Options with Focus on Real Options

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Terminology

- An option is defined as a right, but not an obligation, to buy or sell underlying assets at a fixed price during a specified time period.
- The fixed price is called the exercise price
- Call Option – Right to buy an asset at a specified exercise price on or before the exercise date.
- Put Option – Right to sell an asset at a specified price on or before the exercise date.

Option Obligations

	Buyer	Seller
Call Option	Right to buy asset	Obligation to sell asset
Put Option	Right to sell asset	Obligation to buy asset

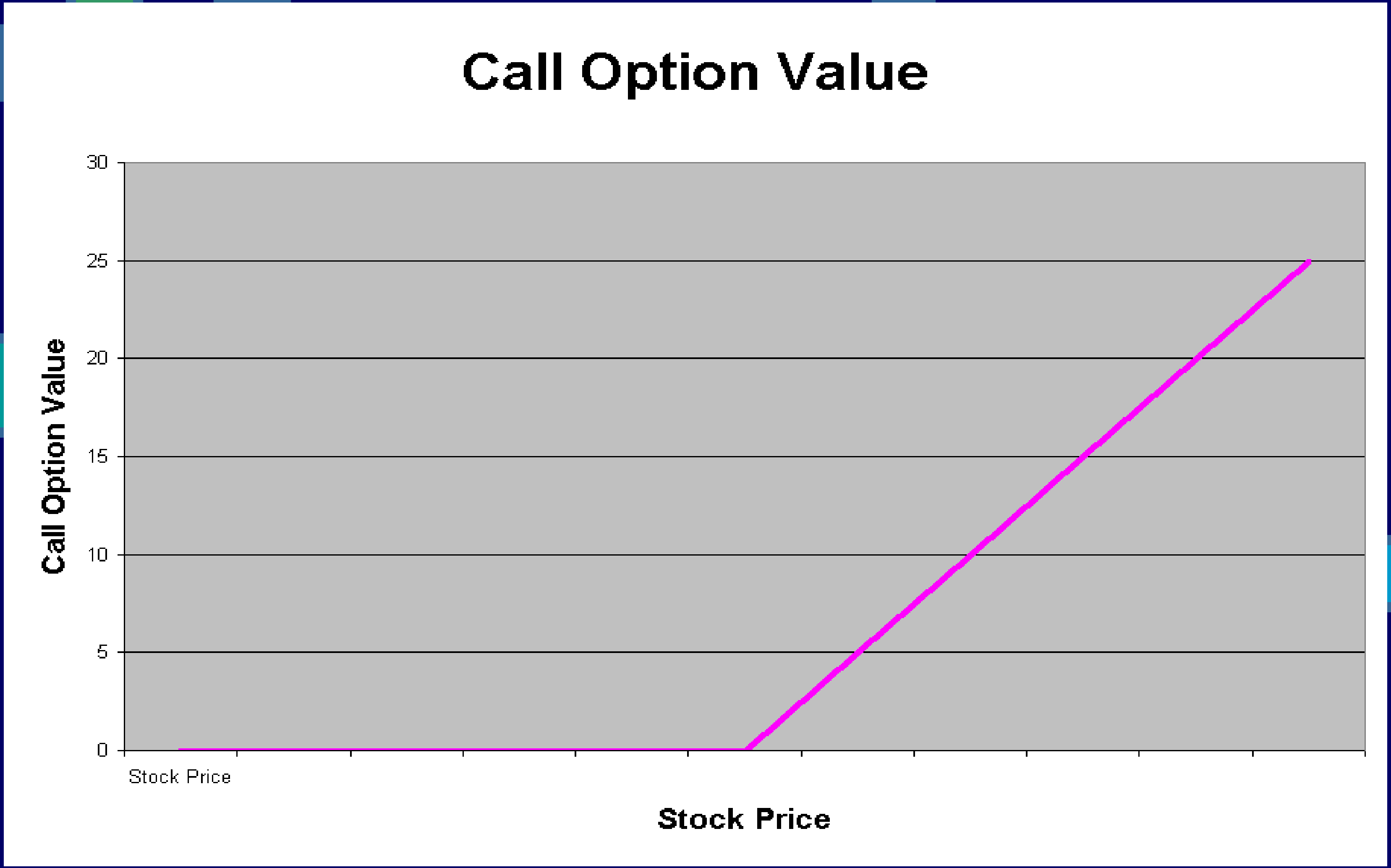
Option buyers have the right to buy or sell assets but option sellers are obligated to sell the asset

Option Value

- The value of option at expiration is a function of the stock price and the exercise price.
- Example: Option values given an exercise price of $85

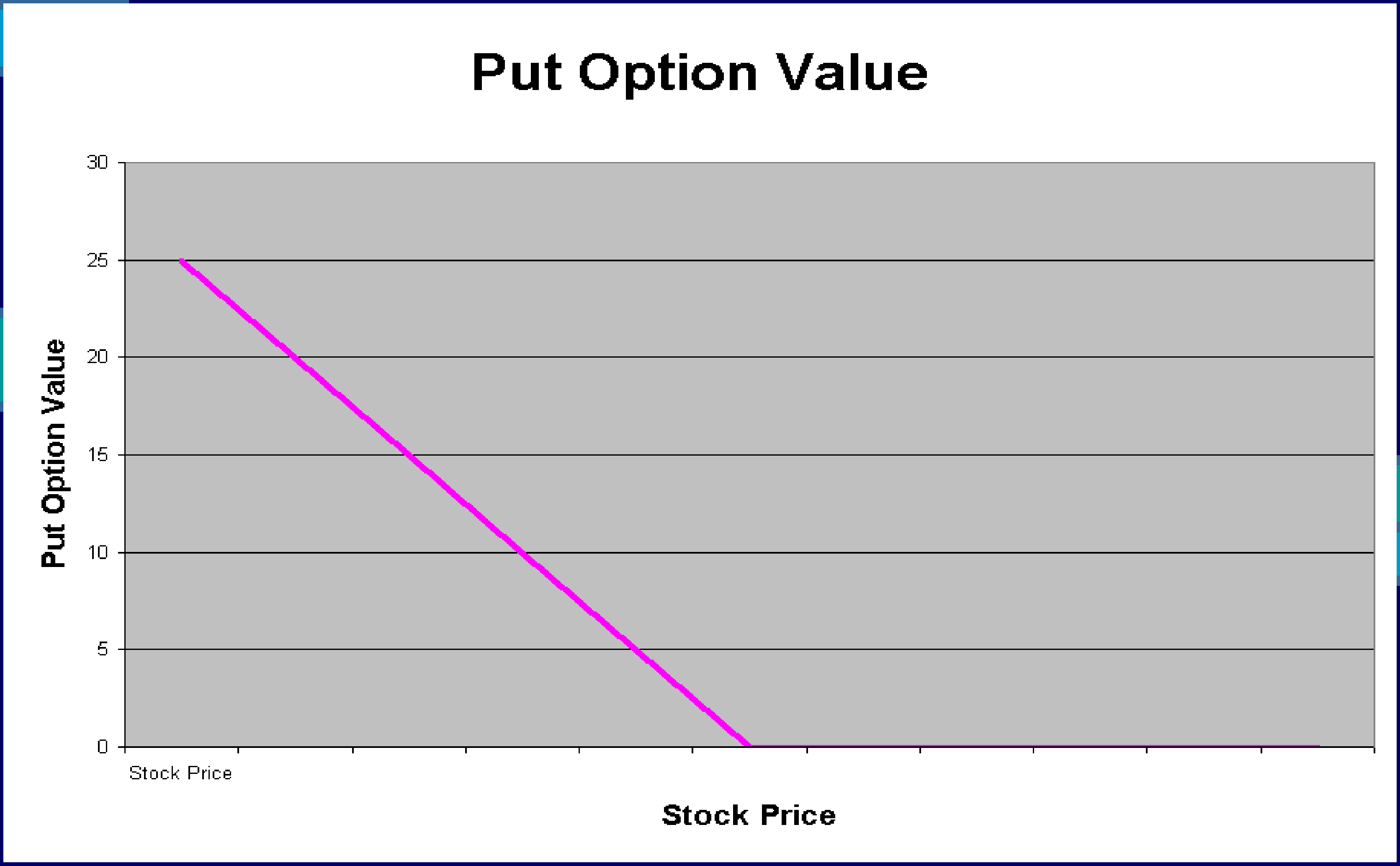
Stock Price	60	70	80	90	100	110
Call Value	0	0	0	5	15	25
Put Value	25	15	5	0	0	0

Given a Rs. 85 exercise price



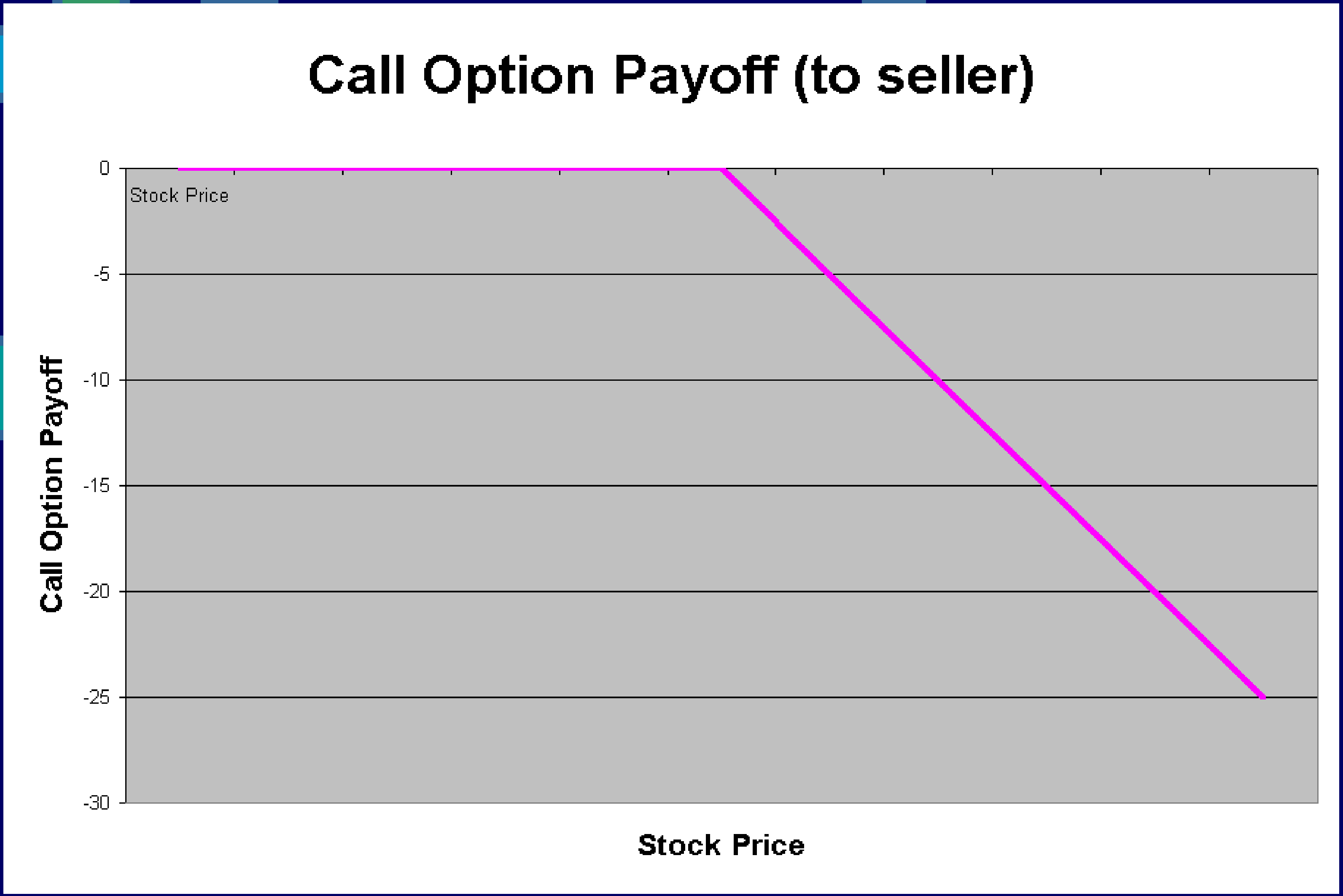
For a buyer of a call option (ignoring transaction costs)

Given a Rs. 85 exercise price



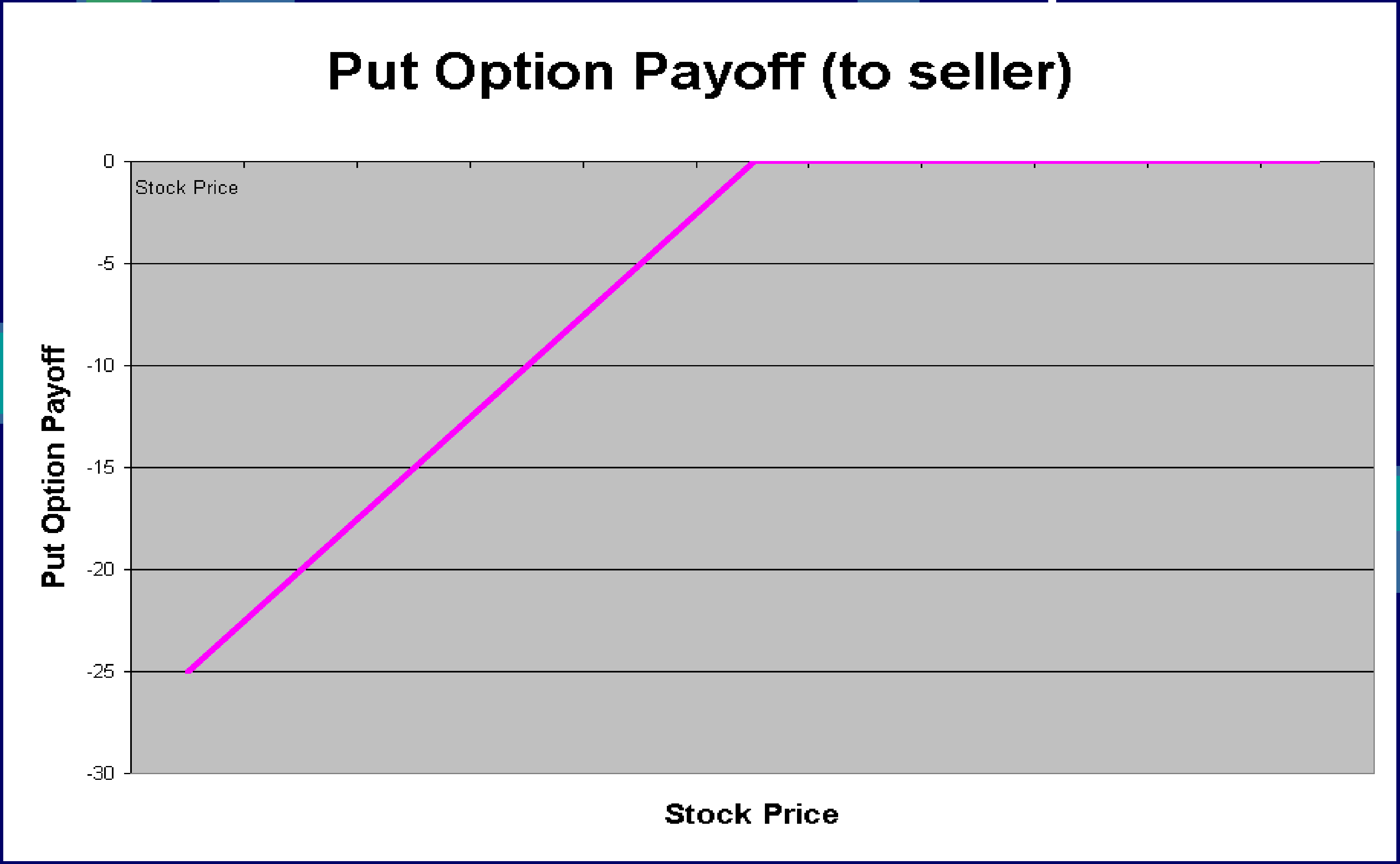
For a buyer of a put option (ignoring transaction costs)

Given a Rs. 85 exercise price



Mirror Image of a buyer of a call option (ignores transaction costs)

Given a Rs. 85 exercise price



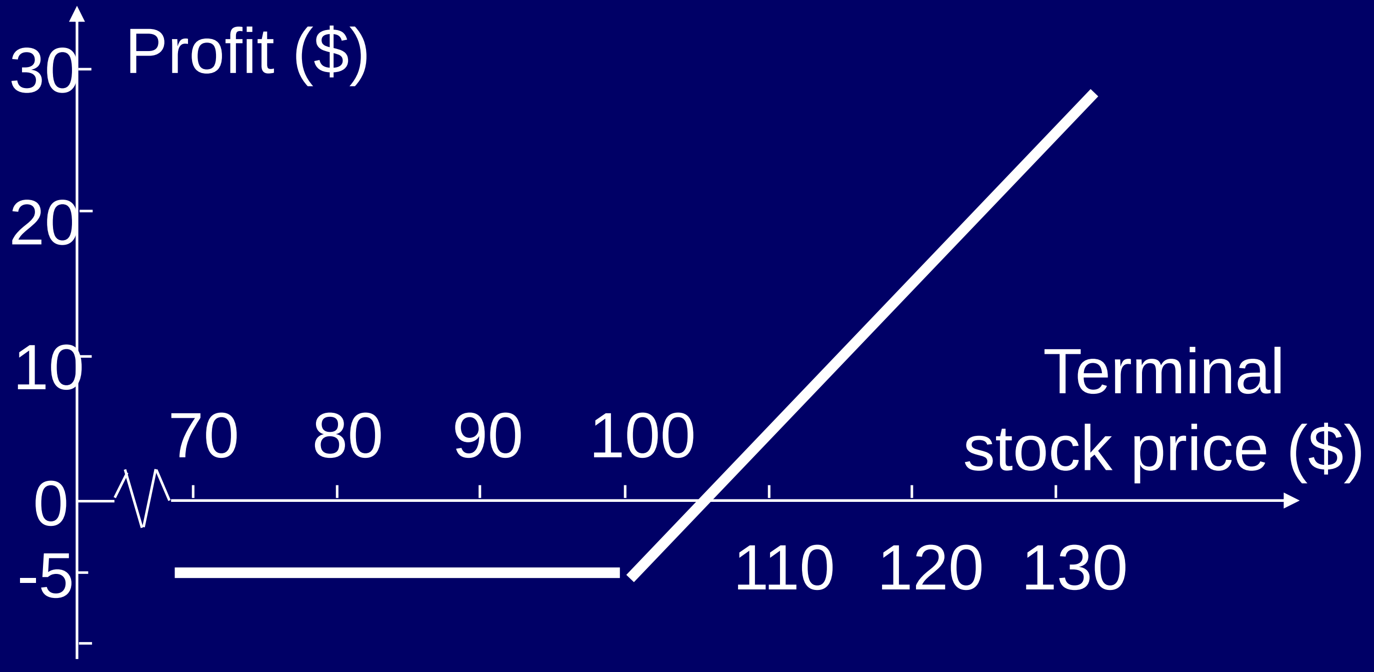
Mirror Image of a buyer of a sell option (ignores transaction costs)

Terminology

- The party that has agreed to buy has what is termed a long position (option holder)
- The party that has agreed to sell has what is termed a short position (option writer)
- An European option can be exercised only on the expiration date
- An American option can be exercised on or before the expiration date
- At the money, In the money (profit), Out of the money (loss)

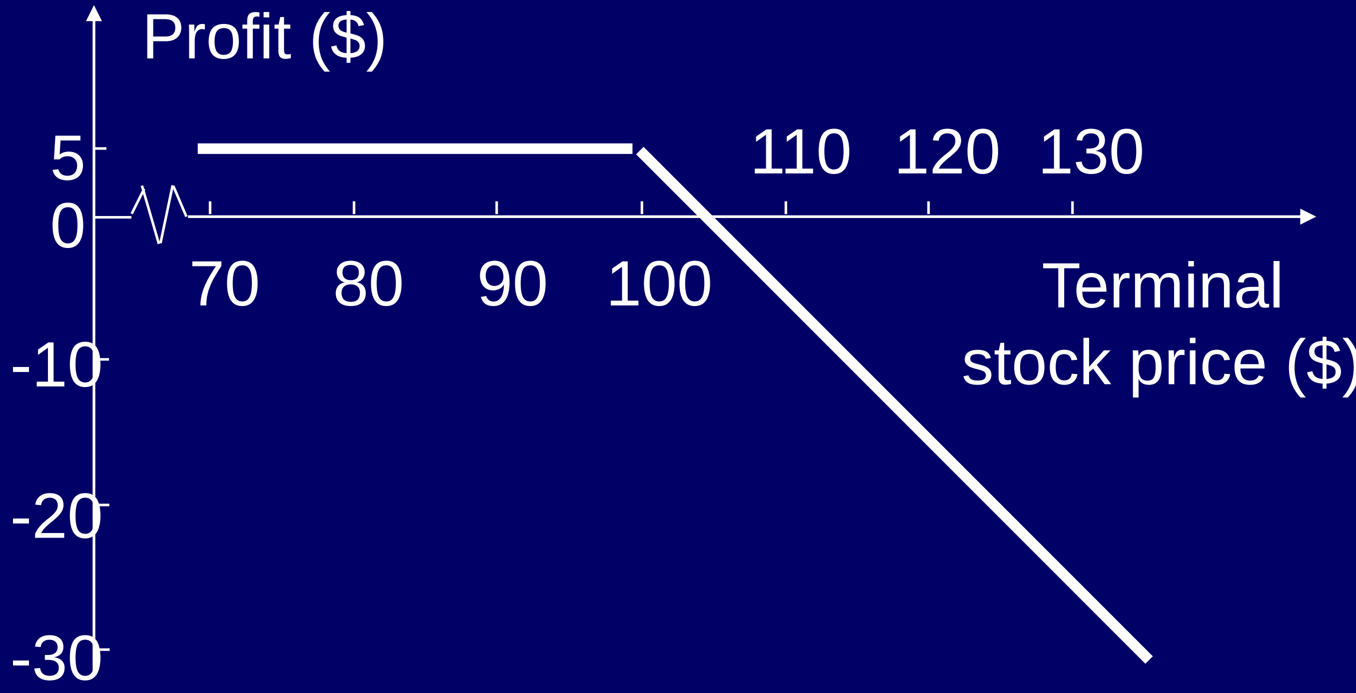
Long Call on IBM (Figure 1.2, Page 7, of 'Option, Futures, and other derivatives' 4th edition, John C. Hull, 1999)

Profit from buying an IBM European call option: option price = \$5, strike price = \$100, option life = 2 months



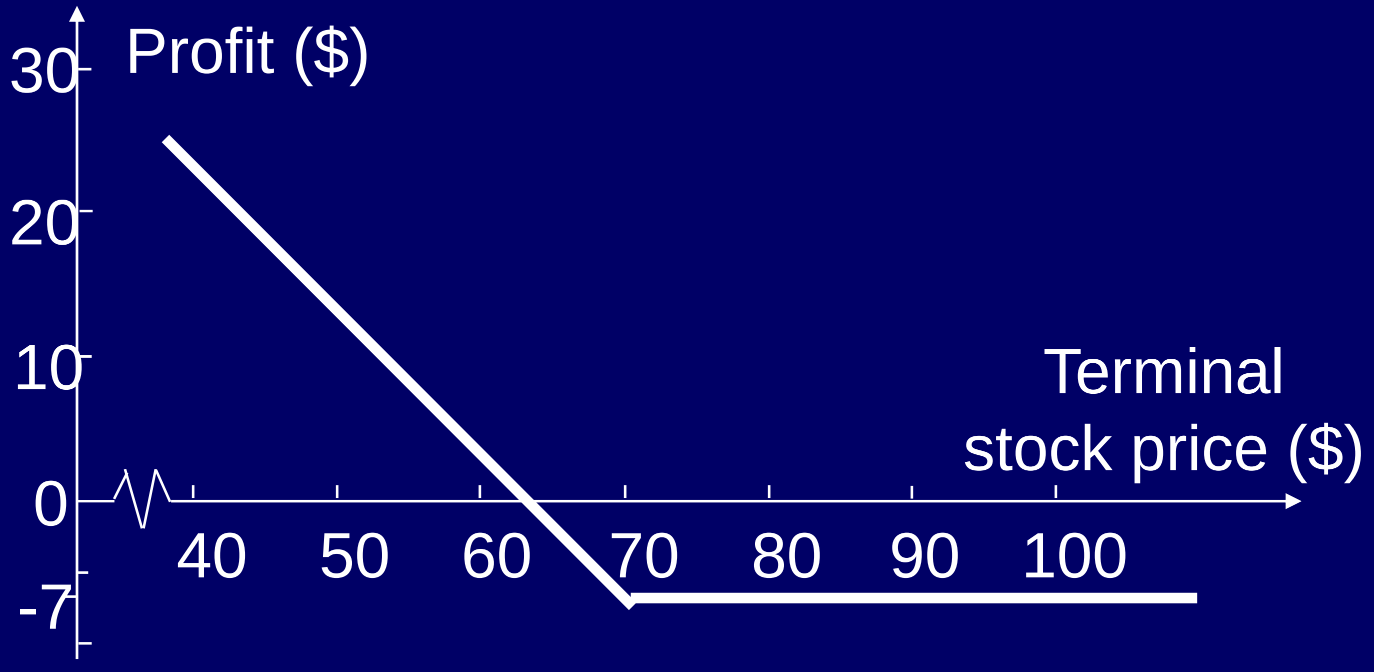
Short Call on IBM (Figure 1.3, page 7, of 'Option, Futures, and other derivatives' 4th edition, John C. Hull, 1999)

Profit from writing an IBM European call option: option price = \$5, strike price = \$100, option life = 2 months



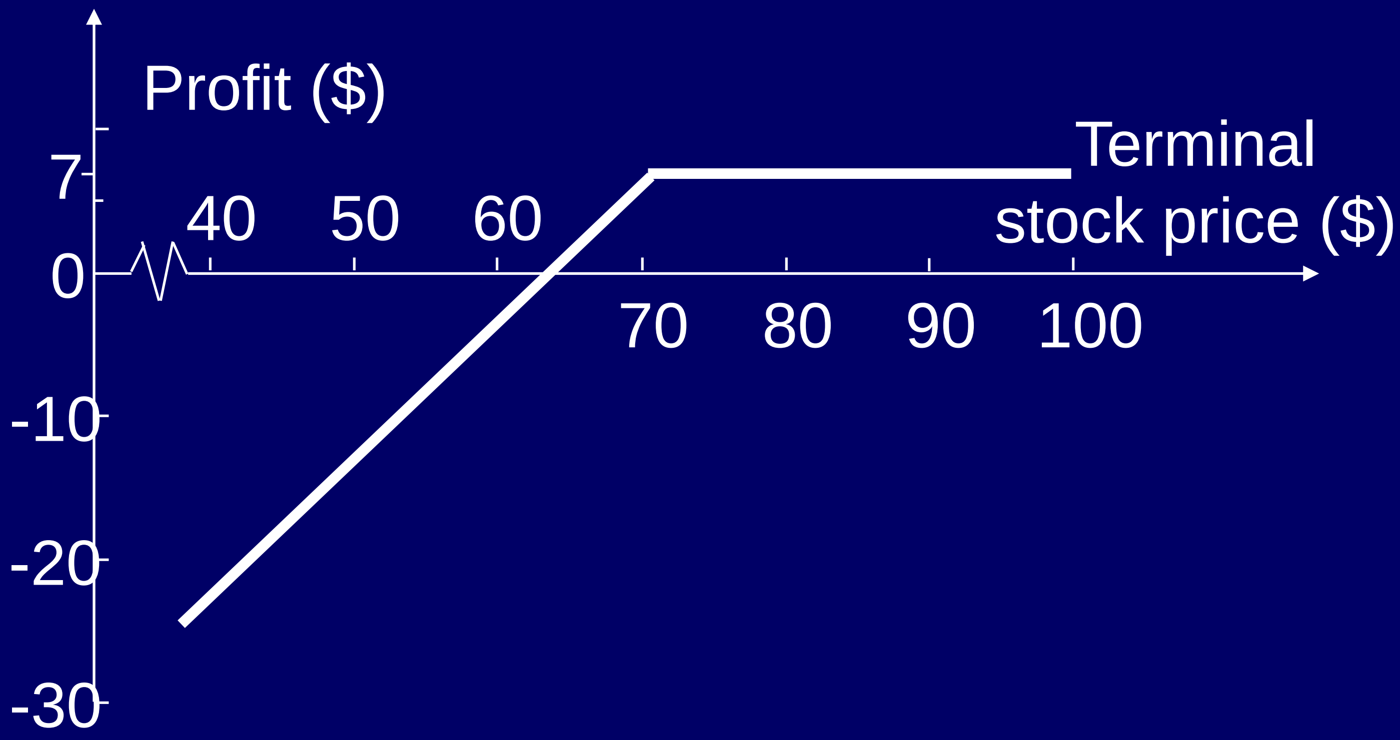
Long Put on Exxon (Figure 1.4, page 8, of 'Option, Futures, and other derivatives' 4th edition, John C. Hull, 1999)

Profit from buying an Exxon European put option: option price = \$7, strike price = \$70, option life = 3 mths

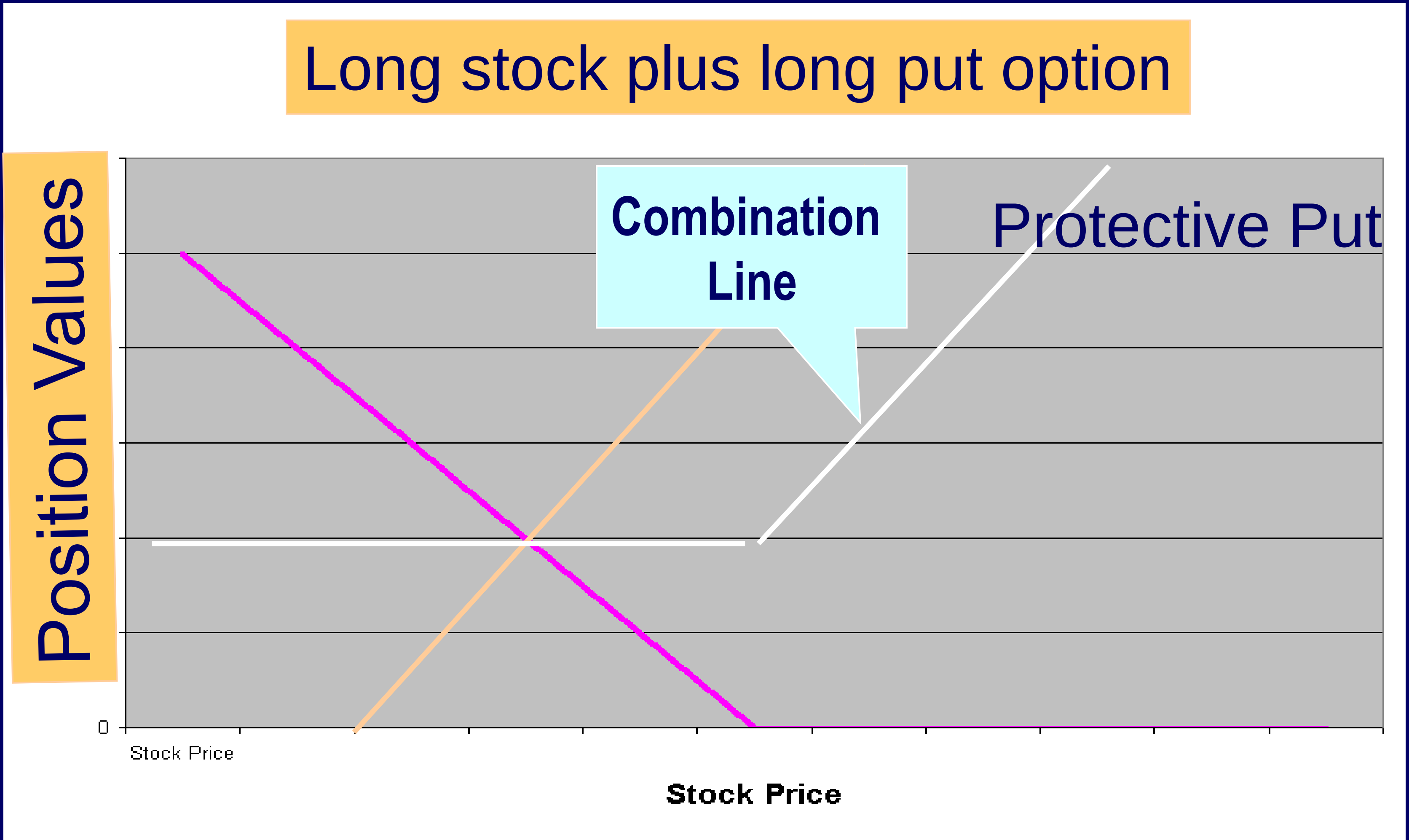


Short Put on Exxon (Figure 1.5, page 9, of 'Option, Futures, and other derivatives' 4th edition, John C. Hull, 1999)

Profit from writing an Exxon European put option: option price = $7, strike price = $70, option life = 3 mths



Protective Put



Can be thought of as insurance against falling shareprice

	Call Option	Put Option
At the Money	Exercise Price = Market Price	Exercise Price = Market Price
In the Money	Exercise Price < Market Price	Exercise Price > Market Price
Out of the Money	Exercise Price > Market Price	Exercise Price < Market Price

Payoff

- If S_1 is the stock price and E is the exercise price
- For a call option, C = Max (S_1 - E, 0)
- For a put option, P = Max (0, E - S_1)

Straddle

- Call and Put options together in the same contract
- Where the exercise price and maturity date are identical for both options
- Good strategy for profiting from high volatility
- This strategy pays off if the share price movement is beyond a certain limit in either direction

Put-Call Parity Theorem

- Example: Bank Deposit + Buy Call = Buy Share + Buy Put
- [Put Value + Current Share Price] is equal to [Call Value + Present Value of Exercise Price]
- Hence, C = S + P - E

Long Call Option Value depends on …

Price of an underlying asset
- Positive

Exercise Price
- Negative

Variability of returns
- Positive

Time left for expiration
- Positive

Risk free interest rate
- Positive

Long Put Option Value depends on …

Price of an underlying asset
- Negative

Exercise Price
- Positive

Variability of returns
- Positive

Time left for expiration
- Positive

Risk free interest rate
- Negative

Black and Scholes Model

- c : equilibrium Call option price today
- p : Put option price today
- S_0 : Stock price today
- X : Strike price
- T : Life of option
- σ^2: Standard deviation of continuously compounded annual rate of return on the stock
- $N(d)$: Value of the cumulative normal density function
- r : Risk-free rate for maturity T with continuous compounding
- e : Base of natural logarithm

$$C_0 = [S_0 N(d_1)] - [(X/e^{rt})\, N(d_2)]$$

- $N(d_1)$ and $N(d_2)$ are values of the cumulative normal distribution functions [after calculating d_1 and d_2 one can get them through statistical normal tables]

Example [from Financial Management: Theory and Practice by Prasanna Chandra, 2001]

- Current Share Price = 60
- Exercise Price = 56
- Continuously compounded risk free annual interest rate = 0.14
- Length of time = 6 months
- Standard Deviation = 0.09
- What is the equilibrium value of a call and put option now?

- $d_1 = 0.761$
- $d_2 = 0.554$
- $N(d_1) = 0.7762$
- $N(d_2) = 0.7102$
- Current Call Value = 9.489
- Current Put Value = 1.703

Common Equity as an Example

- We know, $S + B = V$
- $S = \text{Max}(0, V-B)$
- In case of a insolvent firm, the equity holders will get zero.
- In case of a profitable firm, the equity holders will get (V-B).
- In other words, they will get all the remaining value of the firm after repaying the bond/debt holders.

Managerial Real Options

Management flexibility to make future decisions that affect a project's expected cash flows, life, or future acceptance.

Project Worth = NPV + Option(s) Value

Managerial Real Options

Expand (or Contract)

- Allows the firm to expand (contract) production if conditions become favorable (unfavorable) - GACL

Abandon

- Allows the project to be terminated early - Enron

Postpone (timing option)

- Allows the firm to delay undertaking a project (reduces uncertainty via new information) - Power Producers

Flexible Production Facilities

- Purchasing flexible production facilities - Reliance