potentially unlimited.

⇒ Therefore, the higher potential profits from buying call options makes them more valuable.

→ We have thus established a relationship between the value of put and call options, allowing any valuation of standard European options to focus on call options only.

Implications of the Put-Call parity

- Assume that the strike price is equal to the current price: $K = S$

→ We can now explore some implications of the Put-Call parity.

▶ Let us now assume that the strike price is equal to the current value of the underlying asset.

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