Derivatives contracts - Options

Price Risk and Derivatives Contracts

What is Price Risk?

- Price risk is the risk that the value of a security, commodity or investment will decrease.
- Factors that affect price risk include price changes due to market movement, earnings volatility and poor business management, namely.
- Diversification is the most common and effective tool to mitigate price risk.
- Financial tools, such as **options**, can also be used to hedge price risk.

What is a Derivative Contract?

- Derivatives are securities that derive their value from an underlying asset.
- Common derivatives include **options**, futures contracts, forwards and swaps.
- Exchange-traded derivatives like futures or stock options are standardized and eliminate or reduce many of the risks of over-the-counter derivatives
- Derivatives are usually leveraged instruments, which increases their potential risks and rewards.

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Options

What do the following events have in common? Price uncertainty and Options!

- The coffee roaster, Keurig Green Mountain, buys options that put a ceiling on the price that it will pay for its future purchases of beans.
- Flatiron offers its president a bonus if the company's stock price exceeds $120.
- Blitzen Computer dips a toe in the water and enters a new market.
- Malted Herring postpones investment in a positive-NPV plant.
- Hewlett-Packard exports partially assembled printers even though it would be cheaper to ship the finished product.
- Dominion installs a dual-fired unit at its Possum Point power station that can use either fuel oil or natural gas.
- In 2004, Air France acquires the Dutch airline, KLM, in exchange for a package of Air France shares and warrants. The warrants entitle KLM's shareholders to buy additional Air France shares for $20 each within the next 3.5 years.
- In 2011, AIG distributes 75 million warrants to its shareholders. Each warrant entitles shareholders to buy an additional share for $45.
- In 2014, Twitter issues $1.8 billion of convertible bonds. Each bond can be exchanged for 12.9 shares.

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Options

What do the following events have in common?

Each of these events involves an **option**, and they illustrate why the financial manager of an industrial company needs to understand options.

Companies regularly use commodity, currency, and interest-rate **options** to **reduce risk**.

Most of the time we take risk as God-given. There's nothing the manager can do about it. That's not wholly true. The manager can and should avoid some risks. For example, a petrochemical plant that is designed to use natural gas as a feedstock can buy/sell options on gas, if it wants to reduce the risk of an unfavorable shift in the price of gas.

For example, a meatpacking company that wishes to put a ceiling on the cost of beef might take out an option to buy live cattle at a fixed price. A company that wishes to limit its future borrowing costs might take out an option to sell long-term bonds at a fixed price. And so on.

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Options example: Portfolio Insurance

Your company's pension fund owns an $800 million diversified portfolio of common stocks that moves closely in line with the market index. The pension fund is currently fully funded, but you are concerned that if it falls by more than 20% it will start to be underfunded. Suppose that your bank offers to insure you for one year against this possibility. What would you be prepared to pay for this insurance?

You can shield against a fall in asset prices by buying a protective put option. In the present case the bank would be selling you a one-year put option on U.S. stock prices with an exercise price 20% below their current level. You can get the value of that option in two steps. First use the Black–Scholes formula to value a call with the same exercise price and maturity. Then back out the put value from put–call parity.

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Options example: Executive Stock Options

In fiscal year 2014, Larry Ellison, the CEO of Oracle Corporation, received a salary of $1, but he also pocketed $67 million in the form of stock options. The example highlights that executive stock options are often an important part of compensation. For many years companies were able to avoid reporting the cost of these options in their annual statements.

However, they must now treat options as an expense just like salaries and wages, so they need to estimate the value of all new options that they have granted. For example, Oracle's financial statements show that in fiscal 2014 the company issued a total of 131 million options with an average life of 4.9 years and an exercise price of $31.02. Oracle calculated that the average value of these options was $7.47. How did it come up with this figure? It just used the Black–Scholes model assuming a standard deviation of 27% and an interest rate of 1.3%

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Options

Options Definition

Call Option	Put Option
Right to buy an asset at a specified exercise price on or before the exercise date	Right to sell an asset at a specified exercise price on or before the exercise date

Note: if the option can be exercised only at maturity, it is conventionally known as a European option; in other cases the option can be exercised on or at any time before maturity, and it is then known as an American option.

Options Obligations

	Buy	Sell
	Long	Short
Call option	Right to buy asset	Obligation to sell asset
Put option	Right to sell asset	Obligation to buy asset

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Options terminology

Derivatives - Any financial instrument that is derived from another. (e.g.. options, warrants, futures, swaps, etc.)

Option - Gives the holder the right to buy or sell a security at a specified price during a specified period of time.

Call Option - The right to buy a security at a specified price within a specified time.

Put Option - The right to sell a security at a specified price within a specified time.

Option Premium - The price paid for the option, above the price of the underlying security.

Intrinsic Value - Diff between the strike price and the stock price

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Options terminology

Time Premium - Value of option above the intrinsic value

Exercise Price - (Striking Price) The price at which you buy or sell the security.

Expiration Date - The last date on which the option can be exercised.

American Option - Can be exercised at any time prior to and including the expiration date.

European Option - Can be exercised only on the expiration date. All options “usually” act like European options because you make more money if you sell the option before expiration (vs. exercising it)

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Derivatives contracts

Example: selected prices of put and call options on Google stock in December 2014, when the closing stock price was about $530

The first entry says that for $72.70 you could acquire an option to buy one share of Google stock for $470 on or before March 2015.

Moving down to the next row, you can see that an option to buy for $30 more ($500 vs. $470) costs $27 less, that is $45.70.

In general, the value of a call option goes down as the exercise price goes up. For a put option, is the opposite.

Maturity Date	Exercise Price	Price of Call Option	Price of Put Option
March 2015	$470	$72.70	$7.50
	500	45.70	13.60
	530	28.00	24.64
	560	13.10	43.60
	590	7.50	67.10
June 2015	$470	$80.50	$13.20
	500	56.00	20.65
	530	36.00	**34.55**
	560	20.00	53.70
	590	12.30	72.50
January 2016[a]	$470	$99.10	$28.70
	500	72.00	40.70
	530	54.60	52.40
	560	38.00	67.55
	590	28.30	84.30

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Derivatives contracts

Example: selected prices of put and call options on Google stock in December 2014, when the closing stock price was about $530

Now look at the quotes for options maturing in June 2015 and January 2016.

Notice how the option price increases as option maturity is extended.

For example, at an exercise price of $530, the March 2015 call option costs $28.00, the June 2015 option costs $36.00, and the January 2016 option costs $54.60

Maturity Date	Exercise Price	Price of Call Option	Price of Put Option
March 2015	$470	$72.70	$7.50
	500	45.70	13.60
	530	28.00	24.64
	560	13.10	43.60
	590	7.50	67.10
June 2015	$470	$80.50	$13.20
	500	56.00	20.65
	530	36.00	**34.55**
	560	20.00	53.70
	590	12.30	72.50
January 2016[a]	$470	$99.10	$28.70
	500	72.00	40.70
	530	54.60	52.40
	560	38.00	67.55
	590	28.30	84.30

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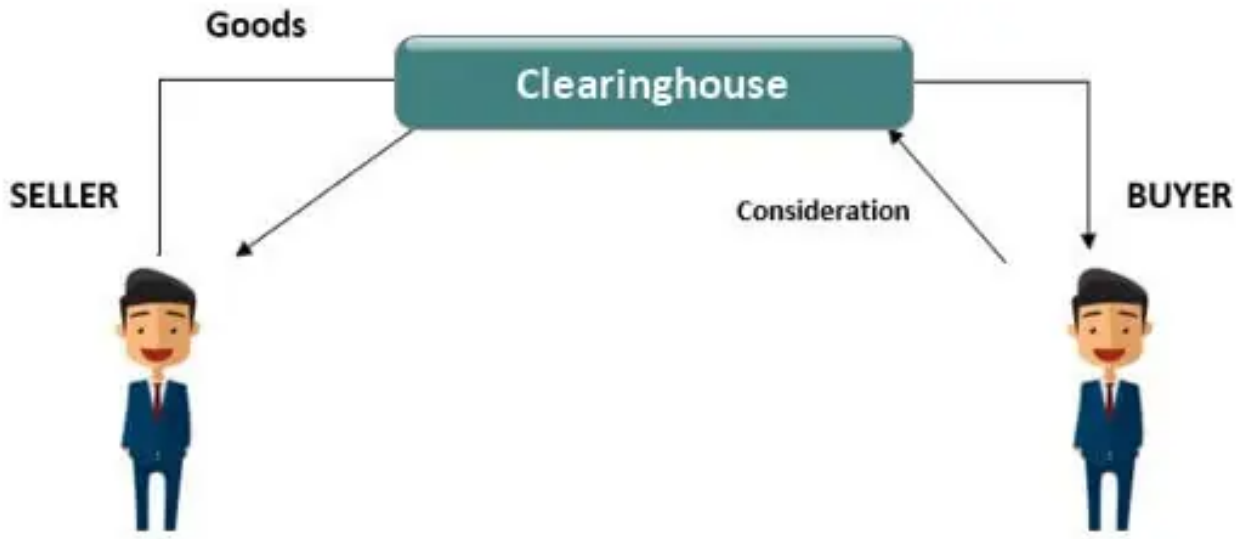
Option value

Clearing houses are the intermediary of the options and futures transactions



There are hundreds of on-line platforms that allows you to buy or sell options instantly, connecting you to the Clearing Houses

A clearinghouse is a designated intermediary between a buyer and seller in a financial market. The clearinghouse validates and finalizes the transaction, ensuring that both the buyer and the seller honor their contractual obligations.

Clearinghouses act as third parties for futures and options contracts, as buyers to every clearing member seller, and as sellers to every clearing member buyer.

Stock exchanges such as the New York Stock Exchange (NYSE) have clearing divisions that ensure that a stock trader has enough money in an account to fund the trades being placed.

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Option value

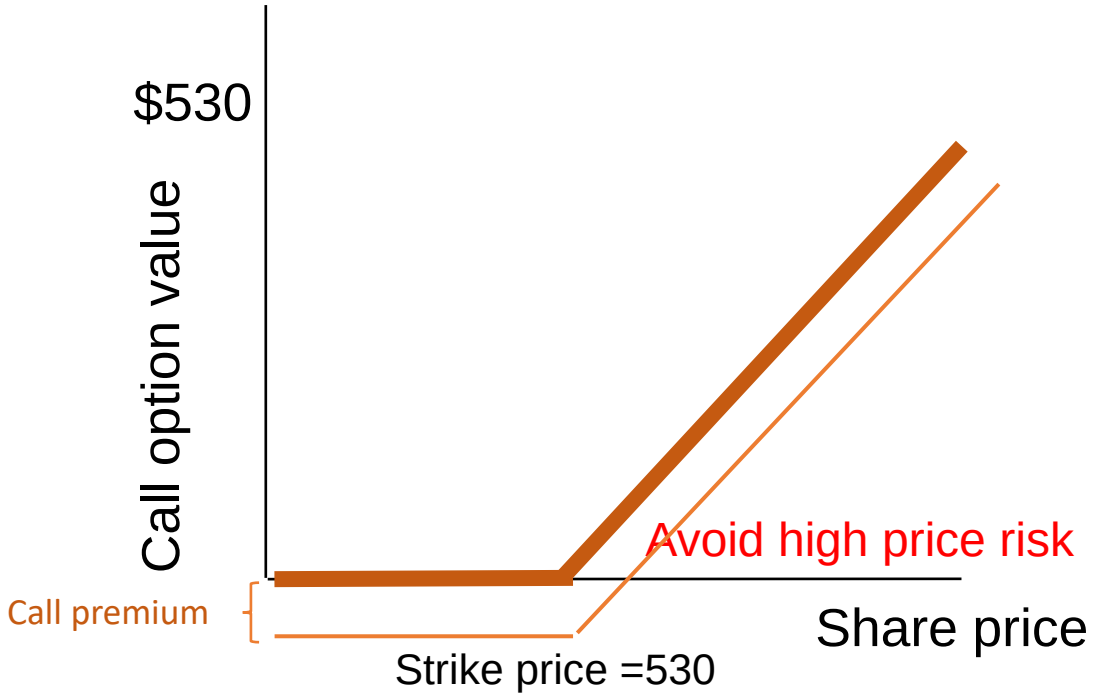
Call example

The outcome from investing in Google calls depends on what happens to the stock price. If the stock price at the end of this six-month period turns out to be less than the $530 exercise price, nobody will pay $530 to obtain the share via the call option. Your call will in that case be valueless.

On the other hand, if the stock price turns out to be greater than $530, it will pay to exercise your option to buy the share. In this case, when the call expires, it will be worth the market price of the share minus the $530 that you must pay to acquire it. For example, suppose that the price of Google stock rises to $600.

Your call will then be worth $600 – $530 = $70. That is your payoff, but of course it is not all profit. You had to pay a premium to buy the call.

Google call option value (graphic) given a $530 exercise price



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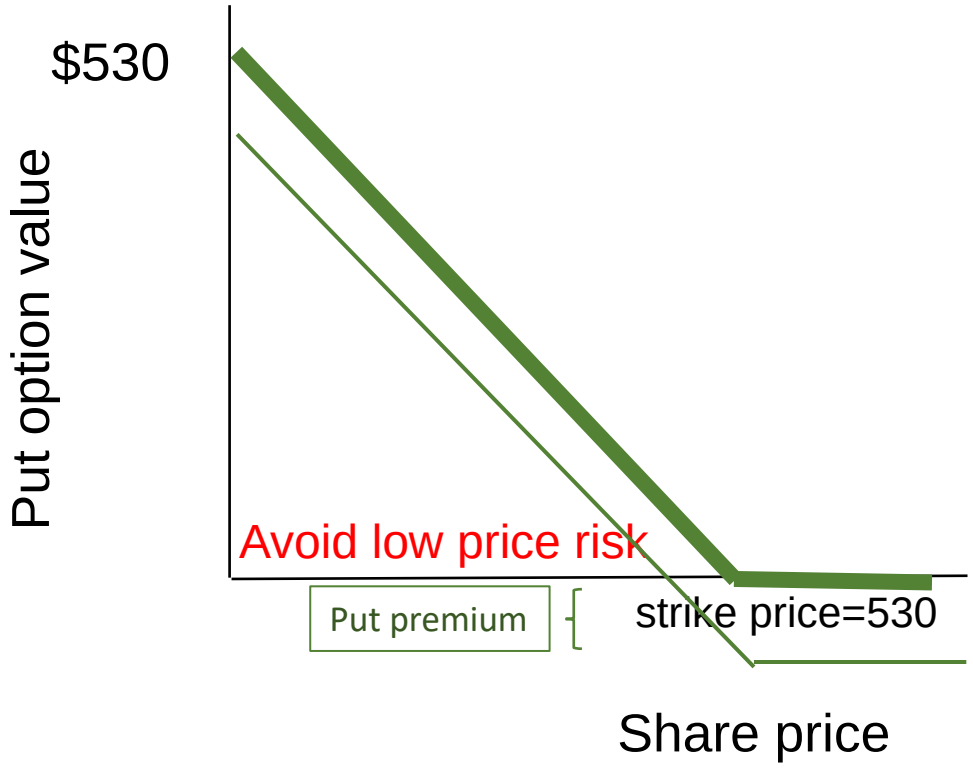
Option value

Put example

The circumstances in which the put turns out to be profitable are just the opposite of those in which the call is profitable. If Google's share price immediately before expiration turns out to be greater than $530, you won't want to sell stock at that price. You would do better to sell the share in the market, and your put option will be worthless.

Conversely, if the share price turns out to be less than $530, it will pay to buy stock at the low price and then take advantage of the option to sell it for $530. In this case, the value of the put option on the exercise date is the difference between the $530 proceeds of the sale and the market price of the share. For example, if the share is worth $440, the put is worth $90: Value of put option at expiration = exercise price – market price of the share = $530 – $440 = $90

Google put option value (graphic) given a $530 exercise price



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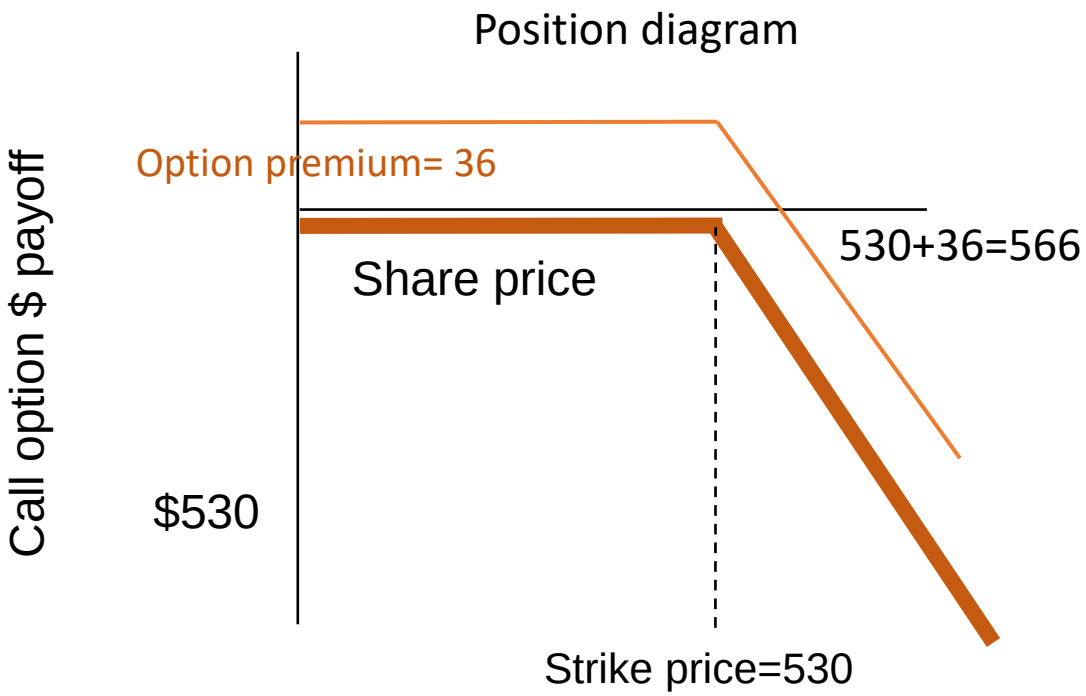
Option value – position diagrams

Selling Calls

If you sell, or "write," a **call**, you promise to deliver shares if asked to do so by the call buyer. If the share price is below the exercise price when the option matures, the buyer will not exercise the call and the seller's liability will be zero. If it rises above the exercise price, the buyer will exercise, and the seller must give up the shares. The seller loses the difference between the share price and the exercise price received from the buyer. Suppose that the price of Google stock reaches $600, which is above the option's exercise price of $530. In this case the buyer will exercise the call. The seller is forced to sell stock worth $600 for only $530 and so has a payoff of – $70. The $70 loss is the buyer's gain.

Google call option payoff (to seller) given a $530 exercise price.



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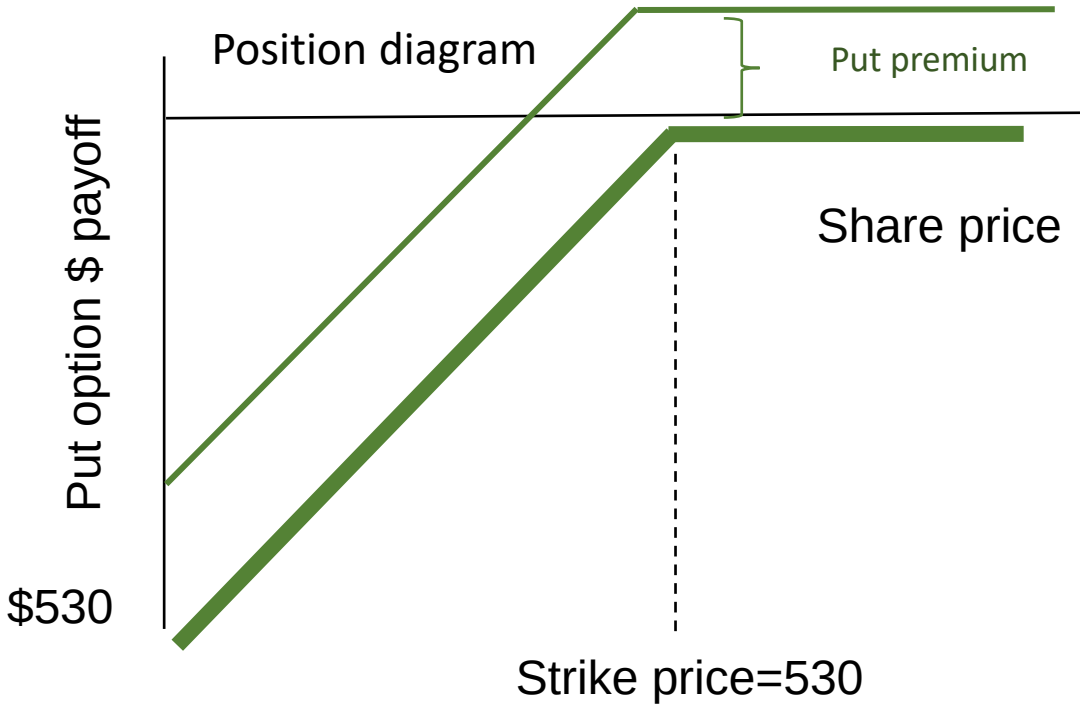
Option value – position diagrams

Selling Puts

In just the same way we can depict the position of an investor who sells, or writes, a **put**. The seller of the put has agreed to pay $530 for the share if the buyer of the put should request it.

Clearly the seller will be safe as long as the share price remains above $530 but will lose money if the share price falls below this value.

Google put option payoff (to seller) given a $530 exercise price.



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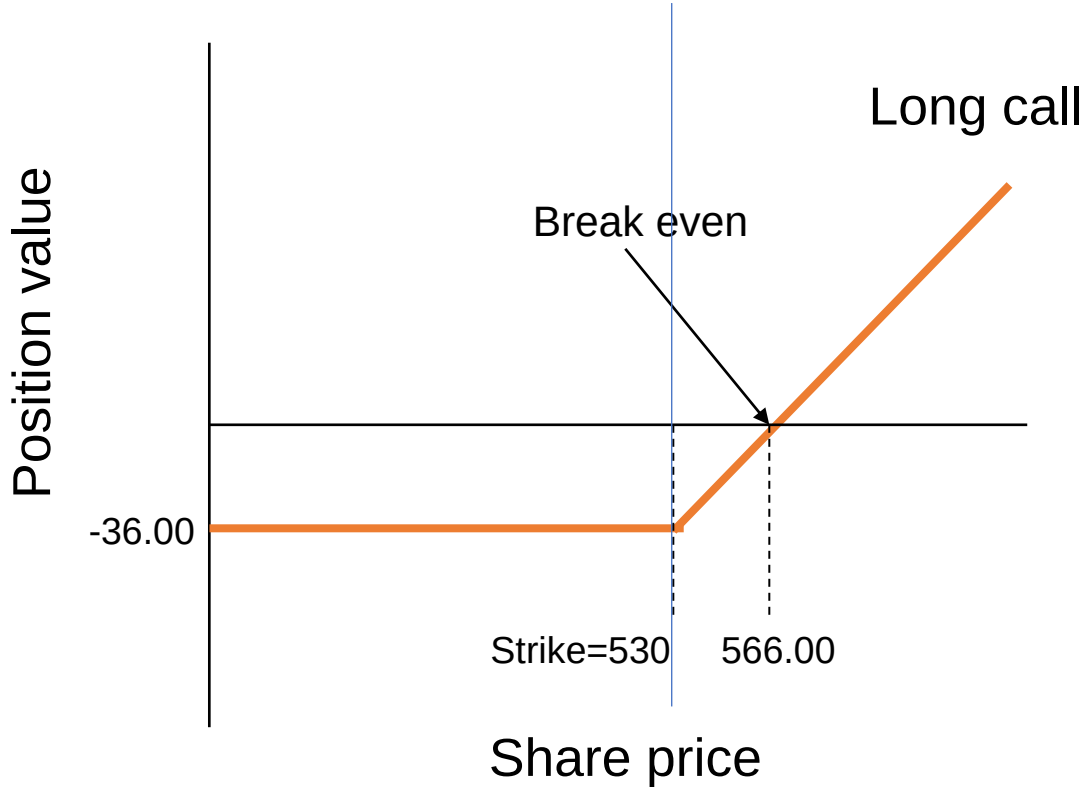
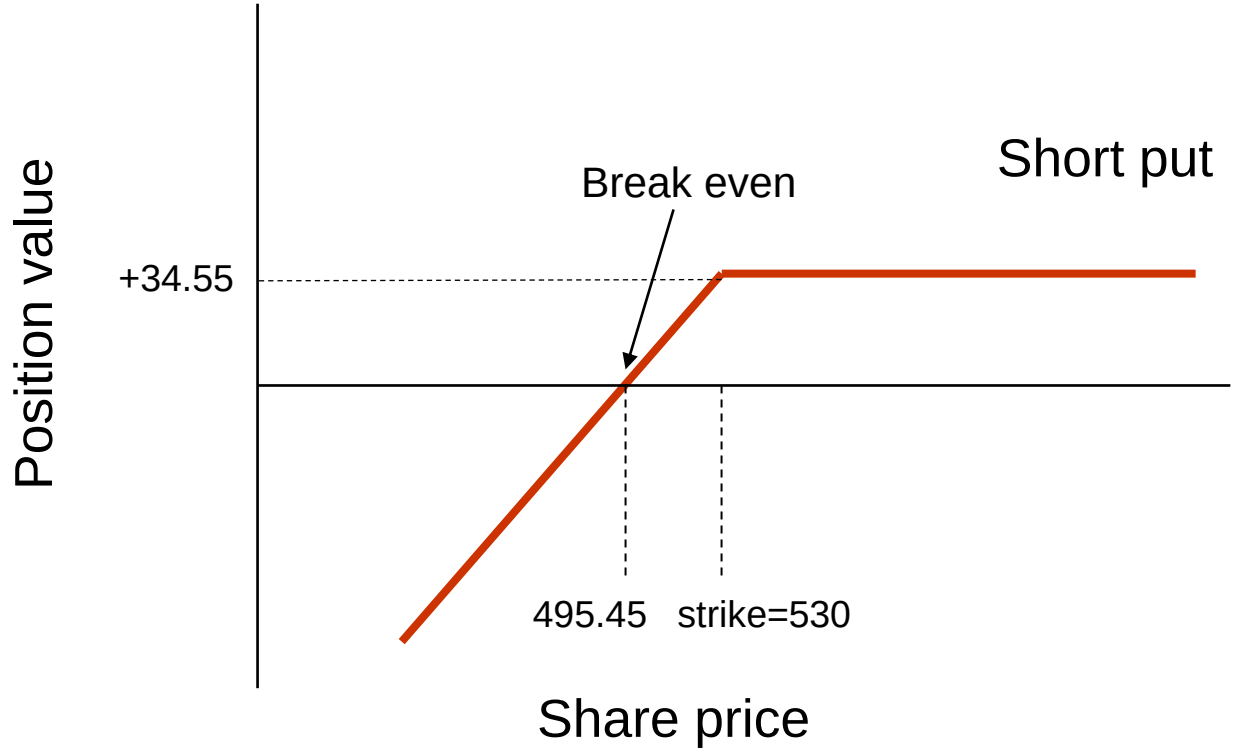
Option value – profit diagrams

Profit diagrams incorporate the costs of buying an option or the proceeds from selling one.

Call buyer profit – assume strike of $530 and option price of $36.00



Put seller profit – assume strike of $530 and option price of $34.55



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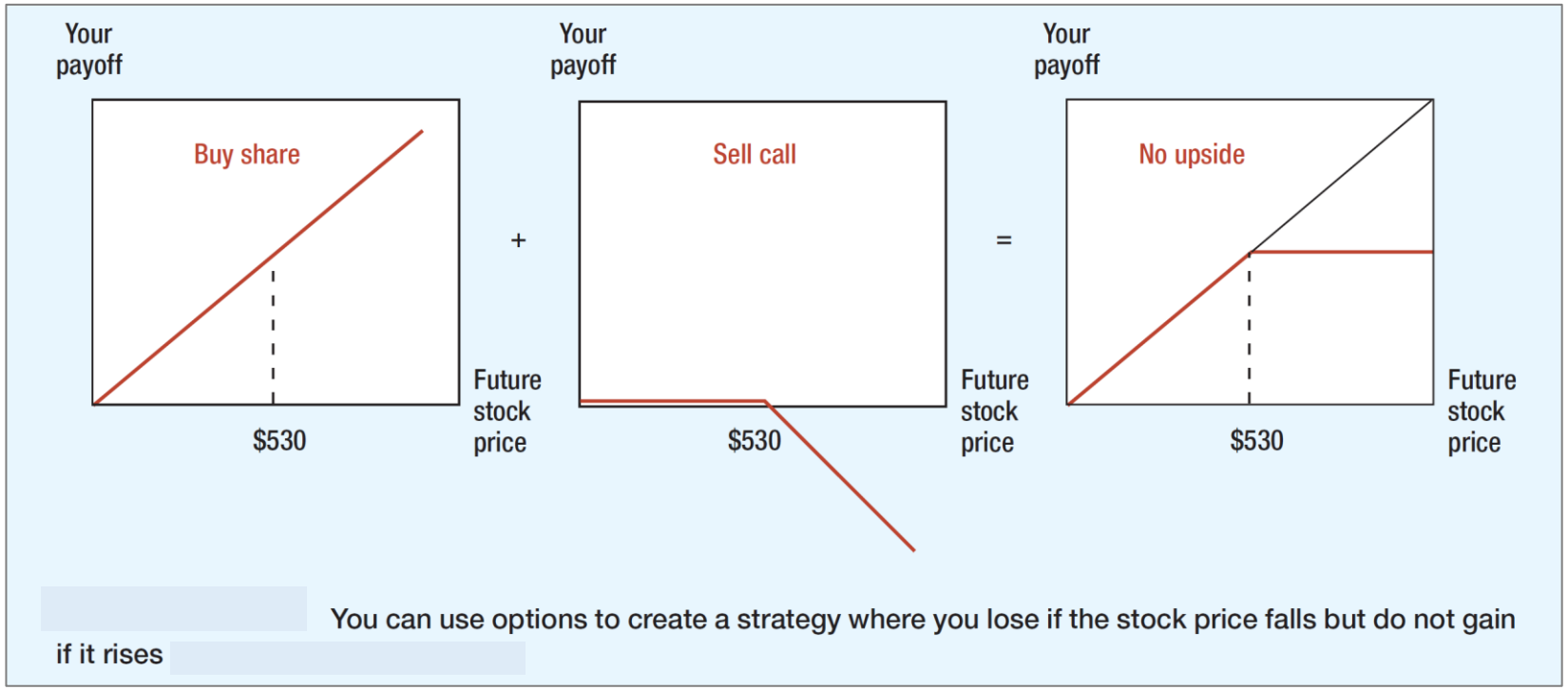
Option strategies

Consider first the strategy for **masochists**. The diagram shows the payoffs from buying a share of Google stock (**Long Stock**), while the second shows the payoffs from selling a call option (**Short Call**) with a $530 exercise price.

The third diagram shows what happens if you combine these two positions.



You can use options to create a strategy where you lose if the stock price falls but do not gain if it rises

The result is the no-win strategy. You lose if the stock price declines below $530, but, if the stock price rises above $530, the owner of the call will demand that you hand over your stock for the $530 exercise price. So you lose on the downside and give up any chance of a profit. That's the bad news. The good news is that you get paid for taking on this liability. In December 2014 you would have been paid $36.00, the price of a six-month call option.

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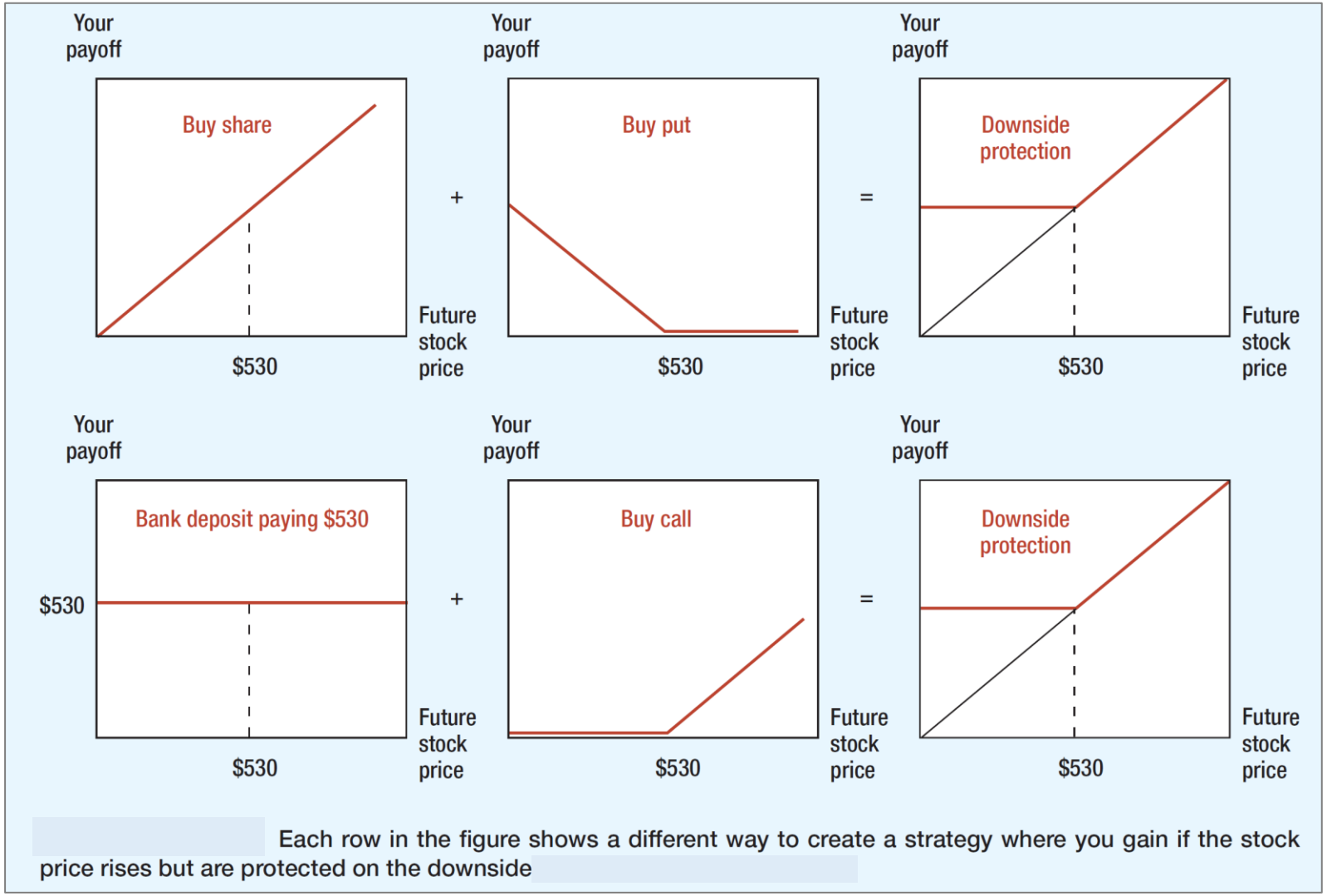
Put–Call parity

The first diagram shows the payoff from buying a share of Google stock, while the next diagram in row 1 shows the payoffs from buying a Google put option with an exercise price of $530. The third diagram shows the effect of combining these two positions. The cost of insuring yourself against loss is the amount that you pay for a put option .

The first diagram shows the payoff from placing the present value of $530 in a bank deposit. Whenever the price of Google stock, your bank deposit will pay off $530. The second diagram in row 2 shows the payoff from a call option on Google stock with an exercise price of $530, and the third diagram shows the effect of combining these two positions.



Each row in the figure shows a different way to create a strategy where you gain if the stock price rises but are protected on the downside

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Put–Call parity

These two rows of previous figures tell us something about the relationship between a call option and a put option. Regardless of the future stock price, both investment strategies provide identical payoffs.

In other words, if you buy the share and a put option to sell it for $530, you receive the same payoff as from buying a call option and setting enough money aside to pay the $530 exercise price.

Therefore, if you are committed to holding the two packages until the options expire, the two packages should sell for the same price today. This gives us a fundamental relationship for European options:

Value of call + present value of exercise price = value of put + share price (1)

This relationship holds because the payoff of *Buy call, invest present value of exercise price in safe asset* is identical to the payoff from *Buy put, buy share*

This basic relationship among share price, call and put values, and the present value of the exercise price is called **put–call parity**. From **(1)** we can write for example:

Value of put = value of call + present value of exercise price – share price

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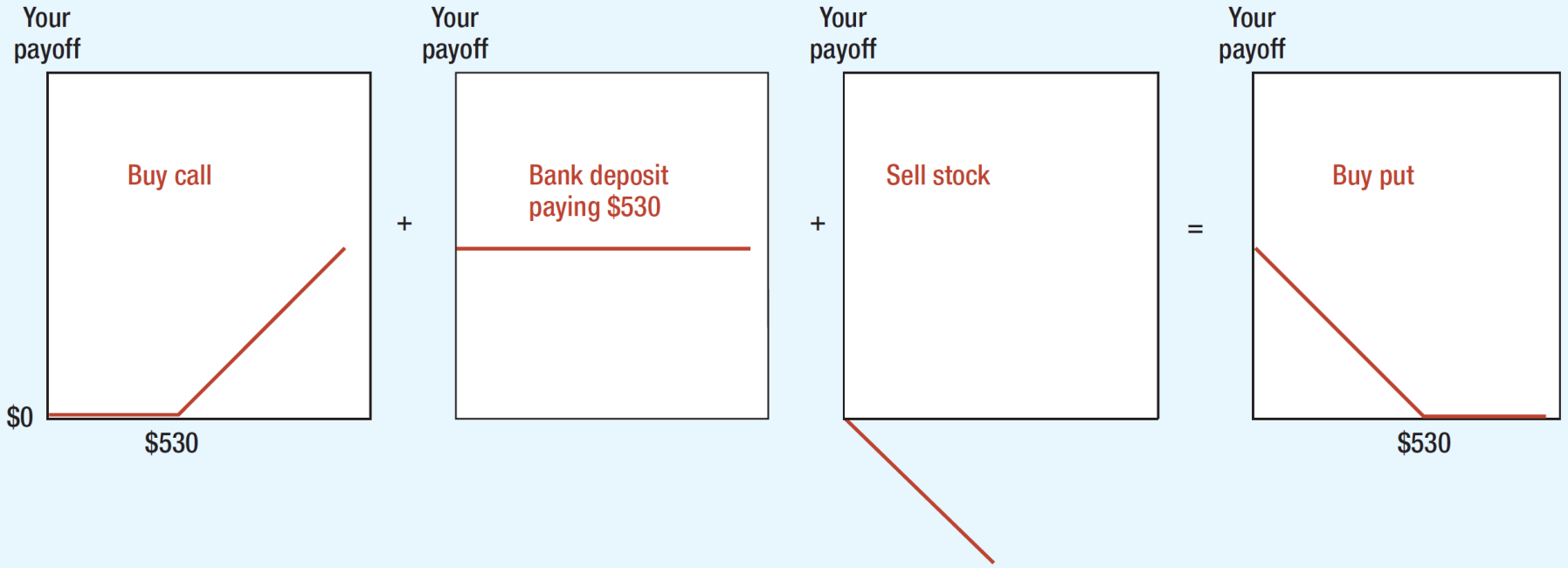
Put–Call parity

In other words, if puts are not available, you can get exactly the same payoff by buying calls, putting cash in the bank, and selling shares.

The figure shows the possible payoffs from each position. The diagram on the left shows the payoffs from a call option on Google stock with an exercise price of $530.



A strategy of buying a call, depositing the present value of the exercise price in the bank, and selling the stock is equivalent to buying a put.

The second diagram shows the payoffs from placing the present value of $530 in the bank. Regardless of what happens to the share price, this investment will pay off $530. The third diagram shows the payoffs from selling Google stock. **Curiosity**: when you sell a share that you don't own, you have a liability—you must sometime buy it back. As they say on Wall Street: *He who sells what isn't his'n, Buys it back or goes to pris´n*

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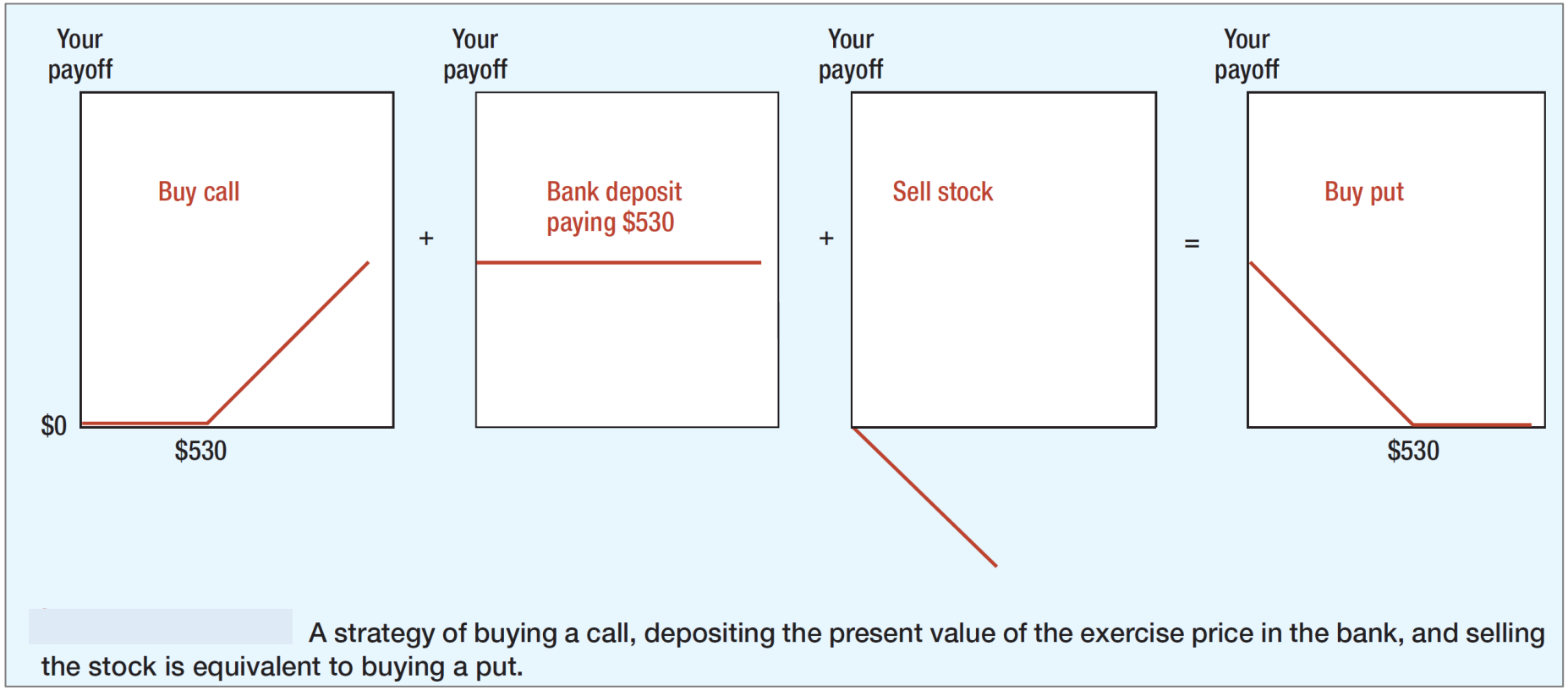
Put–Call parity

Therefore the best that can happen to you is that the share price falls to zero. In that case it costs you nothing to buy the share back. But for every extra dollar on the future share price, you will need to spend an extra dollar to buy the share. The final diagram in the figure shows that the total payoff from these three positions is the same as if you had bought a put option.



A strategy of buying a call, depositing the present value of the exercise price in the bank, and selling the stock is equivalent to buying a put.

Value of put = value of call + present value of exercise price – share price

For example, suppose that when the option matures the stock price is $440. Your call will be worthless, your bank deposit will be worth $530, and it will cost you $440 to repurchase the share. Your total payoff is 0 + 530 – 440 = $90, exactly the same as the payoff from the put.

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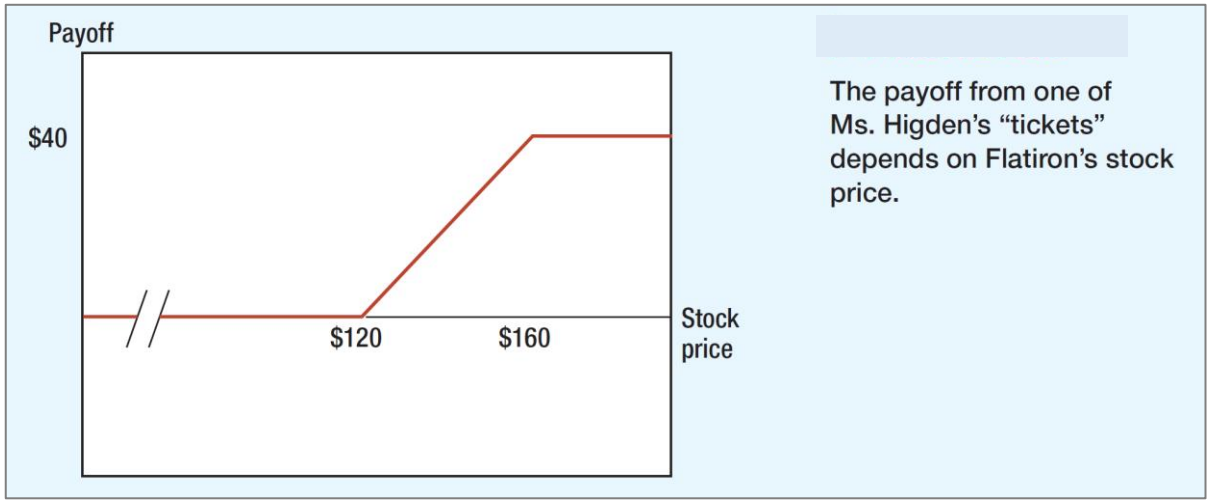
Financial engineering

The Mangle Corporation has offered its president, Ms. Higden, the following incentive scheme: At the end of the year Ms. Higden will be paid a bonus of $50,000 for every dollar that the price of Flatiron stock exceeds its current figure of $120. However, the maximum bonus that she can receive is set at $2 million. The value of each ticket then rises by $1 for each dollar rise in the stock price up to the maximum of $2,000,000/50,000 = $40. Top figure shows the payoffs from just one of these tickets. It is possible to find a combination of options that exactly replicates top figure. The answer is in bottom figure. The solid black line represents the purchase of a call option with an exercise price of $120, and the dotted line shows the sale of another call option with an exercise price of $160. The colored line shows the payoffs from a combination of the purchase and the sale—exactly the same as the payoffs from one of Ms. Higden's tickets.



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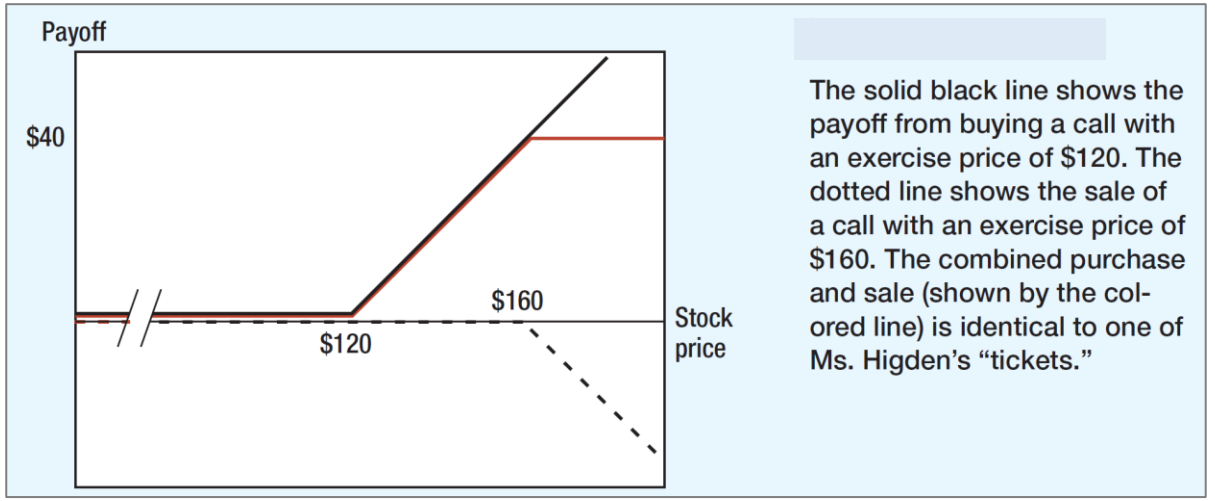
Financial engineering

Thus, if we wish to know how much the incentive scheme is costing the company, we need to calculate the difference between the value of 50,000 call options with an exercise price of $120 and the value of 50,000 calls with an exercise price of $160. The value of these options equals the amount Ms. Higden will receive.

We can state a general theorem: Any set of contingent payoffs—that is, payoffs that depend on the value of some other asset— can be constructed with a mixture of simple options on that asset. In other words, you can create any position diagram—with as many ups and downs or peaks and valleys —by buying or selling the right combinations of puts and calls with different exercise prices.

Finance pros often talk about **financial engineering**, which is the practice of packaging different investments to create new tailor-made instruments.



Perhaps a German company would like to set a minimum and maximum cost at which it can buy dollars in six-months' time. Or perhaps an oil company would like to pay a lower rate of interest on its debt if the price of oil falls. Options provide the building blocks that financial engineers use to create these interesting payoff structures.

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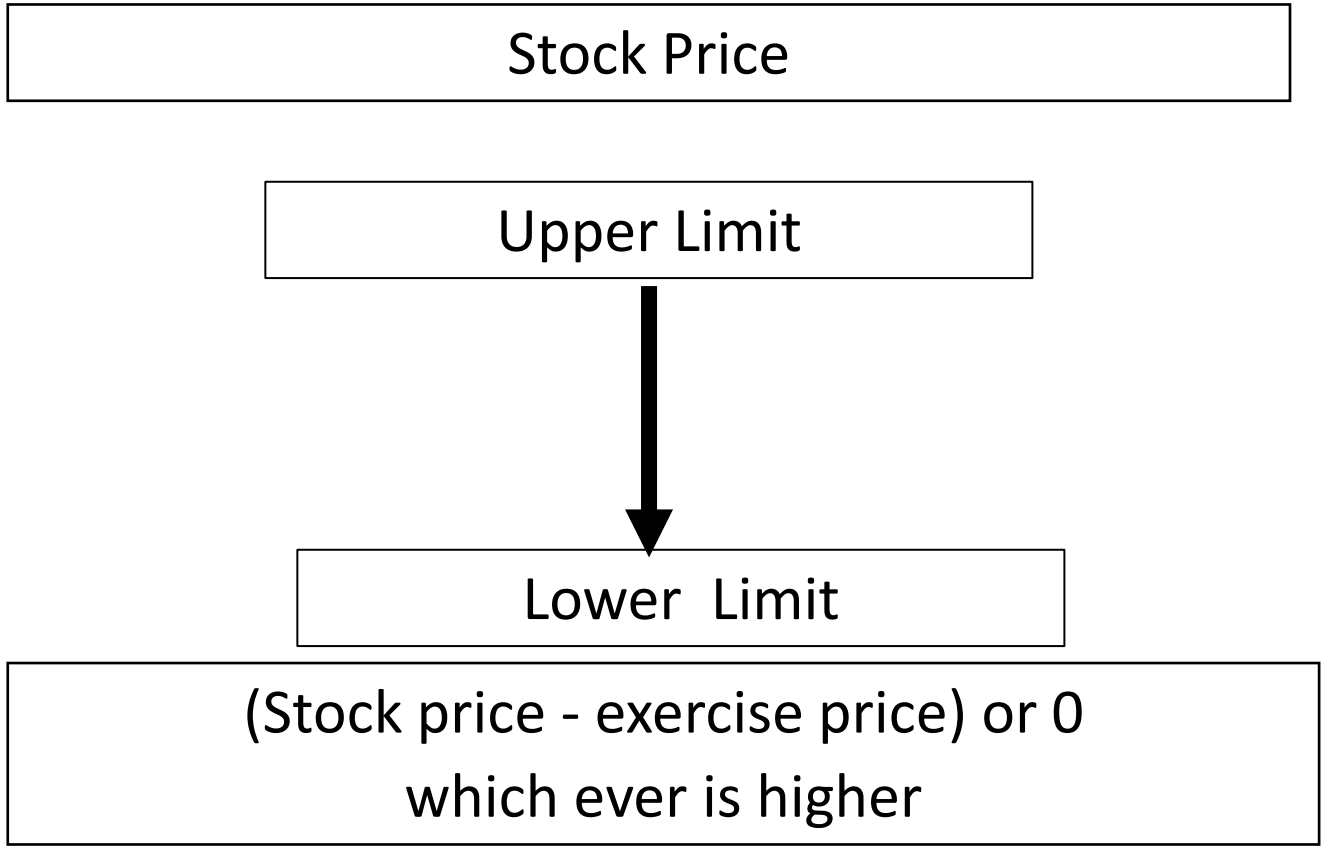
Option value

If at the call option's expiration the stock price ends up above the exercise price, the call option is worth the *stock price less the exercise price*.

If the stock price ends up below the exercise price, the call option is *worthless*.



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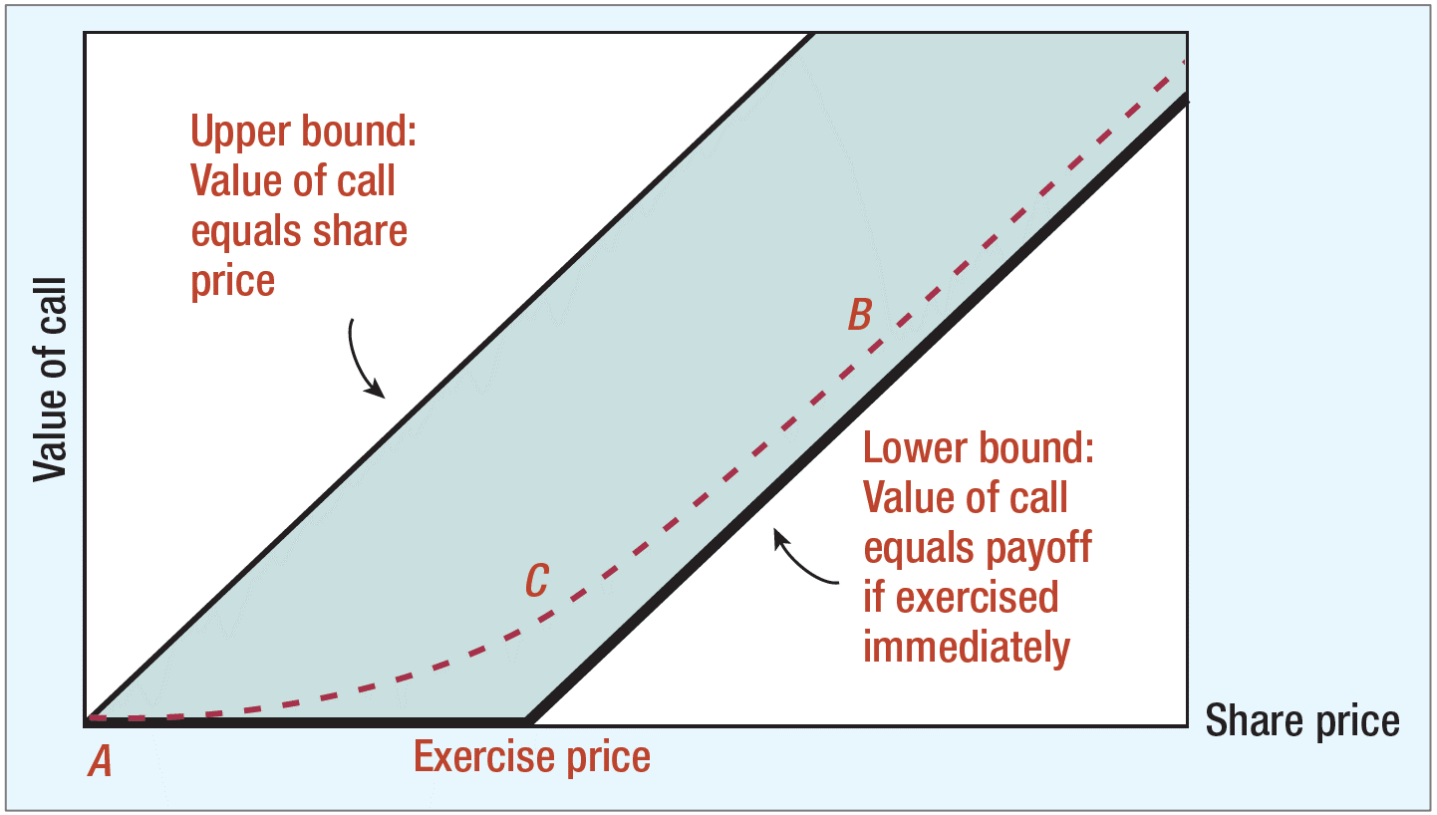
Option value

Point A: When the stock is worthless, the option is worthless.

The value of an option increases as stock price increases, if the exercise price is held constant

Point B: When the stock price becomes large, the option price approaches the stock price less the present value of the exercise price.

The value of an option increases with both the rate of interest and the time to maturity.



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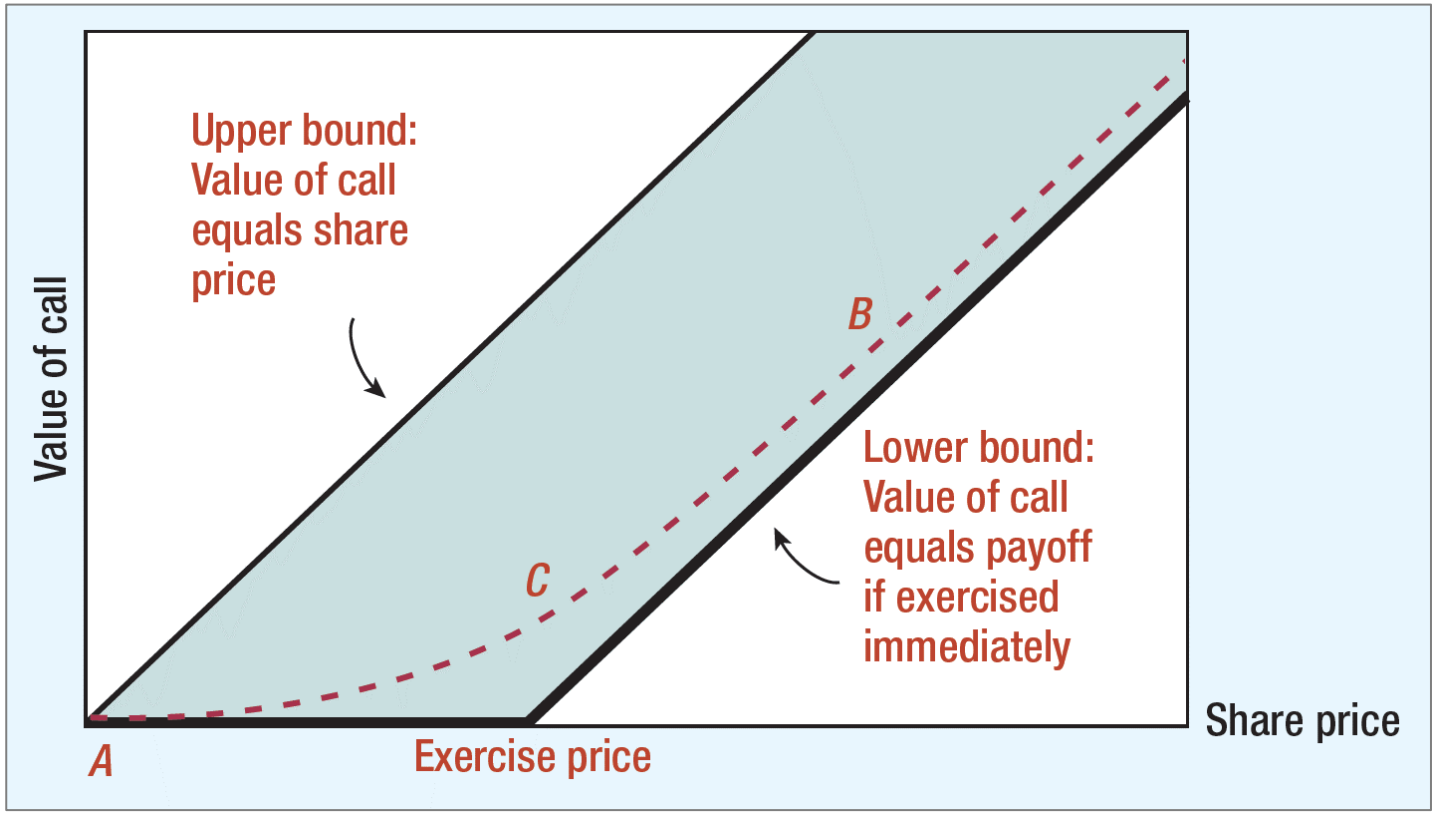
Option value

Point C: The option price always exceeds its minimum value (except when stock price is zero).

At point C, the stock price exactly equals the exercise price. The option is therefore worthless if exercised today.

However, suppose that the option will not expire until three months hence. Of course we do not know what the stock price will be at the expiration date.



There is roughly a 50% chance that it will be higher than the exercise price and a 50% chance that it will be lower.

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Option value with volatility

The possible payoffs to the option are at right table.

Outcome	Payoff
Stock price rises (50% probability)	Stock price less exercise price (option is exercised)
Stock price falls (50% probability)	Zero (option expires worthless)

If there is a positive probability of a positive payoff, and if the worst payoff is zero, then the option must be valuable. That means the option price at point C exceeds its lower bound, which at point C is zero.

An option on a stock whose price is unlikely to change by more than 1% or 2% is not worth much; an option on a stock whose price may halve or double is very valuable.

As an option holder, you gain from volatility because the payoffs are not symmetric. If the stock price falls below the exercise price, your call option will be worthless. On the other hand, for every dollar that the stock price rises above the exercise price, your call will be worth an extra dollar. Therefore, the option holder gains from the increased volatility on the upside, but does not lose on the downside.

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Option value with volatility

A simple example may help to explain. Consider two stocks, X and Y, each of which is priced at $100. The only difference is that the outlook for Y is much less easy to predict.

	Stock Price Falls	Stock Price Rises
Payoff from option on X	$0	$130 – $100 = $30
Payoff from option on Y	$0	$150 – $100 = $50

There is a 50% chance that the price of Y will rise to $150 and a similar chance that it will fall to $70. By contrast, there is a 50-50 chance that the price of X will either rise to $130 or fall to $90. Suppose that you are offered a call option on each of these stocks with an exercise price of $100. The above table compares the possible payoffs from these options.

In both cases there is a 50% chance that the stock price will decline and make the option worthless but, if the stock price rises, the option on Y will give the larger payoff. Since the chance of a zero payoff is the same, the option on Y is worth more than the option on X.

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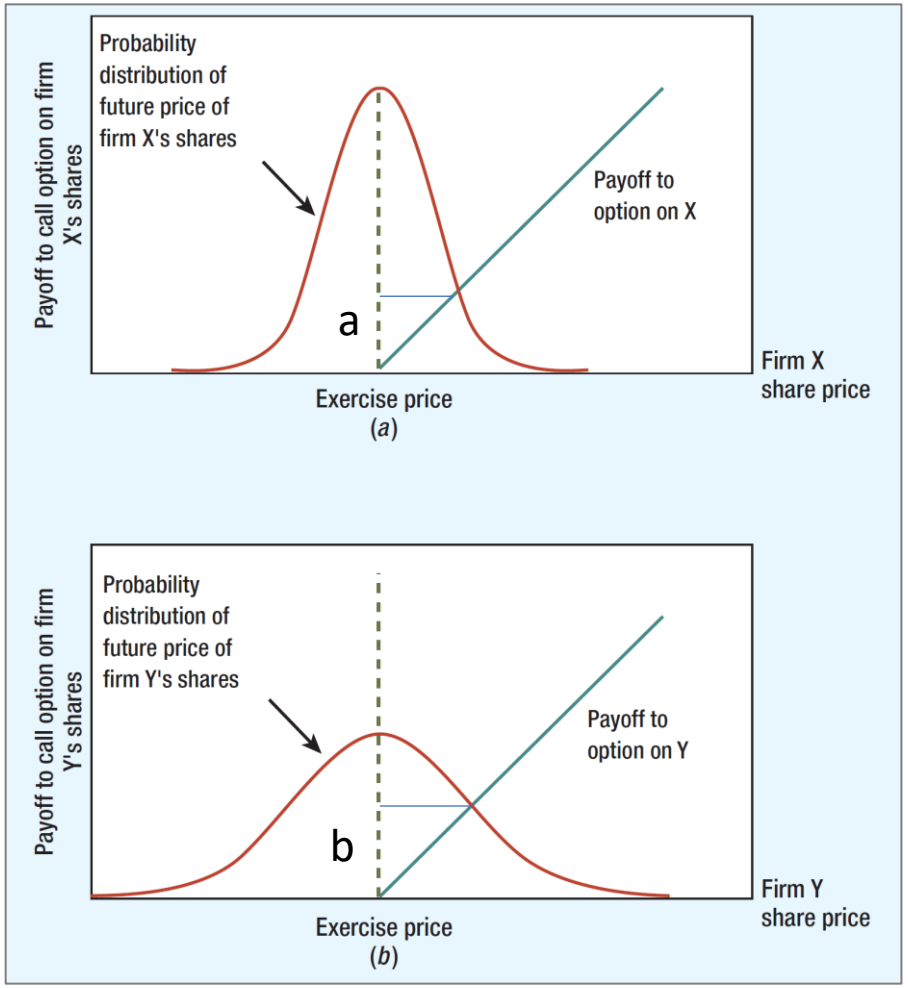
Option value with volatility

At right figure, the greater spread of outcomes for stock Y (higher volatility) than for stock X, again provides more upside potential and therefore increases the chance of a large payoff on the option (**b > a**).

In each case, the current share price equals the exercise price, so each option has a 50% chance of ending up worthless (if the share price falls) and a 50% chance of having value (if the share price rises).

However, the chance of a large payoff is greater for the option on firm Y's shares because Y's stock price is more volatile and therefore has more upside potential.



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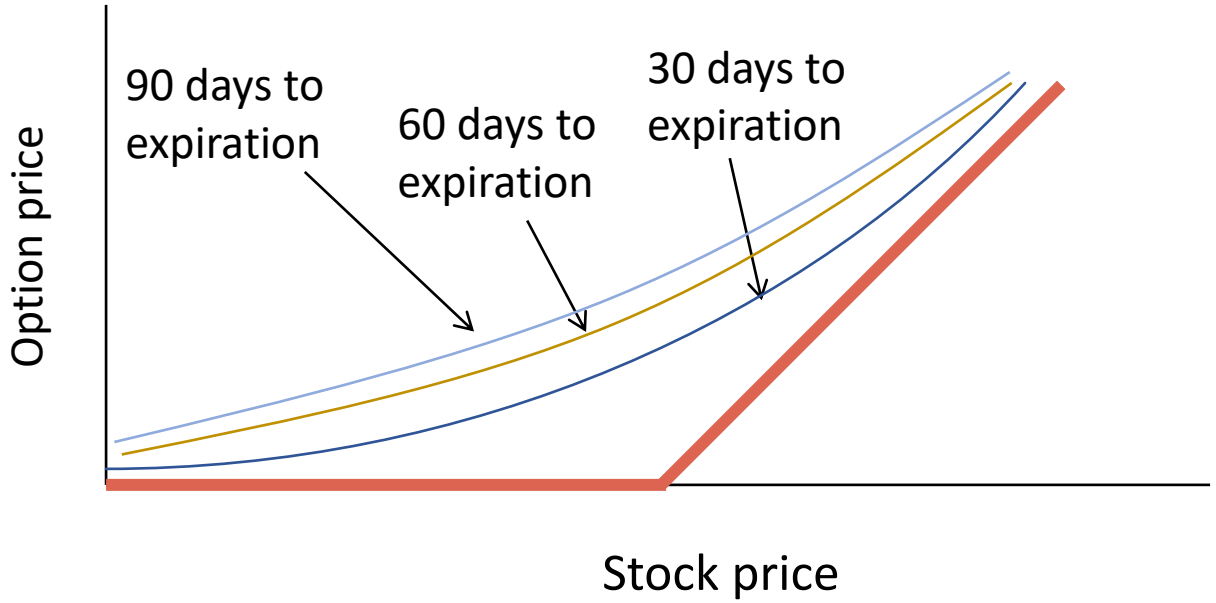
Option value with time to expiration

Option prices decline, *ceteris paribus*, when the time to expiration (i.e. maturity) declines.



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Option value

In most financial settings, risk is a bad thing; you have to be paid to bear it. Investors in risky (high-beta) stocks demand higher expected rates of return. High-risk capital investment projects have correspondingly high costs of capital and have to beat higher hurdle rates to achieve positive NPV. For options it's the other way around. As we have just seen, options written on volatile assets are worth more than options written on safe assets.

Components of the Option Price	Call	Put
1 - Underlying stock price = P_s	+	-
2 - Striking or exercise price = S	-	+
3 - Volatility of the stock returns (standard deviation of annual returns) = v	+	+
4 - Time to option expiration = t = days/365	+	+
5 - Time value of money (discount rate) = r	+	-

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